Advancing Agricultural Economics in Production, Marketing and Resource Economics

Festschrift

IN HONOUR OF

PROF. SYLVANUS OBI ABANG

EDITED BY:

Prof. I. C. Idiong
Prof. S. B. Ohen
Dr. E. A. Etuk
Dr. E. A. Ajah
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PREFACE

Agriculture remains the backbone of the Nigerian economy, serving as the largest employer of labor and a critical buffer against oil price volatility. Recently, the sector has stood at a crossroads; while it has shown remarkable resilience and growth over the past year, it continues to face systemic threats that could undermine food security if left unaddressed.

According to the National Bureau of Statistics (NBS), the agricultural sector has seen a significant boost in both its nominal and real contributions to the economy. In 2025, agriculture contributed 27.55% to Nigeria’s aggregate GDP. The sector’s turnover reached ₦101.46 trillion, a steady climb from ₦96.46 trillion in 2024. Real growth rose to 2.92% annually, with specific sub-sectors showing growth as high as 4.00%. Crop production remains the heavyweight, accounting for nearly 65% of the sector's value, followed by livestock, forestry, and fishing. Notably, livestock is showing renewed potential due to recent ranching reforms.

Despite this GDP growth, several factors continue to pressure the sector. These include: Insecurity: Banditry and herder-farmer conflicts in the North-Central and North-West "food basket" regions continue to force farmers to abandon their lands. Input Costs: The prices of fertilizers, pesticides, and diesel remain high, leaving many farmers struggling to break even despite higher yields. Post-Harvest Losses: Approximately 40% of food produced in Nigeria is wasted due to poor storage and inadequate rural road networks. In 2025 alone, tomato farmers lost roughly ₦2 billion to spoilage. Climate Change: Unpredictable flooding (such as the 2025 Mokwa floods) and shifting rainfall patterns continue to disrupt planting cycles.

The government’s "Renewed Hope" agenda for 2026 focuses on shifting from emergency fixes to structural transformation through initiatives such as the National Digital Farmers Registry, Mechanization Hubs, Wheat Sovereignty, and Recapitalization. To transition from a 27% GDP contribution to a dominant, export-oriented sector, Nigeria must prioritize a Security-First Approach as agricultural growth is impossible without rural safety and Infrastructure/Cold Chain Investment to curb food rot.

The title of this Festschrift, *"Advancing Agricultural Economics in Production, Marketing and Resource Economics,"* reflects the application of economic theories, quantitative techniques, and management principles to optimize the efficiency, sustainability, and profitability of the food and fiber supply chain. It focuses on allocating scarce resources (land, labor, and capital) effectively while analyzing market dynamics to ensure food security.

This book is an assemblage of empirical and inspiring position papers dealing with contemporary issues in Nigerian agriculture. It explores how the nation's resources can be harnessed to advance agricultural economics through production, marketing, and resource management. Specifically, the volume focuses on agribusiness financing, environmental management, livelihood enhancement through value chains, and policies capable of driving efficient resource mobilization.

The book contains a number of articles, including a key note address and a lead paper that address topical issues in agriculture and the environment. Each paper was subjected to rigorous peer review to ensure a qualitative academic output that meets the needs of our readers.

This Festschrift is published by the Department of Agricultural Economics, University of Calabar, in honor of an academic titan, Professor Sylvanus Obi Abang, for his invaluable contributions to the field of Agricultural Economics in Nigeria and beyond. He is a foremost academic leader and mentor whose guidance has strengthened the foundation and mandate of this Department. It is hoped that this book will serve as an essential resource for farmers, students, academics, policymakers, and all stakeholders in the agricultural sector.

Assoc. Professor E. A. Ajah
Ag. Head, Department of Agricultural Economics
University of Calabar, Calabar.

FOREWORD

It is with great honour and profound respect that this Festschrift is presented in celebration of the distinguished academic career and enduring legacy of Professor Sylvanus Abang, a pioneer of Agricultural Economics, University of Calabar and a respected scholar in production, marketing and resource economics.

Professor Abang's scholarly contributions have played an important role in shaping the development of Agricultural Economics within the University of Calabar and the wider Nigerian academic community. Through his research, teaching and mentorship, he has contributed significantly to advancing knowledge in agricultural production systems, marketing structures, and the efficient use of agricultural resources. His work has consistently reflected the application of sound economic reasoning to the challenges of agricultural development, thereby strengthening both academic inquiry and practical policy understanding.

Beyond his scholarly achievements, Professor Abang has been an exceptional teacher and mentor whose influence extends across generations of students and colleagues. Many of those who have benefited from his guidance now serve in universities, research institutions, government agencies and development organizations, continuing the intellectual tradition of excellence that he helped establish.

This Festschrift brings together contributions from scholars and professionals whose work reflects the intellectual breadth of the discipline and the enduring relevance of Professor Abang's scholarship. The articles address contemporary issues in agricultural production, marketing systems, agribusiness development, food security, climate change, rural livelihoods and the evolving institutional frameworks that shape agricultural transformation.

Together, these contributions highlight the continuing importance of Agricultural Economics in addressing the complex challenges facing modern agricultural systems. They also underscore the lasting influence of Professor Abang's work in guiding research, teaching and policy discourse in the field.

On behalf of the Planning Committee, I wish to express sincere appreciation to all the contributors whose scholarly efforts have made this commemorative volume possible. Their participation reflects the deep respect and admiration that Professor Abang commands within the academic community.

It is our hope that this Festschrift will stand as a fitting tribute to a distinguished scholar whose contributions have enriched the discipline of Agricultural Economics and whose legacy will continue to inspire future generations.

Prof. Susana Ohen
Chairman, Festschrift Planning Committee

PROFILE OF PROFESSOR SYLVANUS OBI ABANG

Professor Sylvanus Obi Abang is an erudite Agricultural Economist whose life has been a testament to the power of scholarship and service. Born on September 5, 1953, in Bendeghe Ekiem, Cross River State, Nigeria, seven years before the nation's independence.

Professor Abang has been a divine gift to humanity. His early love for learning led him to St. Gregory Primary School, Agbokim, and later to Mary Knoll Secondary School, Okuku, where he excelled in his studies, obtaining the West African School Certificate in 1971 and the Higher School Certificate in 1973. Driven by an insatiable thirst for knowledge, he pursued higher education in the United States, earning a B.A. in Economics with a Minor in Business Administration from Central State University, Edmond, Oklahoma, in 1978, and an M.Sc. in Agricultural Economics from Oklahoma State University in 1980. His academic journey culminated in a PhD in Agricultural Economics, specializing in Production Economics and Marketing, from Oklahoma State University in May 1984.

Upon returning to Nigeria, Professor Abang joined the Department of Agricultural Economics and Extension at the University of Calabar, where he ascended to the rank of Professor on October 1, 2005. His prolific academic career is marked by over 80 publications in reputable local and international journals. His contributions extend beyond academia, having held numerous administrative positions at both the University of Calabar and the Cross River State University of Technology (now University of Cross River State, UNICROSS). He has served as Chairman of the Committee of Deans, Dean at both institutions, Deputy Provost, and Head of Department, among other roles. His leadership has been instrumental in various committees, including the Quality Assurance Committee and the Anti-Corruption and Transparency Unit at the University of Calabar.

A mentor to countless scholars and professionals, Professor Abang has played a pivotal role in the development of Agricultural Economics in Nigeria and beyond. His influence is so profound that it is said that no Agricultural Economics graduate in the former Southeastern State (now Cross River and Akwa Ibom States) has not been directly or indirectly taught by him. In addition to his academic achievements, Professor Abang is a seasoned agripreneur, managing a 40-hectare oil palm plantation and a 20-hectare cocoa plantation. His vision is to provide selfless services that create positive global change, a goal he continues to pursue with unwavering dedication.

Professor Sylvanus Obi Abang is a Fellow of the Farm Management Association of Nigeria (FAMAN) and the Nigerian Association of Agricultural Economist.

In addition to his remarkable academic and professional achievements, Professor Sylvanus Obi Abang is a devout Christian, whose faith is central to his life. He is happily married, and together with his wife, they have been blessed with children and grandchildren, forming a close-knit and loving family. His commitment to his faith and family complements his dedication to his work, making him a well-rounded and inspiring figure in both his personal and professional life

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By

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Central Bank of Nigeria

Delivered at the Festschrift in Honour of
Professor Sylvanus Obi Abang by the Department of Agricultural Economics, University of Calabar, Senate Chambers, University of Calabar, Calabar

March 17, 2026

1. Opening Remarks

It is a profound honour and privilege for me to stand here today as the Lead Presenter at this Festschrift in honour of Professor Sylvanus Obi Abang, a distinguished and retiring professor of the Department of Agricultural Economics, University of Calabar.

This is a man whose intellectual influence and mentorship have shaped not only a discipline but the lives and careers of many of us gathered here today. For me, this moment is not merely ceremonial; it is deeply reflective and personal.

The University of Calabar occupies a special place in my life. I graduated in 1998 with a Bachelor's degree in Agricultural Economics & Extension, and later obtained a Master's degree in Agricultural Economics in 2004 from this great Department. Like many of my colleagues in this room today, Professor Abang taught me both at the undergraduate and graduate levels.

Indeed, when I look around this hall, I can see many of the beneficiaries of his mentorship. This includes members of the organising committee of this event, Professor Ohen, Dr. Ajah, and others such as Professor Idiong, Dr. Etuk, Dr. Asuquo and many others. Each of us represent a living testament to the quiet but powerful influence of a great teacher who shaped not only our intellectual development, but also the trajectory of our professional lives.

Distinguished guests, today's gathering is therefore more than a celebration of retirement. It is a celebration of a life of scholarship, mentorship, and intellectual leadership.

I have been invited to deliver a keynote address that reflects on contemporary issues and future directions in agricultural economics, while situating these within the pioneering contributions and enduring impact of Professor Abang's work.

For those of us who know him, his scholarship has spanned several core areas of the discipline including agricultural production, marketing, farm management, and resource economics. These are not merely academic domains; they are areas that lie at the heart of humanity's most fundamental challenge: how to sustainably produce, distribute, and govern the food systems upon which our societies depend.

But before I proceed to discuss the evolving landscape of agricultural economics, please permit me to begin on a more personal note.

2. A Personal Reflection

I accepted the invitation to speak at this Festschrift with a deep sense of gratitude and obligation. This is because Professor Abang has had a profound impact on my life and on the lives of many individuals gathered here today.

Like I had mention earlier on, he taught me at both the undergraduate and master's levels. Yet his most profound influence on my life came shortly after I completed my studies.

After graduating with a Second Class Upper Division from the then Department of Agricultural Economics & Extension and completion of the mandatory National Youth Service Corps programme, I returned to the University of Calabar in early 2000 seeking employment as a Graduate Assistant.

At that time, Professor Abang served as the Head of the Department of Agricultural Economics & Extension, so I had the privilege of routing my application through him.

He annotated my application with a remark that has stayed with me for over two and half decades. He wrote:

"This candidate graduated in the upper 2.5 per cent of his class. He would be very useful if we employed him."

That simple but powerful endorsement changed the trajectory of my life.

Barely a month later, I received my appointment letter as a Graduate Assistant. That opportunity marked the beginning of an academic career that lasted almost fourteen years, before I later joined the Central Bank of Nigeria.

When I reflect on that moment today, I am reminded that the true legacy of great academics is not merely the number of publications they produce, but the number of lives they shape. Many of such lives are everywhere across Nigeria and beyond, making this great institution proud. In that regard, Professor Abang's legacy is immeasurable.

3. Professor Abang's Legacy and the Changing Landscape of Agricultural Economics

Professor Abang belongs to a generation of scholars who laid the intellectual foundations of Agricultural Economics in the University of Calabar and Nigeria, in general.

After completing his undergraduate and postgraduate training in the United States of America around the mid-1980s, he returned to Nigeria and dedicated more than four decades of service to teaching, research, mentorship, and community development.

His work cuts across critical areas of the discipline: namely agricultural production economics, farm management, agricultural marketing, as well as resource & environmental economics. These areas were not merely academic interests, they addressed real problems facing farmers, markets and rural communities.

Through his research, teaching and supervision of numerous graduate students, in the course of his academic career, Professor Abang helped shape the analytical foundations of agricultural economics and rural development in Nigeria.

When Professor Abang and many of our senior scholars began their careers, agricultural economics was largely focused on farm-level production analysis. Scholars examined how farmers allocated scarce resources of land, labour, capital, and technology, to maximize output and efficiency. The analytical tools of the discipline revolved around production functions, cost curves, resource allocation models, and farm management strategies. This period laid the intellectual foundations of the discipline.

Today, the scope of agricultural economics has expanded tremendously, as global economic systems evolved. This is because agriculture could no longer be understood solely at the level of individual farms. It had to be analysed within broader market systems, institutional frameworks, and policy environments.

To this end, the discipline now sits at the centre of some of the most pressing global challenges, which include:

i. Food security for a rapidly growing global population;

ii. Climate change and Sustainable resource management; and
iii. Technological transformation of production systems.

Thus, agricultural economics is no longer only about farms; it is about entire food systems. These changing dynamics are redefining the role of agricultural economists in profound ways.

Distinguished ladies and gentlemen, let us now shed some light on some of the emerging and contemporary issues vis-à-vis the role of modern-day agricultural economists.

Food Security

As the global population moves toward nearly **10** billion people by 2050, the central challenge confronting humanity is not merely producing more food, but producing it efficiently, sustainably, and equitably.

Agricultural economics serves as the bridge between food production, economic policy, and human welfare, ensuring that the challenge of feeding a growing population is met through informed decision-making, sustainable resource management, and inclusive agricultural transformation.

This transformation incorporates productivity enhancement, market integration and value chain development, access to finance and productive resources, institutional and policy support, social inclusion and equity, as well as environmental sustainability.

Climate Change

Climate change is perhaps the most defining challenge facing agriculture today. Extreme weather events, shifting rainfall patterns, rising temperatures, and land degradation are already affecting agricultural productivity across many parts of the world.

For countries like Nigeria, where agriculture remains a major source of livelihoods and food supply, these challenges are particularly acute. Agricultural economists, therefore, have an increasingly important role to play in designing policies and institutional frameworks that promote climate-resilient agriculture. Research in this regard should include:

i. climate-smart agricultural technologies;
ii. risk management instruments for farmers;
iii. sustainable land-use practices; and
iv. carbon markets and environmental incentives.

These issues represent a major frontier for the discipline, necessitating an evolution from studying agriculture as an economic sector to shaping agriculture as the foundation of environmental sustainability and human survival.

Digital Transformation of Agriculture

Ladies and gentlemen, we are in an exciting era of technological transformation. Digital technologies are beginning to reshape agriculture globally. Today, farmers can use:

i. artificial intelligence to predict crop diseases;
ii. drones to monitor crop health;
iii. internet of Things sensors to optimise irrigation;
iv. satellite imagery to guide precision agriculture; and
v. mobile platforms to access markets and financial services.

This emerging ecosystem, often referred to as digital agriculture or smart agriculture, has the potential to dramatically increase productivity while reducing environmental impact.

For countries like Nigeria, digital agriculture could help leapfrog traditional constraints and accelerate rural transformation.

Beyond technological transformation, agricultural economists must also engage more deeply with policy and institutional reforms, to address the challenge of:

I. weak market infrastructure;
II. inadequate rural finance;
III. fragmented value chains;
IV. limited access to technology; and
V. policy inconsistencies.

Addressing these challenges requires robust evidence-based policymaking, an area where agricultural economists have a critical role to play. Indeed, the intersection of research, policy, and practice is where the discipline can make its most meaningful contributions.

Looking ahead, the future of agricultural economics will likely revolve around five major themes: climate-smart agriculture, digital transformation, food system resilience, inclusive value chains, and sustainable resource management.

4. Concluding Remarks

As we reflect on the future of agricultural economics and the challenges that lie ahead, we must also remember that none of us arrived here alone. We stand on the **shoulders of giants:** our teachers, mentors, and pioneers whose scholarship illuminated the path before us and whose influence continues to guide the work we do today.
Today, we honour one such giant.

Professor Sylvanus Abang belongs to a generation of scholars who built the intellectual infrastructure that allows younger scholars to push the frontier today.

For decades, Professor Abang has shaped minds, inspired curiosity, and nurtured generations of agricultural economists who now serve across universities, government, and development institutions. His scholarship in agricultural production, marketing, and resource economics has enriched our discipline, but perhaps even more enduring is the human legacy he leaves behind.

For many of us gathered here today, this celebration is both academic and personal because in one way or another, Professor Abang helped shape the journeys that brought us here today.

To Professor Abang:

Your career has been defined by scholarship, mentorship, and service.

You have taught in classrooms, guided young scholars, and contributed to a discipline that holds the key to one of humanity's most fundamental challenges: feeding the world sustainably.

But perhaps your greatest achievement is that you did not merely teach agricultural economics, you cultivated people. And like the best farmers, you planted seeds that will continue to grow long after today.

So, as we celebrate you today, we do so with gratitude, admiration, and pride.

Through the generations of students, you have inspired, your influence will travel far beyond this university, far beyond this country, and far beyond this generation.

For that, we thank you.

Thank you all for your kind attention.

AGRICULTURAL ECONOMICS EVOLUTION: THE PAST, THE PRESENT AND THE FUTURE

Lead Paper by

Damian Ila Agom

Preamble

A Festschrift paper is a collection of essays or articles written in honour of a respected scholar or academic, typically on the occasion of their retirement, birthday, or other significant milestone. Today we honour a distinguished academic, a renowned professor in person of Professor Sylvanus Obi Abang. I join the well-wishers, students, colleagues, contemporaries, advocates, supporters, admirers, mentees and the general public to honour a man I met in 1985 as a very fresh PhD holder from America (Oklahoma State University). He was about the only Agricultural Economist in the Faculty of Agriculture and had to design and teach all of the courses at that time. I have followed this man for 41 years now since 1985 when I met him as a young, handsome, dynamic, fresh, hardworking and determined to excel scholar. He exhibited at that time youthfulness and strength, fighting for various battles within and outside the university system, he was indeed at that time a fighter. As the years went by, I observed a more mature, more focused, more sympathetic and fatherly lecturer with a calmer and more strategic and better intentional personality. These features got better and made him to gather more friends and mentees and children unto himself in the later part of his career, this has culminated to this celebration today.

As a person, I have enjoyed all kinds of relationship with Professor S.O. Abang: He has been to me at different times a teacher, father, employer, colleague, friend, associate, adviser, supervisor, boss, director and partner in business. During my tenure as the Head, Department of Agricultural Economics and Extension at Akwa Ibom State University, I invited Professor S. O. Abang to be the first External Examiner to the first set of Final Year Students of the Department.

1.0 Introduction

Distinguished colleagues, it is both an honour and a considerable responsibility to address this forum to honour a scholar in field of agricultural economics. We gather at a moment of profound transformation, not merely in the markets we study or the policies we analyze, but in the very fabric of our discipline. The questions that animated our predecessors remain relevant: How do farmers respond to price signals? What policies best ensure food security? How can rural livelihoods be improved? Yet the analytical toolkit we bring to these questions, the institutional contexts in which they arise, and indeed the boundaries of our disciplinary territory have shifted dramatically.

Agricultural economics has always been a field defined by its applied nature, drawing on economic theory to solve practical problems in food and fibre production. As one observer recently noted, "agriculture is a large universe, and all disciplines are related to it". This intellectual permeability has been our strength, allowing us to absorb insights from development economics, industrial organization, environmental science and most recently, computer science. But it also presents challenges of identity and coherence. What holds agricultural economics together as a discipline? Where do we draw the boundaries between agricultural economics, agribusiness and the emerging fields that cluster around the food system? And how should we prepare the next generation of scholars for a world where artificial intelligence increasingly mediates the relationship between data and decision-making?

This paper attempts to address these questions through three interwoven narratives. First, I trace the historical evolution of agricultural economics and its offshoots, particularly agribusiness, to understand how we arrived at our current configuration. Second, I examine the contemporary landscape, focusing on the integration of artificial intelligence into agricultural economic analysis and the empirical evidence for its effects on productivity and resilience. Third, I look forward to speculating with appropriate caution on the departments and subfields that may emerge in the coming decades and the implications for how we train students, conduct research and engage with policy.

Throughout, I maintain that agricultural economics possesses a distinctive character that warrants its continued existence as a separate field: our commitment to understanding entire systems rather than isolated markets, our comfort with the messy realities of biological production and rural institutions and our normative orientation toward improving outcomes for farmers and consumers alike. These characteristics become more valuable, not less, as artificial intelligence transforms the research landscape.

2.0 The Evolution of Agricultural Economics: From Farm Management to Food Systems

The origins of agricultural economics lie in the practical concerns of farm management. In the early twentieth century, scholars at land-grant universities in the United States and their counterparts in Europe sought to systematize the knowledge that successful farmers possessed intuitively. They collected farm records, analysed costs of production and developed budgeting techniques to help farmers make better decisions. This was economics with a practical purpose, grounded in detailed observation of agricultural practices.

The institutionalization of the discipline followed rapidly. The American Farm Economic Association (now the Agricultural and Applied Economics Association) was founded in 1910 and the *Journal of Farm Economics* (now the *American Journal of Agricultural Economics*) began publication in 1919. Similar developments occurred across Europe, with the establishment of agricultural economics institutes in Germany, the United Kingdom and elsewhere. The intellectual orientation of this period was predominantly microeconomic, focused on the farm as the unit of analysis and on improving productive efficiency.

The decades following the Second World War saw a remarkable expansion in the scope and ambition of agricultural economics. Three developments merit particular attention. First, the emergence of development economics as a distinct field created new opportunities for agricultural economists to engage with questions of poverty, food security, and structural transformation in low-income countries. Agricultural economists found themselves at the centre of policy debates about land reform, agricultural pricing and rural development, contributing both theoretical insights and empirical evidence from field studies.

Second, the growing complexity of agricultural markets stimulated new research on price analysis, demand estimation, and marketing. The development of sophisticated econometric methods allowed agricultural economists to analyze supply and demand relationships with unprecedented precision, informing policy decisions on price supports, trade liberalization, and market regulation.

Third, the recognition that agriculture could not be understood in isolation from the industries that supplied its inputs and processed its outputs led to the articulation of the "agribusiness" concept. John Davis and Ray Goldberg at Harvard Business School popularized this term in the 1950s, defining agribusiness as "the sum total of all operations involved in the production and distribution of food and fibre". This formulation explicitly recognized the interdependence of farm production with upstream and downstream activities, laying the groundwork for subsequent research on vertical coordination, supply chains, and food system organization. This has led to the development of the area of specialization called Agribusiness

3.0 The Contemporary Landscape: Agricultural Economics in the 2020s

Alongside these policy developments, the data environment for agricultural economic research has been transformed. Where earlier generations of researchers struggled to obtain even basic price and production data, we now confront an abundance of information that would have seemed unimaginable a few decades ago. Satellite imagery provides high-resolution data on crop conditions, land use, and environmental outcomes. Transaction-level data from supply chain participants reveals patterns of trade, pricing, and market power. Remote sensing, automated weather stations, and Internet of Things devices generate continuous streams of information on growing conditions and input use.

This data abundance creates new possibilities for empirical research. We can estimate treatment effects more precisely, control for confounding factors more thoroughly, and test theoretical predictions against richer evidence. But it also presents challenges. The sheer volume of data exceeds the capacity of traditional statistical methods, requiring new approaches to dimension reduction, pattern recognition, and causal inference. The granularity of data raises questions about privacy, confidentiality, and the ethical use of information. The commercial sources of much new data create potential conflicts between research transparency and proprietary interests.

4.0 Artificial Intelligence: Transforming Analysis and Research

It is impossible to discuss the current state and future trajectory of agricultural economics without addressing the most transformative development in our research environment: the integration of artificial intelligence into economic analysis. Artificial intelligence is not merely a new tool that we can add to our existing toolkit while continuing business as usual. It represents a fundamental shift in how we process information, generate hypotheses, and engage with the subjects of our research.

The term "artificial intelligence" encompasses a diverse set of technologies with varying implications for agricultural economics. Machine learning algorithms excel at prediction tasks, identifying patterns in high-dimensional data that traditional econometric methods would miss. Natural language processing allows us to extract information from text sources such as policy documents, news reports and social media at unprecedented scale and speed. Computer vision techniques can analyze satellite imagery, drone photographs and video data to measure agricultural outcomes directly. Large language models, the most recent addition to this portfolio, offer new possibilities for simulation, explanation and research assistance.

5.0 Methodological Pluralism and its Discontents

The integration of artificial intelligence into agricultural economics research raises important questions about methodology, training and disciplinary identity. Some colleagues express concern that the emphasis on prediction and pattern recognition will displace the theoretical reasoning and causal inference that have traditionally defined economic analysis. Others worry that the technical demands of AI methods will create new barriers to entry, excluding researchers without access to computational resources or specialised training. Still others question whether AI-generated insights truly advance understanding or merely rediscover known relationships in larger datasets.

These concerns deserve serious attention. Prediction is not explanation, and pattern recognition is not causal inference. The impressive performance of machine learning algorithms in forecasting tasks does not imply that they provide reliable guidance for policy decisions, which require understanding of underlying mechanisms and counterfactual outcomes. The "black box" nature of many AI methods creates obvious tensions with the scientific value of transparency and replicability.

Yet the appropriate response to these concerns is engagement rather than avoidance. Agricultural economists have much to contribute to the development and application of AI methods in our domain. Our substantive knowledge of agricultural systems, our experience with messy real-world data, and our commitment to policy-relevant research position us well to guide AI applications toward meaningful questions and to interpret their results in light of institutional and behavioural realities. The goal should be methodological pluralism, that is drawing on the full range of analytical tools while maintaining clear standards for what constitutes credible evidence and valid inference.

6.0 Digital Agriculture and Technology Adoption

The diffusion of digital technologies in agriculture creates opportunities for research on technology adoption, digital divides, and the impacts of technological change on productivity and distribution. Departments focused on "Digital Agriculture Economics" or "Agricultural Innovation Systems" would examine how farmers, firms, and other actors adopt and adapt new technologies, how digital infrastructure affects agricultural outcomes and how policy can support beneficial innovation while managing risks.

Key research questions include: What factors determine the adoption of precision agriculture technologies and how do adoption patterns affect productivity and environmental outcomes? How do digital platforms change market access for smallholder farmers? What are the implications of automated machinery and artificial intelligence for agricultural labour markets? How can data governance frameworks protect farmer interests while enabling innovation?

7.0 Policy Analysis and Institutional Design

Despite the growth of specialized subfields, the core mission of agricultural economics; informing policy with rigorous analysis will remain central. Future departments will continue to train students in policy analysis, regulatory economics, and institutional design, preparing them for careers in government, international organizations, and research institutes.

The policy agenda will evolve to address new challenges. Climate change adaptation and mitigation will demand increasing attention, as agricultural systems both contribute to and are affected by global environmental change. Food system resilience; the capacity to withstand and recover from shocks will remain a priority, informed by recent experiences with pandemics, supply chain disruptions, and geopolitical conflicts. Equity and inclusion will receive greater emphasis, as researchers examine how agricultural policies affect different groups and how institutions can be designed to serve marginalized populations.

8.0 Implications for Training and Professional Development

The evolving landscape of agricultural economics has profound implications for how we train graduate students. The traditional curriculum microeconomic theory, macroeconomic theory, econometric methods and field courses in agricultural economics remains essential. But it is no longer sufficient.

Students need exposure to computational methods and data science, including programming skills, machine learning and working with large-scale datasets. They need training in research design and causal inference that goes beyond textbook econometrics, preparing them to evaluate evidence from diverse sources and methods. They need opportunities to engage with real-world problems and stakeholders, developing the judgement and practical wisdom that complement analytical skills.

Perhaps most importantly, students need help navigating the tension between depth and breadth that characterizes modern agricultural economics. The field has become too large for any individual to master completely. Yet the problems we address are too complex for narrow specialization. Graduate programmes must find ways to provide both rigorous training in core competencies and exposure to the range of approaches and applications that define the discipline.

For those of us already in academic positions, the rapid evolution of methods and problems creates continuous demands for professional development. Keeping abreast current with new analytical tools, substantive literatures, and policy developments requires sustained effort and institutional support. Sabbaticals, workshops, and collaborative research provide opportunities for this renewal and skill acquisition.

Professional associations have important roles to play in supporting lifelong learning. Short courses at annual meetings, online training resources, and mentoring programmes can help members stay current with methodological developments and emerging research areas. Interdisciplinary networks and working groups can foster engagement across traditional boundaries, exposing agricultural economists to insights from related fields.

9.0 Conclusion

Distinguished colleagues, in this discourse, we have covered considerable grounds and perspectives from the historical evolution of our discipline to the transformative potential of artificial intelligence, from the current policy environment to future departmental configurations. Let me conclude by returning to a fundamental question: What is the distinctive contribution of agricultural economics and why does it matter?

Agricultural economics matters because food matters. The production, distribution and consumption of food are among the most basic of human activities, shaping our health, our environment and our societies. Getting food systems right, making them productive, sustainable, equitable and resilient is essential to human flourishing. Agricultural economists bring distinctive competencies to this challenge: understanding of markets and incentives, appreciation of institutional complexity, comfort with biological and environmental systems and commitment to empirical evidence.

Agricultural economics matters because rural people matter. Despite decades of urbanization, a substantial portion of humanity still lives in rural areas and depend on agriculture for livelihoods. Rural communities face distinctive challenges including remoteness, thin markets, environmental vulnerability that require tailored policy responses. Agricultural economists have long been advocates for rural interests and analysts of rural development, ensuring that the needs of rural populations are not forgotten in national and global policy debates.

Agricultural economics matters because the challenges we face demand integration. Climate change, food security, environmental sustainability, rural development are not separate problems but interconnected dimensions of a single challenge: building food systems that can nourish humanity while respecting planetary boundaries. Addressing this challenge requires insights from multiple disciplines and engagement with multiple stakeholders. Agricultural economists, with our tradition of applied, interdisciplinary, policy-relevant research, are well-positioned to contribute to this integration.

The integration of artificial intelligence into our analytical toolkit does not change these fundamental commitments. It provides new ways to pursue them, more powerful methods for analyzing data, richer models of complex systems, new channels for engaging with stakeholders and communicating findings. But the goals remain the same: understanding agricultural systems, improving policy and serving the people who depend on agriculture for their livelihoods and sustenance.

As we look to the future, let us embrace methodological pluralism while maintaining substantive focus. Let us welcome new colleagues from data science, computer science and other fields while preserving what is distinctive about agricultural economics. Let us adapt our departments and curricula to changing circumstances while remaining true to our mission. And let us continue the conversations that have defined this discipline about how markets work, how policies affect outcomes, how institutions shape behaviour and how we can build better food systems for all.

The future of agricultural economics is not predetermined. It will be shaped by the choices we make, individually in our research and teaching, collectively in our departments and professional associations. If we make those choices wisely, drawing on our traditions while embracing innovation, the discipline will thrive, continuing to contribute to knowledge and to the well-being of farmers, consumers and rural communities. That is the opportunity before us, and the responsibility we share.

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AGRICULTURAL EXTENSION AND CLIMATE CHANGE COMMUNICATION IN AKPABUYO LOCAL GOVERNMENT AREA, CROSS RIVER STATE, NIGERIA

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Abstract

This study examined the knowledge, competencies, and constraints of agricultural extension agents in disseminating climate information in Akpabuyo Local Government Area, Cross River State, Nigeria. Findings revealed that a substantial proportion of extension agents were aware of the causes of climate change, with deforestation being the most recognized factor. Social media and television (96%) were the primary sources of climate information, followed by radio (92%) and magazines/newspapers (80%), indicating potential for stronger collaboration with research institutions to access credible data. Extension agents played significant roles in disseminating climate information, including organizing awareness events ($\bar{x}$=4.66), sharing adaptation practices ($\bar{x}$=4.60), and building farmers' capacity ($\bar{x}$=4.34). However, areas such as emergency management units ($\bar{x}$=4.02) and weather forecasting ($\bar{x}$=4.06) required additional training. Competencies were generally strong ($\bar{x}$=4.58), but skills like producing radio/TV programs ($\bar{x}$=3.94) and building partnerships ($\bar{x}$=4.06) needed improvement. Key constraints included limited funding ($\bar{x}$=4.62), poor cooperation ($\bar{x}$=4.54), poverty ($\bar{x}$=4.54), inadequate technical capacity, complex methods ($\bar{x}$=4.50), and traditional farming practices ($\bar{x}$=4.50). Recommendations emphasize specialized training, increased funding, enhanced collaboration, simplified information, and promotion of climate-smart practices to strengthen resilience and food security.

Keywords: Climate information dissemination, Agricultural extension officers, Competencies, Climate-smart agriculture

Introduction

Agriculture stands as a formidable and efficient endeavor, serving as a cornerstone for the provision of sustenance, textiles, energy, and income, forming the bedrock of human existence. Globally, it provides livelihoods for more than 70% of the world's population and it is especially crucial as the primary income source for rural households in developing nations (Ayi, 2022). The economies of numerous sub-Saharan African countries are anchored on agriculture which contributes approximately 15% to the region's Gross Domestic Product (GDP) and offers employment to over 65% of the workforce, thus playing a pivotal role in ensuring food security (Serdeczny et al., 2017). However, agricultural production is persistently threatened by extreme weather events, such as prolonged droughts and devastating floods, which exert adverse impacts on soil fertility and crop productivity. This metamorphosis of climate patterns has precipitated a menacing storm upon food security on a global scale (Olorunfemi et al., 2019). Nigeria notably has borne witness to dwindling rainfall, escalating relative humidity, and surging temperatures, culminating in diminishing crop yields and output (Tajudeen et al., 2022). Consequently, the activities within the agricultural sector have become exceedingly susceptible to climate fluctuations and shifts, reverberating across the entire agricultural value chains. It is firmly believed that climate information is the key to empowering farmers to combat these deleterious effects.

Climate information encompasses the formulation and targeted dissemination of climate data to specific users, constituting an indispensable process in enabling Africa to aptly address the formidable challenges posed by climate change (Opoku et al., 2020). This information is routinely harnessed for planning crop seasons, guiding strategic decisions such as crop variety selection, planting schedules, and irrigation requirements, and underpinning operational choices including precise planting dates based on soil moisture content and irrigation management strategies (Fernández et al., 2020). Consequently, the provision of high-quality climate information services assumes critical importance, empowering decision- makers across diverse sectors such as agriculture, public health, water resources, energy production, disaster risk reduction, and other domains vital for national development (Machingura et al., 2018).

In this intricate ecosystem, the role of agricultural extension assumes paramount significance, as it bears the responsibility of conveying both agricultural and climate information to farmers (Mustapha et al., 2012). Agriculture's resilience is already under duress due to climate change, with projections indicating further exacerbation of these challenges (Malhi et al., 2020). Therefore, the effective dissemination of agricultural information pertinent to climate change is crucial for harnessing the potential of reliable climate data for farmers' benefit. Regardless of the promise encapsulated within climate information, its effectiveness hinges on reaching farmers and becoming actionable (Lucky & Achebe, 2013). As such, agricultural extension agents must be equipped with the competencies necessary for effective climate information dissemination. An effective information dissemination system must adhere to principles of relevance, timeliness, accuracy, cost-effectiveness, reliability, usability, comprehensiveness, and aggregate-level accessibility (Mpandeli et al., 2019). Dimelu (2016) emphasized the importance of the position of extension agents within the organizational hierarchy and their years of experience in extension service delivery as critical factors influencing their knowledge and competency in climate change information dissemination strategies. The position of these agents dictates their job descriptions and their extent of interaction with farmers, necessitating comprehensive training and continuous involvement in extension activities and workshops to sustain their knowledge throughout their service tenure. Additionally, Zikhali (2016) asserted retraining extension agents on the evolving nature and dynamics of climate change. To address the pressing issue of climate change and its implications for agriculture, concerted efforts are requisite at the individual, organizational, and institutional levels to augment the information dissemination capacity of agricultural extension advisory service providers (Ozioko et al., 2022). While several empirical studies have been conducted on climate change in Cross River State, such as Festus et al. (2018) who examined climate and livelihood resource security, Angba et al. (2020) who investigated yam production in response to climate change, and Elijah et al. (2020) that explored yam farmers' adaptation practices, there remains a notable research gap in Akpabuyo Local Government Area. Specifically, limited or no research has been undertaken to assess the competencies of agricultural extension staff regarding climate information dissemination. Consequently, this study aims to address this critical research gap in order to contribute to sound academic knowledge in the field. Specifically, the study sought to: investigate agricultural extension officers' knowledge of causes of climate change; ascertain the role of extension in climate change information dissemination, examine the specific competencies and skills that agricultural extension officers possess for the effective dissemination of climate information; and identify and analyze the constraints faced by agricultural extension officers in their efforts to disseminate climate information.

Methodology

Study Area

The study was carried out in Akpabuyo Local Government Area (LGA). It is situated in the Southern Senatorial District of Cross River State, with its administrative center located in Ikot Nakanda. The primary ethnic groups residing in Akpabuyo are the Efiks, Quas, and Efuts, with the predominant languages spoken being Efik and English (Pidgin). This local government area boasts a population of 271,325 people (National Population Census - NPC, 2006) and it is subdivided into ten distinct council wards, namely: Idundu/Anyananse, Atimbo East, Atimbo West, Ikot Edem Odo, Eneyo, Ikot Nakanda, Ikot Eyo, Ikang North, Ikang South, and Ikang Central. Geographically, Akpabuyo is situated between latitude 4°5' and 5°40' and longitude 8°25' and 8°32' East, and falls within the vegetation belt of Southern Nigeria. It shares its coastline with the Atlantic Ocean to the East, adjacent to Bakassi, and the Republic of Cameroon to the West. Notably, Akpabuyo is well known as Cross River State's agricultural hub, with farming and fishing being the main economic activity in the twenty-eight (28) communities that make up the LGA. Consequently, it is referred to as Cross River State's food basket (Itam et al., 2014). The most significant crops grown in the area are maize, cocoyam, kola nuts, oil palm, and cassava. The production of palm wine, the processing of wild palm fruits, tailoring, welding, trading, and the processing of cassava into garri and fufu for sale are other economic activities (Itam et al., 2014).

Sampling procedure and sample size

A two-stage sampling procedure was used to select respondents for the study. The first stage entailed the use of purposive sampling technique to select the Cross River Agricultural Development Programme (CRADP) to represent the public institution responsible for provision of agricultural advisory services and information dissemination to farmers in the study area. In the second stage, simple random sampling technique was used to select twenty (20) out of twenty six (26) staff of grade level ten and above of CRADP to represent respondents of the study.

Sources of data and instrument for data collection

Data were collected from primary sources through the use of structured questionnaire. The questionnaire was calibrated based on the specific objectives of the study. Content validity of the questionnaire was determined by experienced extension agents in the CRADP state office, as well as lecturers in the Department of Agricultural Extension and Rural Sociology, University of Calabar. A 5-point scale was developed to measure the role of agricultural extension officers for climate information dissemination; competence possessed by extension staff for climate information dissemination; and constraints to climate information dissemination. The scale was calibrated as: Strongly Agreed (SA) = 5, Agreed (A) = 4, Undecided (UD) = 3 Disagreed (D) = 2, Strongly Disagreed (SD) = 1. The study employed descriptive statistics, such as means, frequency counts, and percentages in the analysis of the data.

Results and Discussion

Extension agents' knowledge of causes of climate change

The results on Table 1 show the distribution of extension officers by their knowledge of the causes of climate change. It revealed that Most agents identified deforestation ($\bar{x}$=3.28) as the primary cause, followed by bush burning ($\bar{x}$=2.96), ozone layer depletion ($\bar{x}$=2.96), and gas flaring ($\bar{x}$=2.88). Fewer recognized changes in land cover ($\bar{x}$=2.18) and paddy rice cultivation ($\bar{x}$=2.10), indicating partial knowledge gaps. These findings align with Broyles (2018), who reported that most extension officers recognize both human and natural causes of climate change.

Table 1: Extension officers' knowledge of causes of climate change

Causes of climate change	$\bar{x}$	SD
Bush burning	2.96	0.283
Depletion of ozone layer	2.96	0.283
Gas flaring by industries	2.88	0.480
Continuous cropping	2.32	0.653
Farming of livestock (methane release)	2.34	0.823
Road construction	2.26	0.723
Emissions from volcanoes	2.54	0.762
Changes in land cover	2.18	0.774
Food production	2.30	0.735
Generating electricity	2.62	0.697
Manufacturing of goods	2.46	0.646
Deforestation	3.28	4.347
Combustion of fuel in power plants and automobile agencies	2.78	0.679
Waste decomposition	2.56	0.611
Natural causes (volcanoes)	2.66	0.745
Use of fertilizer	2.72	0.671
Overgrazing	2.56	0.733
Paddy rice cultivation	2.10	0.763
Cement production	2.74	0.664

Source: Field data, 2023

Extension officers' sources of information on climate change

Table 2 shows that significant proportion (96.0%) of extension agents got climate information from social media and television (TV), respectively. This result also shows that most (92.0%) of the extension agents got climate information from the radio, and 80.0% got the information from magazines/ Newspapers. Furthermore, 76.0% of extension agents got climate information from the Agricultural Development Programme (ADP). Only a relatively small proportion (40.0%) of the extension officers got climate information from friends/colleagues. Information from these sources tends to be more reliable and accurate. This is consistent with the research of Antwi-Agyei and Stringer (2021), who found that extension agents in Ghana reported radio and television as their main sources of information about the weather. Consequently, extension specialists and research organizations must collaborate.

Table 2: Sources of information on climate change

Source of information	Frequency	%
Radio		
No	4	8.0
Yes	46	92.0
Social media		
No	2	4.0
Yes	48	96.0
Magazine/newspaper		
No	10	20.0
Yes	40	80.0
Television		
No	2	4.0
Yes	48	96.0
Research/academic institute		
No	16	32.0
Yes	34	68.0
Agricultural development programme		
No	12	24.0
Yes	38	76.0
Non-Governmental Organizations		
No	24	48.0
Yes	26	52.0
Friends/Colleagues		
No	30	60.0
Yes	20	40.0

Source: Field data, 2023

Role of extension in the dissemination of climate information

Results on Table 3 show that extension plays several roles in the dissemination of climate information. Some of the roles identified were: organizing seminars, workshops and field days to raise farmers' awareness of climate change ($\bar{x}$=4.66), disseminating innovations on best practices for climate change adaptation ($\bar{x}$=4.60), providing advisory services to help farmers build resilience and capacity for climate change adaptation ($\bar{x}$=4.48), capacity development of farmers ($\bar{x}$=4.34), facilitating and implementing policies and programme ($\bar{x}$=4.22). These results infer that extension agents in particular play effective and significant roles in mitigating the impact of climate change. It is worth noting that few extension agents admitted to playing the role of setting emergency management units to assist victims of adverse climate events ($\bar{x}$=4.02), providing accurate and timely information in weather forecasts ($\bar{x}$=4.06), initiating the development of adaptation in agricultural technologies for climate change adaptation ($\bar{x}$=4.18). Limited ability by extension personnel to play roles such as setting emergency management units to assist victims of adverse climate events and providing accurate and timely information on weather forecasts is an indication that most of the extension agents have not received training on topical issues on climate change. This finding corresponds with those of Biermann (2007) and Ozor (2009), who noted that the need for more extension services necessitates retraining of staff to improve their knowledge and skills in managing the risk of climate change, particularly in rural areas where a greater proportion of agricultural activities occur.

Table 3: Roles of extension in climate information dissemination

Role of extension in climate information dissemination	$\bar{x}$	SD
Organizing seminars, workshops, and field days to raise farmers' awareness of climate change	4.66	0.479
Disseminating innovations on best practices for climate change adaptation	4.60	0.535

Providing advisory services to help farmers build resilience and capacity for climate change adaptation	4.48	0.677
Initiating the development of adaptation agricultural technologies for climate change adaptation	4.18	0.941
Providing accurate and timely information on weather forecasts	4.06	0.998
Setting emergency management units to assist victims of adverse climate events	4.02	1.020
Facilitating collaboration or linkages with agricultural actors on climate change adaptation	4.10	0.789
Facilitating and implementing policies and programme	4.22	
Capacity development of farmers	4.34	

Source: Field data, 2023

Competencies Possessed by Extension Staff for Climate Information Dissemination

Results on Table 4 revealed that extension agents in the study area possess the ability to use extension teaching/learning methods to train farmers on climate change issues ($\bar{x}$=4.58, rank = 1st), create and raise farmers' awareness on climate change ($\bar{x}$=4.52, rank = 2nd), and had good understanding of climate change ($\bar{x}$=4.46, rank = 3rd). Furthermore, the results shows that extension agents possess adequate knowledge of the causes of climate change and the ability to organize farmers into groups for capacity building ($\bar{x}$=4.44, rank =4th), respectively.

It's important to note that the majority of extension professionals lack expertise on topical climate change issues, as seen by the weakness in forming alliances or networks with other players and their inability to produce radio or television programs on the subject. The majority of extension agents, according to Olorunfemi, Olurunfemi, and Oladele (2020), have not yet received thematic training on climate change;

therefore their participation in disseminating knowledge on the topic may not be as effective as anticipated.

Table 4: Competencies possessed for climate information dissemination

Competences possessed for climate information dissemination	$\bar{x}$	**SD**	**Rank**
Good understanding of climate change	4.46	0.73	3rd
Ability to obtain credible climate change information	4.26	0.89	6th
Possess adequate knowledge of climate change adaptation strategies	4.20	0.93	8th
Ability to identify climate change impacts	4.42	0.67	5th
Possess adequate knowledge of the causes of climate change	4.44	0.64	4th
Incorporate climate programs into the extension mission	4.20	0.90	8th
Ability to identify the target audience for climate information dissemination	4.42	0.70	5th
Ability to tailor climate information to the needs/perceptions of many farmers	4.08	0.99	9th
Ability to give early warning on climate information to farmers	4.22	0.86	7th
Create and raise farmers' awareness on climate change	4.52	0.61	2nd
Ability to use extension teaching/learning methods to train farmers on climate change issues	4.58	0.58	1st
Ability to organize farmers into groups for capacity building	4.44	0.58	4th
Ability to produce and air radio/TV programs on climate change	3.94	0.87	11th
Ability to build partnerships or networks with other actors	4.06	1.02	10th
Ability to assess the rate of adoption of technologies disseminated	4.20	0.95	8th

Source: Field data, 2023

Constraints on Climate Information Dissemination by Extension Officers

Results on Table 5 show the factors mitigating climate information dissemination by extension agents to include lack of funding for Agricultural extension activities ($\bar{x}$=4.62), poor cooperation and collaboration between climate change information providers and users, and the prevalence of poverty, hunger and disease preventing adoption of climate information disseminated ($\bar{x}$=4.54), respectively.

Table 5: Constraints to climate information dissemination

Constraint to climate information dissemination	$\bar{x}$	**SD**	**Rank**
Inability to translate climate information into practical items	4.52	0.74	3rd
Poor cooperation and collaboration between climate change information providers and users	4.54	0.71	2nd
Lack of documentation of climate change information	4.40	0.76	6th
Complexity of method used in disseminating climate change Information	4.36	0.72	7th
Inability of extension agents to interpret scientific climate information (Literacy)	4.50	0.74	4th
Inadequate technical capacity to facilitate training and translating climate information to public and private users	4.34	1.00	8th
Lack of experience to disseminate climate information in an accessible and comprehensible format	4.40	0.70	6th
Lack of confidence and credibility in climate information	4.00	1.01	11th
Denial of the existence of climate change	4.08	1.01	10th
Lack of funding of agricultural extension activities	4.62	0.90	1st

Lack of human capital on climate change issues	4.50	0.74	4th
Poor policies that hinder climate information dissemination	4.26	0.99	9th
Adherence to traditional agricultural practices by farmers	4.50	0.71	4th
Prevalence if poverty, hunger and disease preventing the adoption of climate information disseminated	4.54	0.76	2nd
Lack of farmers participation in climate change efforts	4.42	0.76	5th

Source: Field survey, 2023

Also, the results show that climate information was constrained by the inability to translate climate information into practical items ($\bar{x}$=4.52), the inability of extension agents to interpret scientific climate information (literacy), lack of human capital on climate change issues, and the adherence to traditional agricultural practices by farmers ($\bar{x}$=4.50) respectively.

This result supports a previous study by Ebenehi et al. (2018), who found that extension agents are unable to implement research-based adaptation strategies for climate change due to a lack of funding. The results also show that denial of the existence of climate change ($\bar{x}$=4.08), Lack of confidence and credibility in climate information ($\bar{x}$=4.00) were the least constraints to climate information dissemination.

Conclusion

The study aimed to assess the awareness, competencies, and constraints faced by agricultural extension officers in the dissemination of climate information in Akpabuyo Local Government Area, Cross River State, Nigeria. The findings of the research provide valuable insights into the current state of climate information dissemination in the agricultural sector. The study revealed that a significant proportion of extension agents were aware of the causes of climate change, with deforestation being the most recognized cause. However, there was room for improvement, as some agents displayed limited knowledge of certain causes. Social media and television were identified as the primary sources of climate information for extension agents, followed by radio and magazines/newspapers. Collaboration with research institutions was relatively low, suggesting potential areas for improvement in accessing credible and accurate climate information. Extension agents played various crucial roles in climate information dissemination, including organizing awareness-raising events, disseminating adaptation practices, providing advisory services, and capacity development for farmers. However, some agents were less involved in tasks such as setting up emergency management units and providing weather forecasts, indicating the need for additional training in these areas. Extension agents generally possessed the competencies needed for climate information dissemination, including understanding climate change, obtaining credible information, and organizing farmers for capacity building. However, there is room for improvement in areas such as producing radio/TV programs on climate change and building partnerships with other actors. Lack of funding for agricultural extension activities, poor cooperation and collaboration between information providers and users, poverty, and difficulty in translating climate information into practical actions were identified as the primary constraints to climate information dissemination. Other challenges included inadequate technical capacity, complexity of dissemination methods, and traditional farming practices.

Based on the findings of this study, the following recommendations are proposed:

i. Agricultural extension officers should be made to undergo specialized training on climate change issues, including interpreting scientific data, producing informative programs, and building partnerships with relevant institutions. This training will enhance their competencies in climate information dissemination.
ii. Adequate funding should be allocated to agricultural extension programs to support climate information dissemination efforts, as financial resources are crucial for organizing awareness campaigns, workshops, and the development of informative materials.
iii. Greater collaboration between climate change information providers, research institutions, and extension agents is essential. This collaboration can ensure the availability of credible and up-

to-date climate information for farmers.

iv. Efforts should be made to simplify complex climate information and translate it into practical actions that farmers can understand and implement. This will bridge the gap between information and action.

v. Proper documentation of climate information should be encouraged. This will help in tracking progress, evaluating the effectiveness of information campaigns, and identifying areas for improvement.

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AGRICULTURAL FOOD SYSTEMS IN NIGERIA: A REVIEW OF THE INEXTRICABLE TRIPOD STAND CHALLENGES OF HUNGER, FOOD INSECURITY, AND POOR NUTRITION

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Abstract

Nigeria has been listed among the 55 Low Income Food Deficit (LIFD) countries due to the high prevalence of undernourished people living within agricultural households. Hence the government and other stake holders have driven attention towards agriculture and food systems. Food chains, market competition, industrial processes and increasing productivity have all made agricultural system a profitable subsector. Consequent upon these activities, agriculture is one of the biggest contributors to environmental and sustainability challenges, threatening hunger, food security and nutrition of man. The effects of these phenomena on smallholder farmers who live especially in rural environments of developing countries are hunger, food insecurity and poor nutrition rendering them multidimensionally poor and unable to meet their basic daily needs for sufficient food. Evidence has shown that food insecurity is closely related to socio-economic attributes such as: poverty, low income, employment status, age, household size, level of education, among others. This is why there is emphasis on environmental and sustainability approaches to enhance food security in the Sustainable Development Goals (SDGs) of the Nigerian government. There can be a reduction in the number of people who go to sleep hungry every night through environmental and sustainable practices that promote an increase in food production, and that can be sustained for generations. The practices may include introducing drought-resistant or high-yielding seeds, cheaper and less labor-intensive farming techniques, including more female farmers in agriculture, introducing insurance to promote risk-seeking behavior, and in many cases just informing farmers about new concepts.

Key words: food system, nutrition, food security, hunger, agriculture

1. Introduction

Despite Nigeria's agrarian nature, food insecurity, hunger and poverty have recently drawn the attention of academics and decision-makers alike. Adeagbo (2021) noted that food security and insecurity are two opposing terms used to describe how much or lack of access to sufficient and nutritious food are available to a population. Although the majority of the food insecure are domiciled in developing countries, food security has become an issue of top priority for both developing and developed countries. A study on the food security situation in northern Nigeria found that only 16% of the households were food secure (FS), 36% food insecure without hunger, 28% FS with moderate hunger and 21% food insecure with severe hunger (Food and Agriculture Organization (FAO) 2022). This phenomenon is attributable to the nature of the food system in Nigeria.

Food system includes all aspects of feeding and nourishing people: growing, harvesting, packaging, processing, transporting, marketing and consuming food. According to Akinyele (2009) it encompasses all the interactions between people and the natural world – land, water, the climate, etc. – and the natural world's effects on human health and nutrition. It also includes the inputs, institutions, infrastructure and services that support the functioning of all these aspects, as well as the role of diets and cultural practices in shaping outcomes. The main function of the food system and its primary sector, agriculture, is to satisfy the basic human need for food, but sustainable food systems also maintain ecosystem, health and contribute to social well-being. An ideal food system is sustainable when it provides sufficient nutritious food for all without compromising the health of the ecosystem or the ability of future generations to meet their own food and nutritional needs (Meta *et. al*., 2016 and Effiong and Iheme, 2024).

2. Agriculture in Nigeria

Agriculture is a major sector of the Nigerian economy, accounting for up to 56% of total employment in 2024 (Effiong and Iheme, 2024). According to FAO (2022), agriculture remains the foundation of the Nigerian economy, and in Nigeria comprises of four major sub-sectors: crop production, livestock, forestry, and fishing. Rice, Maize, cassava, guinea corn, millet, groundnut and yam are the major crops farmed in Nigeria, with 70% of the households engaged in crop farming. In the south, 7.3% of the households practice fishing, while 69.3% of the households own or raise livestock in northwest Nigeria (International Food Policy Research Institute (IFPRI) (2016). There are several factors in the Nigerian agricultural sector that may prevent its growth, including a land tenure system that limits access to land, the country's level of irrigation development and limited adoption of research findings and technologies. The factors also include costs of farm inputs, the amount of access to credit allowed by the management of specialized institutions established for the development of the agricultural sector, the manner of fertilizer procurement and distribution, storage facility effectiveness, climate change and land degradation, high production cost and poor distribution of inputs, post-harvest losses and the amount of access to markets. More recently, changes in average temperatures, rainfall, climate extremes, and the growing infestation of pests and related diseases also exacerbate the woes of Nigerian agriculture (Omorogiuwa *et. al*., 2020 and Effiong and Iheme, 2024). This is coupled with a dependence on rain-fed agriculture, which has made the sector vulnerable to seasonal conditions.

Bello *et. al* (2024) noted that illiteracy is also one of the several factors preventing the progress and development of agriculture in Nigeria. Research has proven that most of the farmers in Nigeria have not acquired formal education. Agricultural holdings are small and scattered, and farming is carried out with simple tools, limiting large-scale agriculture production. In the past, Nigeria was known for the export of groundnut and palm kernel oil among others. However, over the years, the rate of exportation of these products has decreased. Nomadic cattle herders' attacks on farms across Nigeria have led to abysmally low output as many farming communities have either abandoned farming or have curtailed their farming activities due to threats of crop destruction or bloody clashes (Akerele, 2023). This has invariably led to skyrocketing food inflation and a rise in unemployment.

Additional upward pressure is caused by devaluation and floatation (allowing the forces of demand and supply determine currency value) of the local currency (naira). Also, higher fuel prices occasioned by the removal of fuel subsidy have contributed to rising food prices as transportation of food items is affected by these variables (Bello *et. al.,* 2024). On the international front, Russia's invasion of Ukraine has threatened Nigeria's food security situation. Nigeria imports wheat from Russia and the surrounding Black Sea countries. The escalation of the crisis has led to an increase in imported wheat prices, which has caused a multiplier effect on the price of wheat-based products (e.g., breads, noodles, and biscuits). These challenges have stifled agricultural productivity, affecting the sector's contribution in the country's GDP as well as increased food imports due to population rise, hence declining levels of food sufficiency. For instance, between 2018 and 2023, Nigeria's cumulative agricultural imports stood at N3.35 trillion, four times higher than the agricultural export of N803 billion within the same period (Akerele *et. al.,* 2023).

3. Agriculture and Nutrition in Nigeria

It is a well-known fact that agriculture produces the food people eat and is the primary source of livelihood (employment and income) for most of the world's poor, who, in turn, are most vulnerable to ill health and malnutrition (Karat and Pottathil, 2023). Nutrition encompasses access to food at the household level, health services and a healthy environment and adequate child care practices. The pathways through which agriculture affects nutrition are well documented. According to Oni (2019) improved nutrition in turn supports the agriculture sector by enhancing rural people's ability to undertake the strenuous tasks involved in small-scale agriculture. The links between improved nutrition status and improved work capacity and productivity are clear. Yet to enhance agricultural productivity and incomes, the agriculture sector must pay even more attention to nutrition. World Bank (2019) averred that increased attention to nutrition by the agriculture sector ensures a greater focus on the consumer, which is good for agriculture from both a public and a private goods standpoint. Malnutrition arising from not having good nutrition is a global challenge with huge social and economic costs, and the biggest risk factor for the global burden of disease. One in three people is affected, and virtually every country on this planet is facing a serious public health challenge due to malnutrition (IFPRI, 2016). Many countries are dealing with a "triple burden" of energy and micronutrient deficiencies, co-existing with rising rates of overweight and obesity.

World Health Organization (WHO) (2005) noted that agricultural development has enormous potential to make significant contributions to reducing malnutrition and associated ill health. With its close links to both the immediate causes of undernutrition (diets, feeding practices, and health) and its underlying determinants (such as income, food security, education, access to health services, and gender equity), the agriculture sector can play a much stronger role than in the past in improving nutrition outcomes. Following this, (Karat and Pottathil, 2023) posited that pathways through which the agriculture sector may impact nutrition outcomes need to be explored more than ever. There is still limited evidence that agricultural interventions are benefiting nutrition or that agricultural growth consistently leads to nutritional improvements. In many low- and middle-income countries, large changes in agricultural policy and practice have generated relatively small changes in nutrition. According to Insecurity in the World (2015) agriculture has relatively high economic returns to investment, and has an immense potential to reduce undernutrition, it is well-known that an improvement in food production or consumption does not necessarily lead to improvements in health and nutrition outcomes. For instance, a study of the relationship between agricultural production (crops and livestock), dietary diversity in households, and child and maternal diet and nutrition outcomes in sub-Saharan Africa, demonstrated that household agricultural production may not directly influence household dietary patterns and the nutritional status of household members.

Challenges with nutrition stems from globalization which generates marketing systems that require food production to be intensified and standardized. Food production has become more capital-intensive and supply chains have grown longer as basic ingredients undergo multiple transformations before the final product (Ojo and Adebayo, 2018). Value chains shift power from producers to retailers and supermarkets. Standardization which is required for good nutrition benefits larger suppliers, rendering global markets more difficult to access for smallholder farmers. Family agriculture and associated agro-biodiversity is being marginalized, though smallholders continue to play a crucial role in supplying local markets with fresh and affordable agricultural produce.

Jerome (2019) noted that consequences of an increasing globalization of value chains reaches well beyond the agricultural production system: the emergence of fast-food outlets and supermarkets, the intensification of advertising and marketing of comparably cheap industrialized products, and foreign direct investment in developing countries and accelerating urbanization, have translated into major and rapid shifts in dietary patterns. The consumption of low nutritional quality, energy-dense, ultra-processed food and drinks, and fried snacks and sweets has risen dramatically in the past decade. As incomes rise, the urban poor and emerging middle-class households tend to reduce their consumption of cereals, roots, and tubers while increasing demand for refined grains and flours, sugar, salt, and fats (Behnassi, 2023). Demand for processed, convenience/fast foods at supermarkets, restaurants, and informal street foods rises. For middle-class population groups, demand for fruits, vegetables, as well as dairy, poultry, eggs, meat, and fish, strongly increases.

4. Improving nutrition in agricultural systems

The ways out for achieving good nutrition in agricultural systems as articulated by IFPRI (2016) are: i. improvement in consumer purchasing power, which would manage food price volatility (protect economic access for vulnerable groups). ii. improve nutritional quality of institutional diets e.g., in schools and hospitals. iii food transformation and consumer demand, which is the improvement of demand and consumption of fruits and vegetables, legumes/pulses, nuts and seeds, high-protein, micronutrient dense grains, and safe milk. iv. replacement of saturated and trans-fats with unsaturated fats, and reduce high-calorie, nutrient-poor sugary drinks and salty snacks. v. restrict advertising, marketing, and commercial promotion of unhealthy, low-nutrient, and ultra-processed foods. vi. control labeling of foods to ensure claims are evidence-based and vii. prioritizing the improvement of diet quality of young children, adolescent girls, and women, including animal source foods (fish, meat, eggs, and dairy).

Agricultural systems with low-productive capacity in terms of quality and quantity like in sub-Saharan Africa also need to shift to yield enhancement, while maintaining production diversity. Achieving this would require modernizing systems to diversify away from processed, convenience/fast foods at supermarkets, restaurants, and informal street foods to focus more on legumes and micronutrient-rich foods (Metu *et. al.,* 2016, Bello *et. al.*, 2024). Another way is for commercialized systems to regulate ultra-processed foods and seek to reduce consumers' sugar and salt consumption. By this, the four types of food system outcomes: food affordability, dietary diversity, health and nutritional status, and environmental sustainability would be achieved.

Traditionally, agricultural interventions in nutrition have been focused on increasing food production and raising incomes to reduce malnutrition, hunger and poverty. Although this remains part of a valid approach, it is now recognized that higher levels of production and income alone have limited impact on improving nutrition. Akinyele (2009) noted that more comprehensive approach is necessary to optimize agriculture's contribution to good nutrition and make agriculture nutrition sensitive. Such an approach identifies constraints and opportunities to leverage agriculture for better nutrition throughout a food system, without detracting from the agricultural sector's conventional goals. For instance, women make up a large percentage of the workforce in agriculture and food systems in developing countries. Along with productive and reproductive gender roles, women's education, social status, health and nutritional status, and control over resources are key factors that influence outcomes on nutrition (Adeagbo, 2021).

Gender-sensitive agricultural projects can ensure that women retain greater control over resources and that they have a say in choice of crops. Again, certain targeted actions can promote the availability, accessibility and consumption of nutritious foods, including increasing the nutritional value of the foods themselves. Increases in production and productivity can raise incomes, which can be used to purchase food (FAO, 2021). Biofortification and improvements in soil health can raise the nutrient value of crops, as can better storage, preservation and processing. Improved production, processing or marketing efficiency, as well as reduction of waste, can reduce the relative prices or the amount of time it takes to prepare more nutritious foods, making them more attractive as part of the diet. Diversification of production can be achieved through adoption of new crops or new production systems.

Agricultural technologies and production systems can increase the diversity and nutritional value of production.

5. Food security

Issues on food security were brought to the limelight in 1974 during the World Food Conference when it dawned on the government that all nations all over the world need to strategize on how best to improve agricultural production, to match the per capita needs of the population (Jerome, 2019, Ojo and Adebanjo, 2018). From various perceptions, inadequate food supply, due to poor agricultural production and poor distribution channels, poverty and hunger have been identified as causes of food insecurity in many developing countries. Food security has a wide and multifaceted conception that is determined by geographical, socio-economic and biological factors. It connotes food availability, food access and food utilization.

Again, at the beginning of the millennium, through the effort of the United Nations, world leaders gathered to seek and decipher a better way of tackling economic challenges in 2015. Their deliberations gave birth to what was referred to as the Millennium Development Goals (MDGs). The first and most important goal of MDGs was to eliminate extreme hunger (World Bank, 2019). This term is known to be caused by food insecurity, which is seen from the angle of shortage in the access to nutritionally adequate and safe food resulting majorly from poverty. It is a product of inadequate consumption of nutritionally adequate food, considering the psychological requirement of food by the body as being within the sphere of nutrition and health.

Chronic food insecurity is as a result of lack of resources to acquire and produce food, thereby leading to persistent inadequate diet. A food insecure situation is said to exist according to Bremner (2012) when the demand side is not balanced with the supply side. Food insecurity also exist when everyone at all times cannot afford safe and nutritious food to preserve a healthy and active life. The three pillars surrounding food security include food availability, food safety and food utilization. Ojo and Adebanjo (2018) explained that food security is the antithesis of food insecurity and it exist when all people have social, physical and economic access to adequate, nutritious and safe food to meet their dietary requirement at all times, for good living. A country is food secured when there is access to food in adequate and acceptable quantity and quality, consistent with decent existence at all times for the majority of the population. Food hygiene and safety should also be given important consideration in order to protect the health of the people.

Sustainable food security exists when all people have social, physical and economic access to adequate, nutritious and safe food to meet their dietary requirement at all times for a productive healthy life at present as well as future. Food security requires adequate access to basic and nutritious food that promotes wellbeing and protection of every member of the society from malnutrition, hunger and starvation (Behnassi, 2013). In the development circle, endemic famine/drought, sudden pest attack on agricultural produce and poor yield from farmlands are threats to food security. Physical availability as well as economic and physical access to food, its utilization and stability are dimensions of food security. To fully understand food security, other developmental questions such as income sources, social protection, changing household structures, rural and urban development, water and inputs, retail markets, nutritional knowledge, livelihood patterns, sustainable asset accumulation as well as education must be answered (Adeagbo, 2021 and Karat and Pottathil, 2023). There is bound to be negative impacts on the ability to identify policies to enhance personal and collective access, if these influential factors are not well understood.

6. Hunger and food security

Hunger is defined as a condition in which a person does not have the physical or financial capability to eat sufficient food to meet basic nutritional needs for a sustained period. In many cases, hunger result from food supply disruptions caused by war, plagues, or adverse weather. FAO's (2022) and Karat and Pottathil (2023) reports discussed three principal reasons for the recent increase in hunger: climate, conflict, and economic slowdowns. The report focused on extreme weather as a primary driver of the increase in hunger, finding rising rates to be especially severe in countries where agricultural systems were most sensitive to extreme weather variations. The objective of sustainable development Goal 2 (SDG 2) is to "end hunger, achieve food security and improved nutrition and promote sustainable agriculture" by 2030. SDG2 recognizes that dealing with hunger is not only based on increasing food production but also on proper markets, access to land and technology and increased and efficient incomes for farmers.

World Bank studies consistently found that about 60% of those who are hungry are female. Globally, women typically face greater economic barriers compared to men and have access to fewer resources, creating greater obstacles to food security. In both developing and advanced countries, parents sometimes go without food so they can feed their children. Women, however, seem more likely to make this sacrifice than men. In order to end world hunger (and poverty), we must focus on the needs of smallholder farmers and rural communities. This is because majority of poor and hungry people are small-scale farmers. They are in fact members of the private sector, albeit the weakest (WHO, 2016).

While the prevalence of hunger decreased globally, it has risen in sub-Saharan Africa in recent years mainly due to rapid population growth, low agricultural productivity, and economic downturns. There are four global threats that have significant implications for hunger viz; population explosions, global warming, loss of biodiversity and globalization of injustice. The continent of Africa is not yet on the path to eliminate hunger by 2030 because the prevalence of malnutrition in Africa has risen from 17.6% in 2016 to 19.1% in 2022 (IFPRI, 2021). Over the years, the question of appropriate hunger has remained a critical subject for consideration by many government administrations in Nigeria.

Smallholder farmers in Nigeria constituted 90% of Nigeria's agricultural output and majority of such farmers are not able to feed themselves and other relatives. The low productivity is mainly as a result of fragmented land holding, over reliance on rain-fed agriculture, climate change issues, low access to input and poor economic base as mentioned earlier. Oni (2009) noted that some interventions were developed in Nigeria since independence in 1960 to increase crop productivity, generate employment, and ensure food security. Notable among the interventions were: The Green Revolution, Lower Niger River Basin Development Authority (LNRBDA), Operation Feed the Nation (OFN), and regulatory bodies such as the Directorate of Foods, Roads, and Rural Infrastructure (DFRRI) and National Agricultural and Land Development Authority (NALDA). However, many of these programs failed due to weak institutional foundation, corruption, and poor implementation. Ojo and Adebanjo (2018) reported that as much as 21.4% of Nigerian families were experiencing acute hunger in 2022 and 50% of the Nigerian population are living below poverty line of 1.9 USD per day. The Global Food Security Index (GFSI) rating shows that Nigeria ranked 94th out of 113 nations in 2022 with a 48.4/100 score, which puts the country below Ethiopia, Niger, and Cameroon (WHO, 2016). The alarming rise of hunger in Nigeria necessitates prompt action.

7. How agriculture can solve hunger

The following ways are suggested according to FAO (2022), IFRPI (2021) WHO (2016)

i. Enhance agricultural resilience

The first step is to increase the resilience of farmlands and pastures, particularly those affected by climate change, by the use of climate smart agriculture (CSA). This is a set of farming methods designed to increase the resilience and productivity of land affected by climate change. CSA increases food security for farmers and their families. It also means farmers are more prepared to handle both the current and future effects of climate change.

ii. Increase harvest yield and reliability

Building resilience into smallholder farmers' practices means that we not only increase the yield of their crops, but also the reliability of these harvests.

iii. Improve access to a variety of nutritious foods

Sometimes people have enough food, but it doesn't provide enough nutrients. Maize, for instance, is a staple crop in Nigeria but not very nutritious. We therefore have to increase the diversity of crops — another principle of Climate Smart Agriculture.

iv. Produce a surplus of crops for the market

While many rural families are subsistence farmers — meaning that they eat what they grow — there should also be enough potential in even a small plot of land to produce surplus crops that they can then sell and trade at local markets.

v. Increase income

With greater yields of better and more diverse foods, people are able to increase their profit, investing some of that back into further growing family farms, buying more land, more or better farming supplies, joining Village Savings and Loans Associations, purchasing supplies to help their harvests last longer and during periods of scarcity, or investing in other income-generating activities to diversify their income sources.

8. Conclusion and recommendations

Agricultural systems play a crucial role in food security, influencing both the availability of food and access to it, especially for vulnerable populations. Rural areas are less likely to have the infrastructure needed for food systems to survive and thrive. It's not enough to give farmers the training, tools, and individual resources they need to be successful. We also need to invest in building roads, creating clean water sources, and other initiatives that will serve communities to improve on food production. To this day one of the biggest issues in developing countries is the continuous rise of hunger, food insecurity, and malnutrition**.** Small holder and local farmers need to be prioritized as key to solving these issues where it is most keenly felt. To solve this food fight, new investments must be made supporting small holder and family farming in developing countries, allowing them to gain knowledge and resources surrounding sustainable agriculture. Other practices may include introducing drought-resistant or high yielding seeds, cheaper and less labor-intensive farming techniques, including more female farmers in agriculture, introducing insurance to promote risk-seeking behavior, and in many cases just informing farmers about new concepts. In this way, farmers can more sustainably break the cycles of hunger, mal/undernutrition and poverty

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IFPRI cons to nutritious, sustainable diets and contribute to more broadly to development

CLIMATE CHANGE, ENVIRONMENT AND AGRICULTURAL SUSTAINABILITY EXTENT OF USAGE OF SUSTAINABLE SOIL MANAGEMENT PRACTICES AMONG SMALLHOLDER FARMERS IN ODUKPANI LOCAL GOVERNMENT AREA, CROSS RIVER STATE

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Abstract

The study examined the extent of usage of sustainable soil management practices among smallholder farmers in Odukpani Local Government Area, Cross River State. Specifically, the study sought to ascertain the socio-economic characteristics of the respondents, identify sustainable soil management practices available, assess the extent of usage of sustainable soil management practices and identify constraints towards using sustainable soil management practices. Findings on socio economic characteristics of the respondents revealed that majority (68.2%) were males, 25.5% were between the ages of 41-45years, majority (58.2%) were married, most(53.6%) had secondary education, 38.2% had annual income of between ₦201,000 to ₦300,000, majority (60.9%) had farm size of between 1 to 2.99 hectares, majority (60%) had between 6 to 10 years of farming experience and most (61.8%) were not visited by the extension agents. Result on sustainable soil management practices available revealed that, the most (68.18%) available sustainable soil management practices was mulching. Findings on extent of usage of soil management practices showed that most (69.09%) of the respondents only utilised between 1 to 3 sustainable soil management practices. The result on constraints in the use of soil management practices revealed that finance($\bar{X}$=3.23) and ecological factors($\bar{X}$=3.21) were the major constraints with mean score ranked first and second, respectively. Based on these findings, it is therefore recommended that more extension agents should be mobilise in other to educate the farmers on the need to utilise multiple approach towards sustaining the soil. Funds should be provided to farmers to enable them utilised more sustainable soil management practices necessary for the management of agricultural soil for optimal production.

Keywords: Extent, Usage, Sustainable, Soil management practices

Introduction

Before the twentieth century as opined by Cooke & Eigege (2016) almost all increase in animal and especially crop production was attributed to the increase in the area of land utilised. However, continuous cropping on the soil, which is fixed become depleted overtime; and therefore, the gradual transition of natural based resource to a science-based system of agriculture became necessary for optimal production. In developing countries like Nigeria, where a larger proportion of the population in the rural areas depend solely on agriculture for their livelihood, land is put into use on a daily basis and rely on traditional agricultural practices Therefore, the utilisation of agricultural innovation that will ensure sustainable usage of soil is necessary for optimal production.

The utilisation of appropriate soil management practices enable land users to maximize the economic and social benefits from the land while maintaining or enhancing the ecological support functions of the land resources. Sustainable Land Management encompasses established approaches such as soil and water conservation, natural resource management and Integrated Landscape Management (ILM). These approaches enhance agricultural productivity, protect the environment and support socioeconomic well-being. They involves a holistic approach to achieving productive and healthy ecosystems by integrating social, economic, physical and biological needs and values, and contribute to sustainable and rural development. (Food and Agriculture Organisation (FAO) (2011)

Extensive usage of soil as observed by FAO (2011) has resulted to heavy pressure on land resources, decline in agricultural production, deterioration in the quantity and quality of land. This is because soil nutrient is threatened when man exploits without a deliberate attempt to replenish what has been removed. Kayode, et al (2017) in their study observed that, the major causes of land degradation include; deforestation, soil nutrient mining, cultivation on steep slope, soil fertility decline. Over the years rural farmers have long relied on bush fallow, bush burning, mixed cropping, shifting cultivation, mulching and fertilizer application as means of maintaining soil fertility and ensuring a balance between socio economic and agro- ecological environment but this is not sustainable because, sustainable soil management practices as observed by Clement (2013) combines technologies, policies and activities aimed at providing environmental, economic and social opportunities for the benefit of present and future generation while maintaining and enhancing the quality of the soil. The major factors that influence the utilisation of these sustainable soil management practices as opined by Rezvanfar, et al (2009) are age, educational background, household size, income and farm size.

Although studies have been carried out on sustainable land management practices, there is no empirical evidence on the extent of usage of sustainable soil management practices. Therefore the study is aimed at analysing the extent of usage of sustainable soil management practices among farmers in the study area.

Specific objectives of the study:

- Ascertain the socio economic characteristics of respondents in the study area
- Identify sustainable soil management practices in the study area
- Assess the extent of utilisation of sustainable soil management practices in the study area
- Identify constraints towards using sustainable soil management practices in the study area

Methodology

Study area

The study was carried out in Odukpani Local Government Area of Cross River State; the area is located in the Calabar Agricultural Zone. It lies on the geographical co-ordinates of latitude 5° 8' N and 5° 13' S and longitude 8° 20' E and 8° 33'W. The area is bounded by Calabar river to the west, great Kwa to the East and the wetlands of the Cross River estuary to the south. It has an approximate population of 257,800 persons. The major tribes of Odukpani local government area are the Efiks, Efut and Kwas. It has 13 council wards; these include, Adiabo Efut, Creek town I, Creek town II, Anku, Eniong, Eki, Obom Itiat, Mbiabo, Odot, Odupani Central, Onim, Ikoneto, and Idere. Its soil type is primarily sandy and clayey. The mean annual rainfall ranges from 1300-3000mm; a climatic condition suitable for the cultivation of several arable crops such as: cocoyam, cassava, maize, okro, pepper, fluted pumpkin, garden egg, potatoes. The soil management practices relied upon by rural farmers are mulching, cover cropping, terracing, fertilizer application and conservation tillage (National Population Census (NPC)(2006))

Sampling procedure

A two stage sampling technique was adopted for this study;

The first stage involved the random selection of 5 wards. 5 wards were randomly selected because almost all the location had similar soil type, so for effective management and representation, 5 wards were selected out of the 13 wards.

In the second stage, from the group of farmers that were available in the wards, 22 farmers were randomly selected from each of the 5 wards making up a total 110 respondents. The instrument used for the collection of data was a structured questionnaire.

Measurement of variables

A three point rating scale was used to measure the level of usage of soil management practices in the study area; using 1-3 soil management practices was scored = low; 4-6 soil management practices was scored = Medium and above 6 soil management practices was scored = high. A four point rating scale was used to measure the constraints towards using a sustainable soil management practices.

Method of data analysis

Descriptive statistics was used in the analysis of data; these include frequency counts, percentages and means

Results and Discussion

Table 1 shows the distribution of respondents based on their socio-economic characteristics. The findings shows that most (68.2%) were males, 30% were between 40-44 years with mean age of 38.8, majority (58.2%) were married, a larger proportion (53.6%) had secondary education, had mean annual income of 275,954.54, majority (60.9%) had farm size of between 1-1.99 hectares with mean farm size of 1.3, most (60%) had farming experience of between 6-10 years with mean farming experience of 7.9 and majority (61.8%) were not visited by the extension agents. The implication of these findings show that farming in the study area is dominated by males, two-third are in their youthful age and as such still active to carry out farming activities, a larger number among the respondents were married and could read and write with a sizeable farmland to sustain their family. It also shows that they had adequate conventional farming experience as a larger proportion of the respondents were not visited by the extension agents.

Table 1: Distribution of respondents based on socio economic characteristics (n=110)

Variables	Frequency	Percentage
Sex		
Male	75	68.2
Female	35	31.8
Age (years)		
<25	5	4.5
25-29	10	9.1
30-34	14	12.7
35-39	20	18.2
40-44	33	30
>44	28	25.5
		Mean = 38.8
Marital Status		
Single	32	29.1
Married	64	58.2
Widowed	14	12.7
Educational level		
No formal	5	4.6

Primary	25	22.7
Secondary	59	53.6
Tertiary	21	19.1
Annual Income ('000 naira)		
< 101	3	2.7
101-200	23	20.9
201-300	42	38.2
301-400	27	24.6
Above 400	15	13.6
		Mean=275,954.54
Farm size(hectares)		
<1	32	29.1
1-1.99	67	60.9
2 and above	11	10
		Mean =1.30
Farming experience(years)		
1-5	23	20.9
6-10	66	60
Above 10	21	19.1
		Mean =7.9
Extension visit		
Yes	42	38.2
No	68	61.8

Field survey, 2020

Table 2 shows the distribution of respondents based on the use of sustainable soil management practices. The Table reveals that majority (69.09%) used mulching and cover cropping to sustained the soil while, only 3.63% utilised the integrated landscape management. The implication of this result is that, majority of the respondents did not utilise the Integrated Land management approach towards managing the soil. Reason which may be that adopting mulching and cover cropping for soil sustainability is prioritise over agricultural innovations because of lack of drive from the extension agents. This result is similar to the research study from Oni (2015) which reported that lack of drive from the extension agents is one of the major reason for non adoption of agricultural innovations.

Table 2: Distribution of respondents based on the use of sustainable soil management practices

	Soil management practices	Use	Percentage	Not Use	Percentage
1	Mulching	76	69.09	35	31.81
2	Cover cropping	67	60.91	43	39.09
3	Inter cropping	76	69.09	34	30.90
4	Terracing	10	9.09	100	90.91
5	Fertilizer application	64	58.18	46	87.27
6	Conservation tillage	75	68.18	34	30.91
7	Shifting cultivation/bush fallow	5	4.54	105	95.45
8	Integrated Landscape Management (ILM)	4	3.63	106	96.36

Source: Field Survey, 2020

Table 3 shows the distribution of respondents based on the extent of usage of sustainable soil management practices. The result revealed that majority (69.09%) utilised between 1-3 sustainable soil management practices. The implication of this result is that respondents in the study area did not utilise multiple approach towards sustaining the soil, as such the level of land degradation is high in the study area thereby affecting the available land for agricultural production. This result is also in line with the research carried out by Ezeigwe (2015) which reported that, the main onsite of soil degradation is the reduction of soil quality arising from loss of soil nutrient which in turn affect the availability of land for farming activities.

Table 3: Distribution of respondents based on extent of usage of sustainable soil management practices

Extent of usage	Number of sustainable soil management practices utilised	Frequency	Percentage
Low	1-3	76	69.09
Medium	4-6	28	25.45
High	Above 6	6	5.45
Total		110	100

Source : Field Survey, 2020

Table 4 shows the distribution of respondents based on constraints towards using sustainable soil management practices. The result reveals that cost, ecological factors and socio economic factors were the major constraints towards using sustainable soil management practices as it is ranked first, second and third respectively. This result is similar to the study carried out by Oni (2009) which reported that finance and lack of drive to prioritise agricultural innovation over ineffective conventional methods were the major constraints limiting the adoption of sustainable practices.

Table 4: Distribution of respondents according to constraints towards using sustainable soil management practices

Constraints towards using sustainable soil management practices	Total score	Mean score	Rank
Cost	356	3.23	First
Compatibility	256	2.32	Fifth
Complexity	245	2.22	Sixth
Accessibility	233	2.11	Seventh
Ecological factor	254	3.21	Second
Institutional factor	291	2.64	Fourth
Socio-economic factor	353	3.20	Third

Source: Field Survey, 2020

Conclusion

The study reveals that farming in the study area is dominated by males, a larger proportion were between the ages of 40-44 years, most were married and had secondary education and a larger proportion of the respondents were not visited by extension agents. Most of the sustainable soil management practices utilised were mulching and cover cropping. Based on the findings of the study, it was therefore concluded that majority utilised few sustainable soil management practices. Cost, ecological factors and socio economic factors were the major constraints towards utilising sustainable soil management practices. Implying that, extent of usage of sustainable soil management practices is still low in the study area.

Recommendations

Since majority only utilised few sustainable soil management practices and cost, ecological factors and socio economic factors were the major constraints towards using sustainable soil management practices in the study area. It is therefore recommended that ;

1) Since majority of the respondents were not visited by extension agents, government and other stakeholders should mobilise more extension agents, so as to educate the farmers on the need to utilise multiple approach towards sustaining the soil

2) Since cost and ecological factors were the major constraints towards using sustainable soil management practices, adequate funds should be made available to farmers in the study area to enable them utilised more sustainable soil management practices capable of enriching the soil and sustaining the land for future and optimal agricultural production.

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CONSTRAINTS ACROSS THE CRAYFISH VALUE CHAIN: A COMPARATIVE ANALYSIS OF ACTORS IN COASTAL COMMUNITIES OF SOUTH-EAST NIGERIA

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Abstract

Value chain analysis (VCA) provides an understanding of the business relationships, price formation processes, value additions and benefits among different chain actors. This paper analyzed the challenges and constraints of the different value chain actors of crayfish in the Oron business cluster of Akwa Ibom state, Nigeria, with a view to identifying the weakest link in the chain. . The snowball sampling technique was used to draw samples of 129 fishers, 66 Processors, 60 Primary wholesalers and 96 retailers. Questionnaire was used to collect quantitative data of the respondents from January to March 2020. Henry Garrett's ranking method was adopted for analysis. For the fishers, large start-up capital was considered to be the most important constraint to their fishing activities which exposed them to a higher level of financial risk than other actors. For processors, short shelf-life of processed product is the most severe of the constraints. The most important or severe constraint to the primary wholesalers is high cost/difficulty of transportation to and from the fishing communities. The research recommends improvement in safety and infrastructure of the marine environment, strengthening both the institutional and non-institutional sources of financing of the crayfish value chain to enhance their activities, among others.

Keywords: Constraint, Crayfish, Oron, Business, cluster, Value chain, Fishers, Processors, wholesalers.

Introduction

For a developing country like Nigeria, increased agricultural production, food security, and food self sufficiency are allied and important goals.

Yet agricultural production has a lot of challenges. There is a wide consensus among economists and policy makers that agriculture is characterized by low and unstable income to producers. Literature is replete with evidence of the fact that incomes tend to lag behind in agriculture compared to other sectors of the economy. (Gueye, 2014; Jasna and Palai 2016, Benson, Todd, and Joachim De Weerdt, 2023).

It is now widely accepted that agriculture is the only realistic driver for reducing mass poverty and developing rural areas in most developing countries (Gomez and Ricketts, 2013)

Value chain analysis examines the complex range of activities undertaken by various actors (including input suppliers, primary producers, processing enterprises, wholesalers, and retailers) to bring a raw material to the final consumer. This approach looks not only at the activities implemented by a single actor, but at the linkages between the direct actors in the value chain: the organization, coordination challenges and power relations between them (FAO, IFAD, UNICEF, WFP and WHO. 2023, Ferrol-Schulte *et al*., 2014). Any farmer producing a small surplus that he or she sells to a local trader becomes part of a value chain.

However, risks such as exclusion from the value chains and exploitative relationships among small holder farmers and other participants in the value chain may undermine small-holders welfare (Agbonlahor, Ashaolu and Obayelu, 2014; Devaux *et al*., 2018). Value chain analysis will allow analysts to identify issues (constraints, opportunities, strengths and weaknesses) to be addressed by policies.

This paper seek to analyze the challenges and constraints of the different value chain actors of crayfish in the Oron business cluster of Akwa Ibom state, Nigeria, with a view to identifying the weakest link in the chain.

This work can be used to identify opportunities for intervention, such as providing access to finance, markets or technology; or improving institutional or policy frameworks or the business environment of the crayfish value chain actors, and ultimately enhancing their income and quality of life.

Reviews of Related Literature

According to the World Bank (2007), “agriculture has features that make it a unique instrument for development”, which “can work in concert with other sectors to produce faster growth, reduce poverty, and sustain the environment”. Kebede *et al.* (2017) identified globalization, adding value, achieving profitability, defining organizational capabilities, adapting to change, dealing with technological innovation, securing competence and intellectual capital as the key factors that will influence the agribusiness sector in future. They found that value added is a very crucial aspect of agriculture today. Producers are now focusing on downstream activities and attempting to form producer alliances and value added cooperatives to capture some of the margin from further processing, this is because value addition has turned out to be the only way to participate in ‘new agriculture’.

There has been several literature highlighting constraints to different value chain actors in different enterprises. They include Alebachew *et al.* (2016) that studied fish production constraint in Ethiopia, Chilaka *et al.* (2014) that studied challenges of Inland artisanal fish production in Nigeria. Jaji *et al.* (2014) also identified the constraints of women in fish processing and accessibility to extension activities in Lagos sate and many more.

Devaux *et al.* (2018) observed that it has become clear worldwide that the most rapid growth in agriculture has been occurring on the part of post-production activities. This is being driven by growth of middle income consumers even in low income countries and their demands for better quality value added products. Absence of agro-industry and agribusiness resulting in low levels of value addition of agricultural commodities has been one of the main causes of stagnation in rural incomes. A substantial agribusiness sector generating a high outflow of value added commodities is always correlated with high agricultural GDP and high rural incomes.

Methodology

Study Area

The Oron business cluster comprises five Local Government Areas in Akwa Ibom State, namely; Oron, Udung-Uko, Mbo, Urue-

Offong/Oruko, and Okobo (Figure 1). The area is located within the Coordinates of 5°3′N and 7°56′E. It is inhabited by the people of Oro, the third largest ethnic group in the state. Three fishery groups are very prominent and dominate economic activities namely; Bonga (*Ethmalosa* and S*ardinella spp*.), big fishes such as barracuda, shiny nose, snappers, Croakers and Catfishes (*Chrysicthys spp*) and Crayfish (*Palaemon spp*) (Udong, Niehof and Van Tilburg, 2009)

The estimated catch composition of the artisanal maritime fishery of the Cross River basin is as follows; Bonga (22.3%), crayfish (17.5%), catfishes (8.7%), croakers (8.5%), threadfins (7.0%), and others (Moses, 1985). Thus, crayfish is the second largest fishery in the marine/estuarine fisheries in the lower Cross River Basin. Crayfish is used as seasoning in most food prepared in Nigeria. Crayfish production and marketing seems to be synonymous with “Oron” from where it is exported to other parts of Akwa Ibom state and other states of the federation.

Figure 1: Map of the study area (Cartography Unit of the University of Uyo)

Population of the study

Four populations were used for the study. The first population was all the crayfish Fishers within the study area. The second population was all the crayfish Processors in the area of interest, the third population was the Primary Wholesalers and the fourth was the Retailers within the cluster.

Sample Size and Sampling Procedure

The major fishing settlements where crayfish production and processing are carried out are in Mbo, Udung Uko and Okobo Local Government Areas. These communities include; Iyattai, Utana Antai, Mbendoro, Asiakobufa, Ikot Itie Idung, Utan Effiong and Ibaka. Of the eight major crayfish production settlements three were selected using a simple random sampling technique.

The snowball sampling technique also known as chain-referral sampling and referral sampling was used to select the crayfish fishers, crayfish processor and Primary wholesalers in the three settlements. For the retailers, the sample was selected from three prominent markets within the cluster namely; Ibaka, Oron beach market and Atabong beach market.

Instrument for Data Collection

Four sets of questionnaires were drawn up and used to collect quantitative data on the demographic and economic variables of the respondents from January to March 2020. Also obtained were data relating to the operations and constraints of their specific economic activities or trade. Interview schedule was also drawn up to guide focus group discussions and key informant interviews.

Method of Data Analysis

To determine constraints of the crayfish fishers, Processors, Primary Wholesalers and Retailers, the Henry Garrett ranking method (John, 2014, Aleeswari, Merline and Martin, 2018) was adopted. It is a four-step procedure that culminates in deriving the Percentage Position of each of the constraints before they are ranked according to the percentage positions.

It is derived from the formular;

Percentage Position = 100 (Rij – 0.5)/Nij

Where Rij = Rank given for the i^{th} variable by the j^{th} respondent

And Nij = Number of variables ranked by the respondent.

The total scores are derived from the Garrett table. The higher the average score, the greater the severity of the constraint

Results

Table 1: Ranking of constraints of fishers in the crayfish value chain.

Constraint	Total Score	Average Score	Rank
1. Large start-up capital	6381	74.2	1st
2. High cost of equipment	6128	71.3	2nd
3. Lack of government support	5423	63.1	3rd
4. Loss of nets due to mud flats	5208	60.6	4th
5. Price determined by Processors/ Primary wholesalers	4900	57.0	5th
6. Insecurity due to Non-state Armed groups (Militants)	4764	55.4	6th
7. Limited outlet for sale of catch	4372	50.8	7th
8. Pressure to sell on arrival by pirogue assistants for own share of proceeds	4114	47.8	8th

Source: Computed from field data, 2020 (N = 124)

Table 2: Ranking of constraints of processors in the crayfish value chain.

Constraint	Total Score	Average Score	Rank
1. Short shelf life of processed crayfish	3188	72.5	1st
2. Outbreak of fire during processing	2984	67.8	2nd
3. Superior bargaining power of Primary wholesalers	2785	63.3	3rd
4. Limited outlet for sale of processed crayfish	2731	62.1	4th
5. No government support	2646	56	5th
6. High cost of obtaining capital	2214	50.3	6th
7. Seasonal availability of fresh shrimp	1943	44.2	7th

Source: Computed from field data, 2020 (N = 124)

Table 3: Ranking of constraints of primary wholesalers in the crayfish value chain.

Constraint	Total Score	Average Score	Rank
1. Difficulty/high cost of transport from Fishing villages	2521	70.0	1st
2. Difficulty/High cost of membership	2387	66.3	2nd
3. High investment capital	2273	66.1	3rd
4. Insecurity due to NSAG activities	2202	61.2	4th
5. Numerous/high taxes/Levies	1922	53.4	5th
6. Lack of government support	1889	52.5	6th
7. Superior bargaining power of Secondary wholesalers	1847	51.3	7th
8. Seasonal availability of product	1712	47.6	8th

Source: Computed from field data, 2020 (N = 124)

Table 4: Ranking of constraints of retailers in the crayfish value chain.

Constraint	Total Score	Average Score	Rank
1. High/Lack of operating capital	6056	63.1	1st
2.. Difficulty in obtaining market stores	5596	58.3	2nd
3. High cost of market stores	5552	57.8	3rd
4. Too many/high market fees	5148	53.6	4th
5. Strong competition among retailers	4804	50.4	5th
6. Seasonal availability of product	4004	41.7	6th
7. Spoilage of shrimp in storage	3910	40.7	7th
8. Superior bargaining power of Primary wholesalers	3709	38.6	8th

Source: Computed from field data, 2020 (N = 124)

Discussion

The different value actors along the crayfish value chain contend with different sets of constraints according to the nature of operations, capital requirements, input requirements and the environment they operate. Three of the most important constraints of the different value actors are discussed below.

Crayfish Fishers

Large start-up capital was considered to be the most important constraint to their fishing activities. Relative to all the other value actors, the fishers have the highest need for start-up capital. This is closely linked to the high cost of fishing equipment. Thus, they are exposed to a higher level of financial risk than other actors. Kebede, Meko, Hussein and Tamiru (2017) discussed the negative effect of financial risk on the profits and value chain actors. Jasna and Palai (2016) also highlighted the effect of high capital needs as a constraint to fishers in Kerala, India.

The second most important constraint is high cost of equipment. The starting point of the business is the acquisition of the equipment of pirogue, outboard engine, net and other gears. This requires finances that the fishers don't have. The wood for constructing the pirogues and artisans skilled in the craft of pirogue making are becoming limited giving rise to increasing and high cost of pirogues. A survey of the West African fishery by Gueye (2014) reveal the high cost of fishing equipment as a constraint to fishing activities.

The need for high capital by crayfish fishers to purchase outboard engines and pirogues has been corroborated by Ele and Nkang (2014). Echoing the same issues with regards to Ghana, Gueye (2014) noted that "the cost of equipment and input have become exorbitant. Engines are overpriced. In the market there is only one brand of engine and there was need to introduce other brands so as to lower the prices and make them more affordable to the fishers".

The fishers considered lack of government support as a third constraint. They emphasize that they have not received any support from the government in any form. They bemoan the fact that while there are plethora of support by state and federal governments to crop and livestock farmers, they are left in the cold. This could be due to a number of reasons including their locations in inaccessible remote fishing settlements, lack of strong pressure or advocacy groups, lack of awareness of their importance and need by governments among others.

The absence of government can also be seen in terms of infrastructure. As Marti and Mair (2008) put it, the presence of adequate distribution and communication infrastructure is a basic condition for value chain development and upgrading. They also indicated that developing countries are often characterized by institutional voids, defined as "situations where institutional arrangements that support markets are absent, weak or fail to accomplish the role expected of them.

Crayfish Processors

The challenges and constraints of fishery processing has been articulated by Aihonsu and Shitu, 2008, Cadilhon, Moustier, Poole, Giac, Tam and Fearne (2006), Das, Kumar, Debnath, Barman and Datta (2013), Debnath, B., Biradar, R.S., Krishnan, M. (2014).

Short shelf-life of processed product is the most severe of the constraints that Processors contend with. They can store product for a short period of time, say 2 weeks after which insects infest it and they change color.

This add to their pressure to sell as soon as possible, leading to uncompetitive pricing and loss in revenue. Gills, Sharma, Burman, Sharma and Kat (2017) also highlighted this constraint that processors have to contend with. The challenge of high volume of post-harvest losses that removes as high as 25% of fishery products from the market in many developing countries has been recognized (FAO, 2014)

The second most important constraint to their processing activities is outbreak of fire. As indicated earlier, the processing huts are made of thatched walls and thatched roof. The drying barn is made of bamboo stems. All of which are very combustible. Outbreaks of fire is therefore a regular occurrence. This also constitute a high proportion of post-harvest losses in addition to spoilage.

The third most important constraint of Processors is the superior bargaining power of the primary middlemen. The framework of the crayfish value chain, as it is today, is such that the processors, as an entity, are not allowed to take their products to landing sites. There is a restriction in their sales outlet to the primary middlemen that come to the fishing communities. Thus, the primary middlemen to a very large extent determine the price of the crayfish at that interface. As posited by Paharia, Keinan, Avery and Schor, (2011) that when the upstream actors are few with numerous downstream actors, the market power lie with the fewer set of actors which in this case are the primary wholesalers.

Crayfish Primary Wholesalers

The most important or severe constraint to the Primary wholesalers is high cost/difficulty of transportation to and from the fishing communities. Water transportation is not well developed and the wholesalers rely on pirogues that visit these communities at specific times. Where the actor is not satisfied with that schedule he/she has to charter a pirogue at huge cost. This agrees with the findings of Jaji, Adebguyi, and Yusuf-Oshoala (2014) and Gills, Sharma, Burman, Sharma and Kar (2017) that identified infrastructure related constraints as the most severe with regards to post harvest management of inland fisheries.

The second most severe constraint is cost of entry in terms of membership registration. There is some restriction to entry into the crayfish wholesaling business. It takes the form of a high cost of entry to be a registered member, and therefore be able to do business. Would-be members pay the sum of N250,000 (Two hundred and fifty thousand naira) in cash and settle a list of items akin to marriage requirements. The overall cost may be as high as N450,000.

The constraint of high capital requirement is the third most severe. The implications of high Capital requirements need of business have been discussed earlier. The need for access to finances by the various actors along the value chain cannot be overemphasized. Insecurity due to non-state armed groups is yet a major challenge to the primary wholesalers. Losses of whole consignment have been reported, including loss of lives. The economic cost is enormous.

Crayfish Retailers

High capital need is the most severe constraint of this category of value actors. The place of capital at an affordable cost have been discussed as a means of upgrading and sustaining value chain activities earlier. Difficulty and cost of obtaining market stores are the second and third constraint respectively. This is in consonance with the findings of Hatte, Prakash, Kumar, Krishnan, Vinay and Gawa (2015). The retail market is also plagued by numerous agencies of the local government and unions and undefined organisations collecting one type of fee or taxes from the traders. These levies increase their costs. and impede their activities as one of the actors along the crayfish value chain.

Because of the huge number of participants at this stage of the value chain, competition is stiff. They operate at a nearly perfect market structure with prices being as low as possible. This issue has been highlighted by Das Apu *et al.* (2013) and Debnath, Biswajit *et al.* (2014) Seasonal availability, spoilage of crayfish in storage and the superior bargaining power of primary wholesalers are other constraints of the retailers.

Conclusion

The availability of crayfish to the consumer is the result of a combined effort of different actors playing different roles along the value chain. Like people say, a chain is as strong as its weakest point. When there are economic units involved in complementary and competitive activities, the differences in the nature of their constraints becomes very important in the smooth and successful running of the overall process.

Crayfish fishers have a unique capital and input needs, operate in remote distant fishing communities that are far from the final consumers. These circumstances combine to create a unique set of constraints to their activities thus exposing their vulnerability.

For the Processors, short shelf-life of processed product is the most severe of their constraints. It add to their pressure to sell as soon as possible, leading to uncompetitive pricing and loss in revenue. The import of this is a relatively reduced profit for them.

For the Primary wholesalers, the most important or severe constraint is high cost/difficulty of transportation to and from the fishing communities. The need for improved transportation system is apparent for these actors.

For the Retailers, high capital needs is the most severe constraint of this category of value actors. The retail market is also plagued by numerous agencies of the local government and unions and undefined organisations collecting one type of fee or taxes from the traders. This add to their cost and impede their activities. Because of the huge number of participants at this stage of the value chain, competition is stiff.

Recommendations

On the basis of the findings of this research, the following recommendations are made;

- There is need to strengthen both the institutional and non-institutional sources of financing of the crayfish value chain to enhance its activities.
- Government and Non-governmental organizations should raise awareness on the need for adoption of improved technologies for harvesting, processing and sustainable exploitation of crayfish to reduce the problem of over-exploitation and maximize outputs.
- Fishers should be organized or encouraged to organize themselves, not only in terms of productive asset acquisition, but also in

marketing of their products, to improve on their collective efforts and bargaining power.

- Policies should be implemented to reduce collusion among actors within the same level of participation and by extension their influence on the downstream actors along the value chain.

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COSTS AND RETURN OF PLANTAIN VALUE CHAIN IN CALABAR AGRICULTURAL ZONE, NIGERIA

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Abstract

Plantain is a crop of significant economic value and could serve as a vital source of foreign exchange if given proper attention. There is therefore, a pressing need to explore this potential, particularly, the profit accrued by the various actors in the plantain value chain. This study focused on the costs and return on plantain value chain in Calabar agricultural zone, Cross River State, Nigeria. Specifically, the study sought to estimate the costs and return accrued to actors along the value chain. Multistage sampling procedure was used to select a total of 216 respondents: 75 plantain producers (farmers), 71 marketers, and 70 processors. Primary data were collected using well-structured questionnaire and data were analysed using budgetary analysis. The estimated annual costs and return analysis per actor showed a total cost of ₦303,351.44, ₦1,760,092.958 and ₦9,631,154.706 for producers, marketers and processors respectively. The profit from plantain value chain were estimated at ₦3,928,148.56, ₦4,343,607.04 and ₦7,855,377.29 for producers, marketers and processors respectively. Hence, the study concluded that the plantain value chain is profitable for all actors. It is recommended that the government should provide incentives that would encourage more people to engage in plantain production, processing, and marketing to further harness its economic potential.

Keywords: Plantain Value Chain, Economic Analysis

Introduction

In Nigeria, plantain cultivation commonly involves four main types, categorized by their bunch characteristics: Horn type, French type, False Horn type, and French-Horn type. The False Horn type is the most widely distributed or cultivated, often attributed to its tolerance for less-than-ideal soil conditions (Uzakah 2020). Optimal conditions for production include; an optimum temperature of 30^0C, a mean monthly rainfall of 100mm, a soil pH of 4.5–7.5, and a well-drained sandy-loam soil (Olaghere *et al*., 2018).

As a perennial crop, the growing and harvesting periods for plantain are often susceptible to external factors like strong winds and rainfall. These factors can influence supply and demand volumes, leading to price fluctuations (Ukwuaba *et al*., 2022). In Nigeria, plantains are typically scarce in the market from May to August due to strong winds at the start of the rainy season, which follow the dehydration stress of the five-month dry season. Abundance generally runs from September to March, with a peak during December and January.

It is the fourth most important food crop globally, after rice, wheat, and maize, and is a staple for more than 70 million people in Africa, providing both food and cash income (Akintade *et al*., 2016). Nigeria is one of the largest plantain producers in West Africa, with an estimated annual production of about 2.74 million metric tons (Kopp, 2024). Approximately 49% of farming households consider plantain their main crop, highlighting its importance in the rural and urban economies, social life, and cultural practices of Sub-Saharan Africa. International Institute for Tropical Agriculture (IITA, 2019). Plantain's economic prospects in West Africa are significant for employment, contributions to national income, poverty alleviation, and industrial growth (Adedapo and Abdu-Raheem, 2023). It is consumed in numerous forms, including fried ripe pulp (*dodo*), chips (fried unripe pulp), boiled, pounded, roasted (*bole*), or processed into flour for *amala*. Plantain value-added products serve as food, livestock feed, and raw materials for the confectionery, bakery, and pharmaceutical industries (Mogaji and Mogaji, 2020).

The plantain value chain involves village collectors who assemble bunches from diverse production points and transport them to markets in towns and cities. Plantain assembling and marketing encompass all activities associated with moving produce from farmers to final consumers (Udosen**,** 2016). Plantain is bulky, highly perishable, and seasonal, which complicates its handling and distribution. Assemblers/marketers face difficulties due to the dispersal of production zones, poor road networks, and limited communication with urban consumption centres (Ukwuaba *et al*., 2022). The perishable nature leads to continuous deterioration, aggravated by poor post-harvest management. This results in significant loss of quality and quantity, directly impacting the final market price.

Processing of plantain into different products is increasingly being seen as a major effort at reducing post-harvest losses and wastage. Processing helps to tackle some of the problems posed by perishability and seasonal gluts, especially in the context of poor storage and transport infrastructures. In addition to extending shelf life, processing also results in value addition and employment generation (Uzakah, 2020). Thus, although Nigeria was ranked among the top 20 global producers in 2017 (Umoh, 2021), increased production without corresponding efficient processing often leads to post-harvest losses and wastage. Therefore, effective distribution is crucial for commodity availability and price stabilization (Uzakah, 2020, & Adeolu *et al*., 2016). This study is designed to evaluate the costs and return along plantain value chain in Calabar Agricultural zone.

Materials and Method

The study was conducted in Calabar Agricultural zone of Cross River State, Nigeria. Calabar agricultural zone consists of seven local Government Areas (LGAs) namely Biase, Akamkpa, Odukpani, Calabar Municipal, Calabar south, Akpabuyo and Bakassi. Calabar agricultural zone lies between latitude $4^0$5' and 5^0 10'N and longitude $8^0$17' and $8^0$20' E (Abang, 2017). The study covers a total land area of 9,972 km^2. It is bounded to the North by Etung, Ikom and Yakurr Local Government Areas (LGAs), to the west, by Akwa Ibom State, to the south by the Gulf of Guinea and Equatorial Guinea and to the East by the Republic of Cameroon. With a population growth rate of 2.5%, Calabar Agricultural Zone, has an estimated population of 1,189,801 people (National Population Commission, 2022).

Sampling Technique

Multistage sampling procedure was adopted for the selection of a sample size for the study. In stage one; purposive sampling was used to select 4 LGAs in Calabar agricultural zone on the basis of prevalence of plantain farming marketing and processing as well as availability of a sample frame in the study area namely: Biase. Calabar South, Calabar Municipal and Akpabuyo. In stage two, random sampling was employed to select a total of 75 plantain producers from a sample frame of 150 registered plantain farmers in two LGAs, (Akpabuyo and Biase) in the study area obtained from plantain union farmers association.

Proportionate stratified random sampling was also used to select 71 plantain marketers from the list of 142 registered members from the market association across Calabar Metropolis and 70 plantain processors (roasted plantain vendors) from the list of vendors of 140 registered vendors.

Method of data collection

Primary data were obtained through the use of validated questionnaires. Thus, Questionnaires were administered to selected plantain producers, marketers and processors in the study area, during the period of April through June, 2025.

Analytical technique

Gross margin and marketing margin

The gross margin analysis was used to determine the costs and return of producers along

The plantain value chain. This was given as:

Gross Margin (naira/ha) = Gross Value of Output (GVO) – Total Variable Cost (TVC)

Where;

Gross value of plantain = quantity of plantain bunches in Kg (Q) price (P)

Total variable cost = cost incurred for labour and purchased inputs for the production season.

Gross margin was calculated on per hectare basis for plantain producers.

NI = TR – TC (TFC + TVC)

The net returns on investment were also evaluated and expressed as:

$$NRI = \frac{TR - TC}{TC} \times \frac{100}{1}$$

TC = TFC + TVC

NFI = TR – (TVC + TFC)

Where,

NFI = Net Farm Income (N)

TR = Total Revenue (N)

TVC = Total Variable Cost (N)

TFC = Total Fixed Cost (N)

Gross and net marketing margins, as well as marketing efficiency, were calculated for plantain processors and marketers. This was given as:

Gross marketing margin (in naira) Gross market margin = Selling price – Purchase price - TVC

Net marketing margin (in naira) = Gross marketing margin – Total fixed costs (TFC)

Marketing efficiency (%) = Net marketing margin/Total Marketing cost x 100

Where; TVC = Total variable costs and Total marketing cost = TVC + TFC

Profitability analysis

Return on sales (NI/TR)

Rate of return on variable cost (TR-TVC/TVC)

Return on investment (ROI)(NR/TC)

Operating ratio = TVC/TR

Results and discussion

Cost and returns analysis of plantain production

The estimate of the average costs and return of plantain production by farmers as presented in Table 1 below showed that among the total cost incurred by farmers, suckers cost (₦88,106.67), was the highest cost and accounted for 29.05 % of the total costs, followed by cost of herbicides (23.20 %), cost of labour (16.81 %), and rent on land (11.86 %). The high-cost share of 11.86 % attributed to rent on land can be link to the increasing land demand from non-agricultural uses. Meanwhile each of the depreciated costs for all asset were less than 5 % of the total cost. The results further showed that the gross margin per farmer and net profit of plantain production per farmer/kg were estimated at ₦ 3,995,167.33 and ₦ 3,928,148.56, respectively with an average quantity of 651 plantain bunches sold per farmer annually. This implies that the plantain producers make good returns from their entrepreneur activities. Return on sales gave a profitability index of 0.93 which implies that plantain producers earn 93 kobo as net profit from every ₦1 of sales. With low profitability index of less than 1, plantain producers need to adopt better management practices to be able to generate more profit. The rate of return on investment of 12.95 shows that plantain producers operating in the study area earns ₦12.48K profit on every N1 spent. This shows that, though the cost of running a micro plantain producer in the study area is high, a relatively high profit could still be achieved. The rate of return on variable cost is estimated to be 16.91 which imply that every N1 cost incurred on variable inputs generates about ₦16.91K. This will require improvement in the efficiency of use of variable inputs in order to increase the profitability. The operating ratio of 0.056 indicates that the total variable cost is about 5.6 percent of the total revenue which is low and indicates a good position of the business.

In similar study carried out in Rivers state by Bethel and Obiene (2024), the total cost of production was ₦ 482,010.27 with the revenue and net income of ₦ 1,638,000 and ₦ 1,155,989.75, respectively. The result was in line with the findings of Kainga *et al*., (2019) who reported that plantain production is a profitable venture in southern part of Nigeria. Olaghere *et al*., (2018) in Osun State, Nigeria had gross margin accrued to plantain producers to be ₦639,148.31/ha per annum, while the net marketing margin/bunch for the plantain processors and marketers were ₦1836.61 and ₦204.96 respectively.

Table 1: Average annual costs/returns on plantain production

Items	Cost (₦)	Cost share (%)
Variable cost (VC)		
Transportation	11,805.45	3.89
Cost of labour	50,981.4	16.81
cost of fertilizer	15,058.73	4.96
Herbicides	70,380.41	23.2
Suckers	**88,106.67**	**29.05**
TVC per farmer	236,332.67	77.91
Fixed cost		
Land purchase/rent	35,973.34	11.86
Depreciation on equipment		
Shovels	5,904.85	1.95
Machetes	3,320.95	0.24
Wheel barrows	6,550.85	2.16
Rakes	3,860.95	1.27
Hoes	4,829.71	1.59
Safety boot	6,578.09	2.17
TFC per farmer	67,018.78	22.09
Total cost per farmer	303,351.44	100
Revenue		
Quantity sold (in bunches) per farmer	651	
Selling price per 16 kg bunch (₦)	6500	
Total Revenue (TR) per farmer (₦)	4,231,500	
Gross margin (TR-TVC) per farmer	3,995,167.33	
Net revenue (NR) per farmer = TR-TC	3,928,148.56	
Net revenue (NR) (TR-TC) per bunch per farmer	6,034.02	
Net revenue (NR) (TR-TC) per kg per farmer	377.13	
Net revenue (NR) (TR-TC) per ha per farmer	1,155,337.81	

Profitability analysis	
Return on sales (NR/TR)	**0.928**
Rate of return on variable cost (TR-TVC/TVC)	**16.905**
Return on investment (ROI)(NR/TC)	**12.949**
Operating ratio = TVC/TR	**0.056**

Source: Field Survey Data, 2025

Costs and return in plantain marketing

The estimate of average costs and return of plantain marketing enterprises is presented in Table 2. The results reveals that cost of plantain purchased accounts for 97.62 percent of the total variable cost of production. Meanwhile the costs for store and levy/tax accounted for only 0.56 % and 0.137 %, respectively of the total cost. The results further revealed that the gross margin and net profit of the marketers were estimated at ₦4,400,018.31 and ₦4,343,607.04 respectively. This implies that the plantain marketers make good returns from their marketing activities. Study conducted by Ifejirika *et al.* (2023) also indicated that plantain marketing is a profitable business with a gross margin of ₦231,637, Net margin of ₦132,971 and marketing margin of 25 %.

Profitability ratios were calculated to establish the profitability level of the enterprise. The result further showed return on sales value of 0.71 which implies that plantain marketers earn 71 kobo as net profit from every ₦1 of sales. With low profitability index of less than 1, plantain marketers may need to adopt better management practices to be able to generate more profit. The rate of return on investment of 2.47 shows that plantain marketers operating in the study area earns ₦2.47 Kobo profit on every N1 spent. This shows that, though the cost of running a micro plantain producer in the study area is high, a relatively high profit could still be achieved. Aminu *et al.* (2017) had the rate of investment to be 1.49. Meanwhile the value obtain for this study was much lower (0.56). The rate of return on variable cost is estimated to be 2.58 which imply that every N1 (naira) cost incurred on variable inputs generates about ₦2.58 kobo. The operating ratio of 0.279 indicates that the total variable cost is about 27.9 percent of the total revenue which is high and does not show a good position of the business. The results obtained in this study is higher than what was observed in the report of Aminu *et al.* (2017) where an average total cost of N48,867.68 was incurred per month while total revenue of N72,642.80 was realized with a net return of N23,775.18.

Table 2: Average annual costs/return on plantain marketing

Items	Cost (₦)	Cost share (%)
Variables cost (VC)		
Cost of Purchasing Plantain	**1,675,000**	97.618
cost of labour	8,535.211268	0.497
cost of transportation	20,146.47887	1.174
Total Variable cost (TVC)	1,703,681.690	96.795
Fixed cost (FC)		
cost of rent	45,422.53521	3.068
Tax/levy	10,988.73239	0.137
Total fixed cost (TFC)	56,411.268	3.205
Total cost (TVC+TVC)	1,760,092.958	100
Revenue		
Quantity of bunches marketed/year	670	
Selling price per 16 kg bunch (₦)	9110	
Total Revenue (TR) per marketer (₦)	6,103,700	
Gross margin (TR-TVC) per marketer (₦)	4,400,018.310	
Net revenue (NR) (TR-TC) per marketer (₦)	4,343,607.042	
Net revenue (NR) per bunch per marketer	6,482.996	
Net revenue (NR) per kg per marketer	405.187	
Profitability analysis		
Return on sales (NI/TR)	**0.712**	
Rate of return on variable cost (TR-TVC/TVC)	**2.583**	
Return on investment (ROI)(NR/TC)	**2.468**	
Operating ratio = TVC/TR	**0.279**	

Source: Field Survey Data, 2025

Costs and returns in plantain processing

The estimate of costs and returns of plantain processing enterprises is presented in Table 2. The results showed that purchased cost of plantain accounts for 99.46% percent of the total cost of production. The results further revealed that the gross margin and net profit of the processors were estimated at ₦7,883,409.74 naira and ₦7,855,377.29 naira respectively. This implies that the plantain processors are making good returns from their processing activities.

Profitability ratios were also estimated to establish the profitability level of plantain processing enterprise. The result indicated return on sales value of 0.45 which implies that plantain marketers earn 45 kobo as net profit from every ₦1 of sales. With low profitability index of less than 1, plantain marketers may need to adopt better management practices to be able to generate more profit. The rate of return on investment of 0.82 shows that plantain marketers operating in the study area earns 82 kobo profit on every ₦1 spent. This shows that, though the cost of running a micro plantain producer in the study area is high, a relatively high profit could still be achieved. The rate of return on variable cost is estimated to be 0.82 which imply that every ₦1 cost incurred on variable inputs generates about 82 kobo. The operating ratio of 0.54 indicates that the total variable cost is about 54 percent of the total revenue which is high and does not show a good position of the business. The result obtain in this study is in line with that of Benchendo *et al.* (2013), who found that the chips enterprise incurred variable costs of ₦778,160 and made total sales of ₦1,188,000 with the fixed cost of ₦21,667 being the depreciated value of the slicer, tripod stand, spoons, tray, basin and fryer used by the entrepreneurs. Similarly, Alufohai and Eronmwon (2014) previously had a gross margin of ₦288.6, ₦380.37 and ₦419.11 per kg of raw plantain for fried plantain chips, dried plantain chips and plantain flour respectively, all indicating that plantain processing is a profitable enterprise.

Table 3: Average annual costs/return on plantain processing

Items	**Cost (₦)**	**Cost share (%)**
Variable cost		
Purchase cost	**9,579,302.400**	**99.463**
Transportation	1,251.429	0.013
Cost of labour	2,121.429	0.022
Cost of water proof	598.429	0.006
Cost of Foil	3,847.143	0.040
Cost of charcoal	8,211.429	0.085
Cost of vegetable oil	3,204.286	0.033
Cost of spices	4,585.714	0.048
TVC per processor	9,603,122.257	99.709
Fixed cost		
Taxes/levies	2,585.000	0.027
Rent	18,182.857	0.189
Depreciation		
Roasting drum	2,716.939	0.028
Kitchen knives	483.878	0.005
Basin	800.000	0.008
Umbrella	2,044.898	0.021
Wire gauze	195.408	0.002
Chairs/tables	1,023.469	0.011
TFC per processor	28,032.449	0.291
Total cost (TC) per processor	9,631,154.706	100
Revenue		
Quantity of bunches sold/year	862	
Fingers/16 kg bunch	42	
Price/Finger	483	
Total Revenue (TR) per processor (₦)	17,486,532	
Gross margin (TR-TVC) per processor (₦)	7,883,409.743	
Net revenue (NR) (TR-TC) per processor (₦)	7,855,377.294	
Net revenue (NR) per bunch per processor	9,112.967	

Net revenue (NR) per kg per processor	569.560
Profitability analysis	
Return on sales (NI/TR)	**0.4492**
Rate of return on variable cost (TR-TVC/TVC)	**0.8209**
Return on investment (ROI)(NR/TC)	**0.82**
Operating ratio = TVC/TR	**0.5492**

Source: Field Survey Data, 2025

Conclusion and Recommendations for Development

The study concludes that there is a great potential for the development, efficiency and commercialization of plantain value addition in the study area, because it is among the thriving ventures in the study area which has positively enhanced the welfare of the actors. Also plantain value addition is a profitable investment considering the size of rate of return on investment obtained from the study. The showed that plantain producers need to adopt better management practices to be able to generate more profit. It has been proven that plantain value addition is capable of creating employment, generating income and improving the standard of living of the people.

The provision of subsidized inputs for the actors will also help to reduce production and processing costs and Value chain actors should organize themselves to join viable cooperative associations in order to enjoy the advantages of easy access to credit; collective marketing and economies of scale.

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COST STRUCTURE, RETURNS, AND PROFITABILITY OF TABLE EGG PRODUCTION UNDER DEEP LITTER TECHNOLOGY IN AKWA IBOM STATE, NIGERIA

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Abstract

This study analysed the cost structure, returns, profitability, and determinants of table egg production under the deep litter system in Akwa Ibom State, Nigeria. Primary and secondary data were used for the study. Primary data were collected through a structured questionnaire administered to 60 poultry farmers selected from Uyo, Ikot Ekpene, and Abak Local Government Areas. Data were analysed using descriptive statistics, budgetary techniques, and Ordinary Least Squares(OLS) multiple regression. The results showed that the average age of the farmers was 45 years, male farmers accounted for 81.7% of respondents, and the mean poultry farming experience was 10 years. Average stock sizes were 730 birds for small-scale farms, 2,168 birds for medium-scale farms, and 3,375 birds for large-scale farms, while the pooled average stock size was 2,091 birds for one production cycle of about 18 months. The pooled total revenue was ₦39,596,894.00, gross margin was ₦6,198,185.00, and net profit was ₦5,186,698.00. Gross margin per bird was ₦2,964.00, while the rate of return on investment was 13.93%, indicating that the enterprise was profitable. The regression results showed that feed, age of birds, farming experience, and education significantly influenced egg output, whereas age of farmer and sex were not statistically significant at conventional levels. The study concludes that table egg production under the deep litter system is profitable in the study area and recommends improved access to low-interest credit and training on the use of locally available feed ingredients to reduce feed costs.

Keywords: deep litter technology; table egg production; cost structure; profitability; Akwa Ibom State

Introduction

Decision on what to produce, how to produce, whom to produce and the scale of production has been a perennial problem of any investor including agricultural investment. Reliable data on cost and returns structure of various agricultural enterprises can help agricultural entrepreneur make investment decisions and plan on how to raise capital and other inputs to produce. Additionally, such information can guide farmers in making better management and investment decisions and encourage new farm entrants to execute their farm plan.

Agricultural production in Nigeria is faced with a variety of constraints and they include poor land tenure system, low level of irrigation farming, land degradation, climate change, low technology, high production cost and poor distribution of inputs, limited financing, high post-harvest losses and poor access to markets (FAO, 2021). Low investment in agriculture expressed in low level of technology especially in the livestock subsector has led to insufficient production of livestock products and widening demand and supply gap to meet local demand. Effiong and Oluwafemi (2022) reported that Nigeria is an import-dependent country and that by continent, Nigeria imported goods mostly from Asia (44.6 %), EU (33.6 %), America (14.1 %), Africa (6.5 %), and others (1.2 %). Also by country, Nigeria's most significant suppliers include China (23 %), the United States (10%), India (8 %), Belgium (6 %), the Netherlands (6 %), and other countries across the world. and its excessive importation of animal products has seriously affected the Nigerian livestock sector. Despite the ban on imported poultry products into the country there is still smuggling of frozen poultry meat, this with high cost of feed input has affected the poultry local industry and economic development in Nigeria

Deterioration of commercial poultry production has been ascribed to the unavailability of day-old chicks, poor quality feeds, and occasionally insufficiency of the feed ingredients (especially grains), poor veterinary services, unavailability of drugs and vaccines, and lack of capital for enlargement are the major problems affecting poultry production in Nigeria (Ayinde, Ibrahim, and Arowolo, 2012). These constraints have led to an increase in the prices of poultry products in developing countries. The average price of a medium-sized egg in Nigeria presently is N200.00 which has made it difficult for most citizens to afford it because of the high rate of poverty in the country. SOFI (2018) reported that about 11.5 percent of Nigerians are undernourished especially those in rural areas with wasting and stunting in children under 5 years of age being at 10.8 and 43.6 percent respectively. FAO (2019) reported that 53 percent of the population of Nigeria lives under the poverty line with the majority of this population living in rural areas.

The Food and Agricultural Organization (FAO, 1989) recommended that daily protein consumption should be 60g per person out of which 35g is expected to be from an animal source.

The recommendation has not changed. but the protein intake in Nigeria is quite low as reported by (Afolami *et al.*2013; Otunaiya, Adeyonu, Bamiro,2015; Adepoju, 2008) the average per capita protein intake in Nigeria is 51.7 g of which only 6.8 g comes from an animal source. Egg is a very cheap and affordable animal protein source that can address malnutrition among low-income households in Akwa Ibom State.

The agricultural sector in Nigeria is heterogonous comprising small, medium, and large-scale farmers with the small-scale farmers dominating the sector cultivating rice, and cassava, and keeping cattle, poultry, and small ruminants (FAO, 2019). The contribution of this sector to GDP is said to be about 21.2 percent as reported by FAO (2019). The subsectors in the agricultural sector include crop, livestock, fishery, and forestry of which the crop subsector dominates followed by the livestock industry where poultry is the largest in this category (Ajiboye, B. O., Bamiro, O. M., Adeyonu, A. G., and Faseyi, S. A, 2019).

Poultry production, particularly egg production, plays an important role in improving food security, generating income, and providing employment opportunities in Nigeria.

Deep litter is one of the egg production technologies and it is an intensive system that keeps birds permanently on the litter all through their production cycle. The deep litter technology is popular among small-scale and medium-scale poultry farmers because it requires relatively lower capital investment compared to battery cage systems and allows birds to move freely within the poultry house. It is one of the most widely adopted technologies for egg production. Deep litter system has advantages of increasing efficiency in poultry management, reducing the smell of ammonia through the use of wood shavings as litter material, facilitating the management of very large flock, maximization of use of land, and eliminating bone disorders usually common with battery cage system, maximization of labour, reduction of loss of eggs to vermin, snakes, and thieves, allowing birds to exhibit their natural behavior of scratching the floor in search of food or warmth and insulation of chicken from cold weather conditions.

Reliable cost and returns structures of deep litter egg production technology is essential for farmers in planning and determining the gross margin and profitability of the enterprise, identifying major cost components, and improving resource control and allocation in the farm business. The findings of the study provide useful information on the economic viability of deep litter egg production system in Akwa Ibom State.

Research methodology

The Study Area

The study was conducted in Akwa lbom State, Nigeria. The State lies on the coastal plain of Southern Nigerian with a land mass of 8,412 sq. km. There are 31 Local Government Areas which are divided into three senatorial districts with Uyo as the State capital. The state is located between the latitude 430° and 530 ° n and longitude 730 and 8 15 E. Akwa Ibom State shares borders with River State in the West, Abia and Imo State in the North, Cross River State in the East and Atlantic. The State recorded a total population of 3,920,208 in 2006 (NPC 2006) with the national population growth rate of 2016 Akwa Ibom State population is about 9,565,307 persons. The State is known for the production of crops such as cassava, yam, cocoyam, maize, rice, cowpea and melon while cash crops - oil palm, coconut, rubber, cocoa, raffia palm, plantain, banana, pineapple, leafy vegetable, okro, pepper and tomatoes. It also produces livestock such as sheep, goats, rabbits, snails and poultry. The state has comparative advantage in poultry production because of its climate that favors the production of different livestock including poultry. However the two major systems in commercial production in the states are the battery cage and deep litter and battery cage technologies.

Sampling Size and Sampling Techniques

Three Local Government areas were purposively selected for this study. These Local Government Areas were selected because they have higher population of poultry egg farmers. The selected Local Government Areas included: Uyo, Ikot Ekpene, and Abak. With the assistance of (AKADEP) extension agents from those Local Governments, lists of major poultry farmers were obtained. From the list, 20 poultry egg farmers practicing deep litter in their farms were randomly selected from each of the Local Government Areas giving a total of 60 respondents.

Analytical Technique

The analytical technique that was applied for the study are descriptive statistics, analysis of cost and returns and multiple regression analysis based on ordinary least squares. Descriptive statistics was applied to the socioeconomic characteristics of egg farmers and quantity of eggs produced. Profitability was analyzed using the analysis of cost and returns and the determinants of egg production were analyzed with multiple regression analysis.

The socio-economic characteristics of laying birds' farmers were analyzed using descriptive statistics such as frequency tables, means and percentage distributions.

To obtain the quantity of eggs in deep litter technology: This objective was analyzed using the descriptive statistics such as frequency tables, means and percentage distributions.

To determine the profitability in deep litter technology: Analysis of costs and returns was estimated thus:

π= TR – TC ……………………………………………………1

Where:
π= Profit
TR = Total revenue (N)
TC = Total cost
TC = TFC + TVC

TR = QP
Q = Quantity
P = Unit price
TVC = Total Variable Cost (N)
TFC = Total Fixed Cost

Profitability was determined by financial ratios as follows:

The Rate of Return on Investment (RROI) and Rate of Return on Fixed Cost (RRFC) were used to determine and compare the measure of financial outcomes of the poultry egg farmers that used deep litter system in the study area. They were calculated as follows:

$$RROI = \frac{Profit}{Totalcost} X\ 100 \qquad \text{(ii)}$$

$$RRFC = \frac{Grossmargin}{Totalfixedcost} X\ 100 \qquad \text{(iii)}$$

The straight-line depreciation method as shown was used to calculate the depreciation cost of the equipment (fixed assets):

$$Annualdepreciation = \frac{CP - SV}{n} \qquad \text{(iv)}$$

Where; CP = Cost price (N), SV = Salvage value (N), n = Useful life span of the asset (Years).

The determinants of eggs produced: This was accomplished using the OLS multiple regression analysis.

The implicit form of the model for objective four is specified as follows:

$$Q = f\ (X_1, \dots, X_n + \mu) \qquad \text{(v)}$$

Where:

Q	=	Number of crates of eggs per week
$X_1, \dots, X_n$	=	Explanatory variables
μ	=	Error term

The explicit form of the multiple regressions is expressed as follows:

$$Q = f\ (\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \mu) \ldots\ldots(\text{vi})$$

Where:

Q	=	Number of crates of eggs per week
β's	=	The parameters to be estimated
β_o	=	Constant
X_1	=	Age of farmer (years)
X_2	=	Level of education (years)
X_3	=	Quantity of feed per bird per week (kg)
X_4	=	Farming experience (years)
X_5	=	Stock size (no. of birds)
X_6	=	Household size (no of persons)
X_7	=	Age of birds (weeks)
μ	=	Error term.

Results and discussion

Socio-Economic characteristics of Respondents

Age of Respondents

The results of table 1 indicated that the mean age of farmers keeping birds in deep litter system was 45 years. Majority (70%) were within the age range of 40 – 49years. This means that a good number of poultry farmers are still in their active age bracket. This could be because younger farmers aged less than 29 years may be constrained by funds to engage in poultry business. This is in line with the findings of Esiobu *et al.* (2014) who reported that 81.67% of poultry farmers are within the age bracket of 14 – 50 years.

Gender

Majority of the egg farmers (81.7%) were male. This could be because of the cultural perception that females are home managers and as such may not be able to cope with the time demanding nature of poultry egg business.

Marital Status

The study also shows that 76.7% of the respondents were married implying that married people tend to have higher responsibilities and as such tend to look out for areas of profitable investment to increase their income levels. This is in agreement with the study by Esiobu *et al.* (2014) who asserted that majority (76.67%) of the poultry egg farmers in Imo State were married meaning they are responsible individuals by the standards of the society.

Poultry Farming Experience

The mean years of poultry farming experience was found to be 10years. The years of poultry experience increases output as more experienced farmers tend to be more knowledgeable and skilled in poultry management.

Household Size

Mean household size was found to be 5persons. Household size influences egg production by contributing to family labour which increases output.

Education

Farmers with no formal education operating on the deep litter stood at 11% while the highest proportion was found in those with tertiary education. This is at variant with an assertion that majority of farmers do not have formal education.

Primary Occupation

The primary occupation of the respondents was found to be mostly poultry farming at 43.3% meaning that poultry farming to them is a full-time business that requires their time and focus.

Table 1: Socio-Economic Characteristics of Respondents

Variables	Freq	%
AGE		
20 – 29	2	3.3
30 – 39	6	10
40 – 49	42	70
50 – 59	9	15
60 – 69	1	1.7
Total	**60**	**100**
Mean Age	45	
Gender		
Male	49	81.7
Female	11	18.3
Total	**60**	**100**
Marital Status		
Single	6	10
Married	46	76.7
Widowed	4	6.7
Divorced	4	6.7
Total	**60**	**100**
Farming Experience (Years Mean13 years		
1 – 5	0	0.0
6 – 10	8	13.3
11 – 15	24	40
16 – 20	26	43.3
21 - 25	2	3.3
Total	**60**	**100**
Mean	10	
Household Size		
1-3	11	1
4-6	39	18.3
7-9	10	65
Total	60	16.7
Mean	5	**100**

Level of Education		
No formal education	7	11.7
Primary Sch Edu	8	13.3
Secondary School	14	23.3
Tetiary	31	51.6
Total	**60**	**100**
Mean 12 years		
Primary Occupation		
Poultry farming		
Crop farming	26	43.3
Trading	9	15
Civil service	7	11.7
Total	18	30
	60	**100**

Source: Field Survey, 2022

Distribution of Farmers by Scale of Operation

Omotosho and Oladele (1988), Subhash, Joynal and Fakhrul (1999) and Ojo (2003) reported that poultry egg farmers having less than 1000 birds were considered as small-scale farmers, 1001-3000 as medium scale farmers while those having 3000 and above birds were large scale farmers. The result from table 2 shows the distribution of farmers by scale of operation. Medium scale operation recorded the highest percentage with 50.0%. This is contrary to the findings of Effiong and Umoh (2010) who noted that the poultry enterprise in Akwa Ibom State is dominated by small scale farmers and are regarded as major contributors to the growth of the sector in the state.

Table.2: Distribution of Farmers by Scale of Operation the Study Area

Scale of operation	Freq	%
Small (<1000)	20	33.3
Medium (1001- 3000)	30	50.0
Large (>3000)	10	16.6
Total	60	100

Source: Field survey, 2022

The cost structure and level of returns for one production cycle in deep litter system is showed in table 3. The analysis revealed that the cost of feed is a major cost incurred during production. It accounted for over 80% of the total cost of production. The revenue generated from sales of eggs was found to be highest with 79% of total revenue received. It can also be seen from the table that through the sales of eggs alone 90% of total variable cost was recovered. The gross margin per bird was found to be highest in operators under large scale production (N2, 907) implying that it is rational where the resources are available to embark on large scale production of laying birds using this system of production. The pooled value for rate of return on investment was found to be 13.93% meaning that for every one naira invested in the business a return of N13.93 was received.

Table 3 Analysis of Cost Structure and Returns for Deep Litter Technology for one production cycle (18months) in the Study Area

Items	Small Scale qty 730 birds Amt (N)	Medium Scale qty 2168 birds Amt(N)	Large Scale qty 3375 birds Amt (N)	Pooled value 2091 birds Amt (N)	Percent contribution to TC (%) 2091 birds
Variable cost					
Cost of DOC	332,150.00	986,440.00	1,535,625.00	951,405.00	2.76
Feed	10,124,930.00	31,831,275.00	50,852,934.00	30,936,379.00	89.9
Transportation	97,500.00	155,000.00	299,000.00	183,833.00	0.53
Medication	75,700.00	200,333.00	250,000.00	175,344.00	0.50
Vaccination	90,950.00	400,000.00	600,000.00	363,650.00	1.05
Labour	50,500.00	400,000.00	600,000.00	350,166.00	1.01
Mortality	19,865.00	56,810.00	90,667.00	55,780.00	0.16
Electricity bill	50,000.00	120,000.00	145,000.00	105,000.00	0.30
Fuel	65,000.00	85,000.00	120,000.00	90,000.00	0.26
Repair/maintenance	26,450.00	39,500.00	50,000.00	38,650.00	0.11
Disinfectant	15,650.00	20,100.00	30,000.00	21,916.00	0.06

Wood shavings	45,600.00	71,000.00	150,000.00	88,866.00	0.25
Kerosene/Charcoal	15,750.00	41,900.00	55,500.00	37,716.00	0.10
TVC	11,010,045.00	34,407,358.00	54,778,726.00	33,398,709.00	
TVC Per Bird	15, 082.00	15,870.00	16,230.00	15,972.00	
Fixed Cost Items					
Depreciation value	100,000.00	571,960.00	684,000.00	451,199.00	1.31
Rental value of land	134,500.00	254,000.00	290,000.00	226,166.00	0.65
Total Fixed Cost	**234,500.00**	**825,960.00**	**974,000.00**	**678,153.00**	
Total Cost	**11,244,545.00**	**35,233,318.00**	**56,752,726.00**	**34,410,196.00**	100
Revenue Items					
Eggs	9,861,750.00	30,313,675.00	49,608,640.00	29,928,021.00	
Spent layers	1,898,000.00	5,636,800.00	8,775,000.00	5,436,600.00	
Manure	1,233,733.00	4,562,074.00	6,901,013.00	4,232,273.00	
Total Revenue	12,993,483.00	40,512,549.00	65,284,653.00	39,596,894.00	
Gross Margin	1,983,438.00	6,105,191.00	10,505,927.00	6,198,185.00	
GM Per Bird	**2,717.00**	**2,816.00**	**3,113.00**	**2,964.00**	
Profit	1,748,938.00	5,279,231.00	8,531,927.00	5,186,698.00	
RROI	14.24%	13.75%	13.81%	13.93%	

Source: Field survey, 2022

The regression estimates of the factors affecting egg output is shown in the table 4below. Feed (α 0.01), age of birds (α 0.05), experience (α 0.05), and education (α 0.05), are significant variables affecting egg production in the study area. Feed was positively related with egg output implying that when birds are fed ad libitum, they tend to produce more eggs. Age of birds on the other hand had a negative relationship with quantity of eggs produced implying that as birds get older the level of production begins to decline. The farmer most be sensitive to sell off the spent birds when the quantity of eggs produced can no longer buy feed for the birds. Experience as expected was positively related to egg output. Experienced farmers have more knowledge and skills of operating a profitable layer enterprise. Education was found to be negatively associated with level of egg production. By implication education may only be a necessary but not sufficient condition of running a layer business.

Table 4: Regression Estimates of factors affecting output of poultry egg in deep litter technology the study area.

	Coefficient	*Std. Error*	*t-ratio*	*p-value*
Const	28.8322	13.7397	2.098	0.0407**
Feed	9.41692e-06	1.19909e-07	78.53	<0.0001***
Age of farmer	−0.512340	0.328469	−1.560	0.1249
Age of Birds	−0.229035	0.0949954	−2.411	0.0195**
Experience	1.07116	0.611672	1.751	0.0858**
Sex	−1.36061	4.99145	−0.2726	0.7862
Education	−0.697746	0.338215	−2.063	0.0441**

Mean dependent var	277.8281	S.D. dependent var	151.0733
Sum squared resid	7142.977	S.E. of regression	11.72028
R-squared	0.994604	Adjusted R-squared	0.993981
F(6, 52)	1597.447	P-value(F)	4.05e-57
Log-likelihood	−225.2096	Akaike criterion	464.4192
Schwarz criterion	478.9620	Hannan-Quinn	470.0962

Conclusion and Recommendations

The study established that table egg production under the deep litter system is profitable in Akwa Ibom State. The enterprise recorded positive gross margin, positive net profit, and a favourable rate of return on investment. Feed was the dominant cost item, while egg sales remained the principal revenue source.

The regression analysis further showed that feed, age of birds, farming experience, and education were important factors influencing egg output. Overall, the findings suggest that deep litter technology remains an economically viable option for commercial egg production in the study area. The following recommendations are made;

1. Poultry farmers should be given better access to low-interest credit to support working capital and business expansion.
2. Extension agencies should train farmers on least-cost feed formulation using locally available feed ingredients in order to reduce the heavy burden of feed cost.
3. Farmers should adopt timely flock replacement strategies because productivity falls as birds become older.
4. Greater attention should be paid to practical management training and farm record keeping so that experience and managerial skill can translate into higher output.
5. Farmers should strengthen secondary revenue channels such as manure sales and spent layer sales to improve overall enterprise returns.

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DETERMINANTS OF FOOD EXPENDITURE PATTERNS AMONG RURAL HOUSEHOLDS IN AKPABUYO LOCAL GOVERNMENT AREA, CROSS RIVER STATE, NIGERIA

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Abstract

This study examined the determinants of food expenditure patterns among rural households in Akpabuyo Local Government Area (LGA), Cross River State, Nigeria. Primary data were collected from 115 rural households using a structured questionnaire and analyzed using descriptive statistics, an independent samples test, and multiple regression analysis. Results showed that non-food expenditure accounted for a slightly higher proportion (52.8%) of total household expenditure compared to food expenditure (47.2%). Statistical comparison revealed no significant difference between food and non-food expenditure. Regression results from the double-log model indicated that income, educational level, age of household head, household size, and farm size had positive and significant effects on household consumption expenditure, with the model explaining 67% of the variation in expenditure. The findings highlight the role of socio-economic characteristics in shaping expenditure behaviour and suggest that policies aimed at improving income, education, and agricultural productivity can enhance household welfare and food security in rural Nigeria.

Keywords: Food expenditure, rural households, consumption patterns, income, Nigeria.

1. 0 Introduction

Food expenditure is a core determinant of household welfare and food security, particularly in developing countries where a large share of income is devoted to basic consumption (Abdullah and Ismail, 2019). According to Engel's Law, the proportion of income spent on food declines as income increases (Engel, 1857). In sub-Saharan Africa, food constitutes a major budgetary share and is central to poverty reduction strategies and economic policy (Food and Agriculture Organization [FAO], 2019; World Bank, 2020). Rural households in Nigeria face persistent challenges including income volatility, limited market access, rising costs of living, and environmental shocks that influence consumption patterns (International Food Policy Research Institute [IFPRI], 2020). Socio-economic factors such as income, education, and household size significantly affect food expenditure patterns (Aminu *et al*., 2016; Babalola and Isitor, 2014; Joseph, 2012). However, existing studies often generalize across regions, overlooking local cultural and economic dynamics in rural households (Hossain *et al*., 2019). This study focuses on rural households in Akpabuyo LGA, Cross River State, to identify determinants of food expenditure patterns and to inform policy interventions that align with Sustainable Development Goal 2, which seeks to end hunger and improve food security by 2030 (United Nations, 2015).

1.1 Problem Statement

Although prior research has explored food expenditure patterns in Nigeria, there is limited empirical evidence specific to Akpabuyo LGA. Many studies generalize patterns without accounting for local socio-economic diversity. This limits effective policy design at the local level. For example, while urban households may benefit from market policies, rural households require strategies that consider subsistence agriculture and vulnerability to climate and economic shocks. This study addresses this gap by examining detailed socio economic determinants of food expenditure in Akpabuyo.

1.2 Research Questions

i. What is the level of expenditure on food and non-food items among rural households in Akpabuyo LGA?

ii. Is there a significant difference between food and non-food expenditure?
iii. What socio-economic factors determine household food expenditure patterns?

1.3 Objectives of the Study

The main objective is to analyze determinants of food expenditure patterns among rural households in Akpabuyo LGA.

Specifically, the study aims to:

I. Examine the level of total expenditure on food and non-food items.
II. Compare food and non-food total expenditure levels.
III. Analyze determinants of household total expenditure patterns.

2.0 Literature Review

2.1 Empirical Literature

Empirical evidence confirms that food expenditure patterns are influenced by diverse socio-economic factors. Deaton (2001) identified income, savings constraints, and shocks as critical determinants of consumption in developing countries. Çağlayan and Astar (2012) reported that food expenditure dominates household budgets and decreases proportionately with rising income, affirming Engel's Law. Ademola (2012) found food expenditure as the largest household spending category in Nigeria, with implications for tax and subsidy policies. Recent research confirms and extends these findings. For example, household survey data across Sub-Saharan Africa indicate that non-farm income diversification significantly affects food purchase and consumption patterns (Tadesse *et al.*, 2024). A 2025 study in Ghana found that food budget share declines with higher income, and educational attainment led to more diversified consumption (Owusu *et al.*, 2025). In Nigeria, recent panel data suggest income, household size, and age of the household head are significant predictors of weekly food expenditure among rural households (Okeke and Nwankwo, 2024). Another 2026 study in rural Nigeria showed non-agricultural income sources improve dietary diversity and food security outcomes (Ogunleye *et al.*, 2026).

2.2 Theoretical Framework

The study is grounded in consumption theories: Absolute Income Hypothesis (Keynes, 1936) argues consumption depends on current income. Relative Income Hypothesis (Duesenberry, 1949) emphasizes social comparison in consumption decisions. Permanent Income Hypothesis (Friedman, 1957) contends that long-term expected income drives consumption. Life-Cycle Hypothesis (Modigliani and Brumberg, 1954) suggests consumption smoothing across life stages. These theories justify including income, education, and household size in the analysis.

3.0 Methodology

3.1 Study Area

Akpabuyo Local Government Area (LGA) is situated in Cross River State, Nigeria, with its administrative headquarters in Ikot Nakanda. Established in 1991 from the former Odukpani Local Government Area, Akpabuyo encompasses several towns, including Atimbo, Eneyo, Ikang, Idundu, Ikot Edem Odo, and Ikot Eyo. It shares borders with Akamkpa Local Government Area in the North, Republic of Cameroon in the East, Bakassi Local Government Area in the South and Calabar South Local Government Area in the West. The area spans approximately 1,241 km² (479.2 square miles) and, according to the NPC, 2006 it has a population of about 271,395 people. Akpabuyo is located within latitude 04º 58′ 00″N and longitude 08º 26′ 00″E, with agriculture and fishing as primary activities. Major crops include cassava, oil palm, maize, yams, and vegetables.

3.2 Sampling Method and Data Collection

A multi-stage sampling technique was used for the study. In the first stage, six communities Atimbo, Eneyo, Ikang, Idundu, Ikot Edem Odo, and Ikot Eyo were purposively selected from the study area. These communities were selected based on their predominantly rural characteristics, high concentration of farming households, and their active participation in agricultural production and marketing activities, which makes them suitable for examining household food expenditure patterns. In addition, the communities were chosen due to their accessibility and availability of households relevant to the objectives of the study. The second stage involved the random selection of two villages from each of the six selected communities, giving a total of twelve (12) villages. In the third stage, ten (10) households were randomly selected from each of the twelve villages, resulting in a total sample size of 120 respondents. Primary data were collected using structured questionnaires administered to the selected respondents to obtain information on socio-economic characteristics, income, and household expenditures. However, 115 questionnaires were successfully retrieved and found suitable for analysis, representing a response rate of 95.8 percent.

3.3 Analytical Techniques

Descriptive statistics examined expenditure patterns. An independent samples test compared food and non-food expenditure. Multiple regression analysis identified determinants of household expenditure. The double-log model was chosen based on best fit criteria.

Model Specifications

$Y=\beta_0+ \beta_1X_1+ \beta_2X_2+ \beta_3X_3+ \beta_4X_4+ \beta_5X_5+ \beta_6X_6+ \beta_7X_7+\ldots\ldots \beta_0X_{11}\ e_i$

Where:

Y= Total expenditure (Dependent variable)

β_0=Intercept

β_1-β_7=Regression parameters or coefficients

Where

X_1: Income Level (naira)

X_2: Marital Status (married=1 unmarried=0)

X_3: Education Level (years)

X_4: Age of the head of house(years)

X_5: Occupation of the household head (farming= 1, otherwise= 0)

X_6: Sex (male= 1, female= 0)

X_7: Household size (numbers)

X_8: Farm size (in hectares)

X_9: Extension contacts (number of contact)

X_{10}: Land ownership (owned= 1 otherwise= 0)

X_{11}: Farming experience (in years)

4. Results and Discussion

4.1 Socio-economic Characteristics

The socio-economic profile of respondents is presented in Table 1, This shows that the majority of household heads were male (56.5%) which aligns with rural household structures documented across southern Nigeria, where male heads often control income and expenditure decisions. However, the relatively high proportion of female-headed households (43.5%) suggests growing diversification in household leadership patterns, which may influence consumption priorities. The mean age of 42 years indicates that most household heads are in their economically productive years, consistent with life-cycle consumption theory (Modigliani and Brumberg, 1954), which predicts higher expenditure during active working ages. Educational attainment remains relatively low, with over 65% having only primary education or less. Empirical studies in West Africa show that education significantly influences consumption diversification and dietary quality by improving income potential and decision-making capacity (Babatunde *et al*., 2022; Ogundari and Abdulai, 2023). Thus, the observed education distribution provides structural context for later regression outcomes. Farming was the dominant occupation (83.5%), confirming the agrarian nature of Akpabuyo LGA.

Table 1: The Socio-Economic Characteristics of the Respondents (n = 115)

Variable	**Frequency**	**Percentage**
Sex:		
Male	65	56.5
Female	50	43.5
Total	**115**	**100**
Age:		
20 -29	9	7.8
30 – 39	23	20.0
40 – 49	44	38.3
50 – 59	19	16.5
60 and above	20	17.4
Total	**115**	**100**
Mean		**42**

Household size		
1 – 5	72	62.6
6 – 10	40	34.8
11 – 15	3	2.6
Total	**115**	**100**
Mean		**5**
Education:		
No formal education	30	26.1
Primary education	44	38.3
Secondary education	24	20.9
Tertiary education	17	14.7
Total	**115**	**100**
Mean		**6**
Marital status:		
Married	75	65.2
Single	40	34.8
Total	**115**	**100**
Occupation:		
Farming	96	83.5
Trading	19	16.5
Total	**115**	**100**
Farm size:		
1 – 5	106	92.2
6 – 10	9	7.8
Total	**115**	**100**
Mean		**1.5**
Extension contacts		
Yes	17	14.8
No	98	85.2
Total	**115**	**100**
Land ownership		
Yes	77	67.0
No	38	33.0
Total	**115**	**100**

Source: Field Survey, 2025

4.2 Expenditure Patterns

The distribution of household expenditure is presented in Table 2. The finding indicates that non-food expenditure (52.8%) slightly exceeds food expenditure (47.2%) represents an important structural observation. Classical Engelian theory predicts high food budget shares among low-income households; however, the nearly balanced allocation suggests a transition in rural consumption structure. Recent Nigerian household panel data analyses (NBS, 2022; World Bank, 2023) indicate that rural households increasingly allocate expenditure toward healthcare, transportation, communication, and education due to rising service costs and rural monetization. Moreover, farming households often consume part of their own agricultural produce, reducing recorded food expenditure. This may partially explain why food expenditure does not dominate total spending. This pattern suggests that rural households in Akpabuyo are not purely subsistence-oriented but are increasingly integrated into market systems.

Table 2: Distribution of Household expenditure of respondents

Expenditure type	Mean annual expenditure ₦	Percentage %
Food expenditure	96,478.26	47.2
Non – food expenditure	107,890.35	52.8
Total	**204,368.61**	**100**

Source: Field Survey, 2025

4.3 Comparison of Food and Non-food Expenditure

Table 3 presents the results of the independent samples test comparing food and non-food expenditure. The independent samples test confirms no statistically significant difference between food and non-food expenditure ($p > 0.05$). From a welfare perspective, this balanced expenditure structure may indicate that households face simultaneous pressure from food security needs and essential non-food obligations. This suggests that rural households in Akpabuyo allocate their resources relatively evenly between food and non-food needs. The absence of statistical difference implies a balanced consumption structure rather than dominance of one expenditure category over the other. Recent studies in Ghana and Kenya (Adjognon *et al*., 2023; Muriithi and Matz, 2024) show similar convergence in rural food and non-food shares due to increased school enrolment, healthcare spending, and energy costs. This convergence suggests structural transformation rather than deprivation alone. It reflects the reality that rural welfare depends not only on caloric intake but also on investments in human capital.

Table 3: Independent Samples Test Comparing Food and Non-food Expenditure

Variable	Mean ₦	Std. Deviation	t-value	p-value
Food Expenditure	96,478.26	32,450.18	0.657	0.512
Non-food Expenditure	107,890.35	35,128.42	-	-

Source: Field Survey, 2025

4.4 Determinants of Household Consumption Expenditure

The regression results from the selected double-log model are presented in Table 4. The double-log specification allows elasticity interpretation of coefficients, enhancing theoretical alignment. Income elasticity (0.512) indicates that consumption is income-inelastic but responsive, confirming Engel's proposition that food expenditure share declines as income rises while total expenditure increases, and previous empirical findings (Aminu *et al*., 2016) as well as the Absolute Income Hypothesis. The positive and significant education coefficient (0.184) suggests that a 1% increase in education level increases consumption by 0.18%, consistent with findings from rural Ethiopia (Tafere and Woldehanna, 2022) and Nigeria (Ogundari and Abdulai, 2023). Household size elasticity (0.295) reflects scale effects in consumption needs. Larger households demand more food and non-food goods, consistent with Keynesian consumption theory. Farm size (0.168) indicates productive asset influence on expenditure, implying that agricultural capacity enhances income and thus consumption smoothing. The adjusted R^2 of 0.673 suggests strong explanatory power compared to similar rural studies in sub-Saharan Africa, where R^2 values typically range between 0.45–0.65.

Table: 4 Double-Log Regression Results of Determinants of Household Expenditure

Variable	Coefficient	Standard Error	t-value	Significance
Constant	1.245	0.412	3.02	0.003
Income	0.512	0.098	5.22	0.000***
Age	0.231	0.089	2.60	0.011**
Education	0.184	0.072	2.56	0.012**
Household Size	0.295	0.104	2.83	0.006**
Farm Size	0.168	0.081	2.07	0.041*

Model Statistics: $R^2 = 0.689$
Adjusted$R^2 = 0.673$
F-statistic = 3.138 ($p < 0.01$)
Significance levels: ***1%, **5%, *10%
Source: Field Survey, 2025

5. Conclusion, and Policy Recommendations

5.1 Conclusion

The study provides empirical evidence that rural household expenditure behavior in Akpabuyo LGA is significantly shaped by income, education, demographic characteristics, and productive assets. The near balance between food and non-food expenditure signals structural transition in rural consumption patterns. The elasticity estimates confirm that Income remains the strongest determinant, consistent with global evidence (Okeke and Nwankwo, 2024; Owusu *et al.*, 2025), reinforcing classical consumption theory while reflecting contemporary rural realities. Policies that enhance income diversification, agricultural productivity, and human capital development are critical to achieving sustainable food security in rural Nigeria.

5.3 Policy Recommendations

i. Enhance income-generating opportunities through rural employment and agribusiness programs.
ii. Strengthen educational access to improve household decision-making.
iii. Improve agricultural productivity through extension services and credit.
iv. Expand social services like healthcare and education to reduce non-food burdens.

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DETERMINANTS OF SAVINGS AND INVESTMENTS AMONG POULTRY FARMERS IN CALABAR METROPOLIS, NIGERIA

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Abstract

This study examined the determinants of savings and investment among poultry farmers in Calabar Metropolis, Cross River State, Nigeria. The specific objectives were to determine the different forms of savings and investment patterns adopted by poultry farmers, identify the factors that determine savings and investment, examine the difference between the amount saved and the amount invested, and identify the constraints to savings and investment. A multistage sampling technique was used to select 110 poultry farmers. Primary data were collected using structured questionnaires and analyzed using descriptive statistics, multiple regression analysis, Z-test, and Varimax Principal Component Analysis. The results revealed that 74.5% of the farmers saved in one form or another, while 70% invested in various investment areas. Household annual income and farm size significantly influenced both savings and investment decisions. The regression results showed that the explanatory variables jointly explained 63.6% and 54.6% of variations in savings and investment respectively, with both models significant at 1% level. Major constraints to savings and investment included low literacy level, poor market structure, lack of trusted investors, risk of theft, high bank charges, and lack of bank branches. The study concludes that the propensity to save and invest among poultry farmers in Calabar Metropolis is relatively high, and recommends policy interventions to strengthen financial inclusion and investment-support mechanisms.

Keywords: Savings, Investment, Poultry farmers, Financial constraints, Calabar Metropolis

Introduction

Agriculture remains a critical sector of the Nigerian economy, providing employment for about 35% of the population as of 2020 (World Bank, 2020). According to the Food and Agriculture Organization, agriculture continues to serve as the foundation of the Nigerian economy despite the prominence of the oil sector (FAO, 2016). The sector comprises four major subsectors: crop production, livestock production, forestry, and fisheries. Livestock production contributes about one-third of Nigeria's agricultural GDP and provides income, employment, food, manure, and other socio-economic benefits of which poultry farming is one of such (Jeffrey, 2013). Poultry farming is one of the fastest-growing agricultural subsectors in Nigeria and plays a critical role in food security, employment creation, and income diversification for rural and peri-urban households (Ojo *et al*., 2023). Within the livestock subsector, poultry production stands out because of its relatively low entry cost, short production cycle, and quick returns, making it an attractive enterprise for smallholder farmers seeking to supplement household income and improve livelihoods (Ojo, 2002). In Nigeria, poultry farming is dominated largely by small-scale producers whose sustainability and growth depend not only on technical efficiency but also on sound financial decisions, particularly savings and investment behaviour.

Savings and investment play a central role in agricultural development and capital formation. Savings enable farmers to build financial buffers, cope with income fluctuations, and reinvest in productive inputs such as feed, vaccines, housing, and flock expansion. Investment decisions, on the other hand, determine the scale, productivity, and long-term profitability of poultry enterprises (Wen and Ishida, 2001; Ike and Idoge, 2006; Amu and Amu, 2012). Economic theories such as the Keynesian savings function, the savings–investment theory, and the life-cycle hypothesis emphasize income, demographic characteristics, and expectations as critical drivers of savings and investment behaviour (Nikita, 2013; Kadariya, 2014; Ajah *et al.*, 2017). Empirical evidence also supports the view that improved savings behaviour enhances farmers' ability to adopt new technologies, withstand production risks, and expand farm operations (Adeyemo and Bamire, 2005; Odoemenem *et al*., 2013; Ojo *et al*., 2023).

Despite the recognized importance of savings and investment, studies across Nigeria consistently report that many poultry farmers struggle to accumulate adequate savings and make productive investments.

Irregular income flows, high production costs, dependence on informal savings mechanisms, and limited access to formal financial institutions remain major challenges (Nwibo, 2013; Ogbonna and Eremi, 2019; Yusuf *et al*., 2025). Babatunde *et al*., (2023) found that savings and investment strategies among poultry farmers in Kwara State were significantly influenced by income, education level, farm size, and access to credit. Similarly, studies among farmers in Bauchi, Kaduna, and Kogi States show that farm size, off-farm income, cooperative membership, and household characteristics play important roles in shaping savings and investment behavior (Maigari *et al*., 2023; Makama *et al*., 2024; Ayanlere, 2022; Babani, 2015).

In many rural and peri-urban areas, farmers rely heavily on personal savings and informal financial arrangements such as rotating savings associations, cooperatives, and money kept at home, often due to mistrust of formal banking systems, high transaction costs, and limited physical access to financial institutions (Hakeem, 1989; Nwibo, 2013; Ogbonna and Eremi, 2019). Yusuf *et al*. (2025) reported that over half of poultry farmers in Ogun State financed their operations primarily through personal savings, with minimal reliance on bank or cooperative credit, a situation that constrains investment scale and enterprise growth. Furthermore, constraints such as low literacy levels, poor market structures, disease outbreaks, price volatility, and weak rural financial infrastructure further undermine farmers' capacity to save and invest consistently (Thingan, 2001; Browning and Lusardi, 1996; Odoemenem *et al*., 2013).

In Cross River State, poultry farming constitutes an important livelihood activity, particularly within Calabar Metropolis, where urban demand for poultry products continues to grow. However, empirical studies in the state have largely focused on farmers' participation in formal and informal credit markets, with limited attention given to savings behaviour and its interaction with investment decisions (Ukpe and Ewung, 2023). While access to credit is critical, savings remain a foundational source of capital for many smallholder poultry farmers, especially in contexts where credit access is limited, costly, or uncertain (Nwibo, 2013; Uhuegbulem *et al*., 2025).

The limited empirical evidence on how poultry farmers in Calabar Metropolis save, invest, and allocate their income creates a significant knowledge gap. Without a clear understanding of the forms of savings and investment adopted, the factors that influence these financial decisions, the relationship between savings and investment levels, and the constraints faced by farmers, policy interventions aimed at strengthening agricultural finance may remain ineffective or poorly targeted. Addressing this gap is particularly important given the growing role of poultry farming in urban and peri-urban food systems and its potential contribution to employment and income generation in Cross River State.

It is against this backdrop, that this study examines the determinants of savings and investment among poultry farmers in Calabar Metropolis, Nigeria, with specific emphasis on identifying savings and investment patterns, analyzing the socioeconomic factors influencing these behaviours, determining the difference between the amount saved and invested, and identifying the major constraints to effective savings and investment. By providing location-specific empirical evidence, the study contributes to the broader literature on agricultural finance and offers policy-relevant insights for improving savings mobilization, investment capacity, and the sustainability of poultry enterprises in Cross River State.

Literature Review

2.1 Theoretical Framework

The study is anchored on the Keynesian savings theory, which postulates a positive relationship between income and savings (Keynes, 1936). According to this theory, household income can be allocated to consumption, savings, or taxes, and savings increase as income rises, though at a decreasing rate (Nikita, 2013). The savings–investment theory further explains that equilibrium between savings and investment is achieved through changes in income and interest rates, with disequilibrium leading to fluctuations in output and prices (Kadariya, 2014).

The life-cycle hypothesis complements this framework by explaining savings behaviour across different stages of life. Individuals tend to dis save during early life, save during middle age, and consume accumulated savings during retirement (Ajah *et al*., 2017). These theories provide a foundation for understanding savings and investment decisions among agricultural households.

2.2 Empirical Review

Studies have shown that farmers adopt both monetized and non-monetized forms of savings, including bank deposits, livestock, land, jewelry, and rotational savings schemes (Hakeem, 1989; Nwibo, 2013). Cultural factors, literacy level, and availability of financial institutions significantly influence the choice of savings methods (Khan *et al*., 2002).

Empirical evidence indicates that income, education, farm size, household size, and access to credit are key determinants of savings and investment behaviour among farmers (Adeyemo and Bamire, 2005; Ajah *et al*., 2017; Odoemenem *et al.,* 2013). Nwibo (2013) and Babani (2015) observed that farmers generally save a smaller portion of income relative to investment expenditure. Constraints to savings and investment include low income, high consumption, lack of financial institutions, high transaction costs, and inadequate information (Browning and Lusardi, 1996; Nwodo *et al*., 2017).

Methodology

3.1 Study Area

The study was conducted in Calabar Metropolis, Cross River State, Nigeria. Calabar comprises Calabar Municipality and Calabar South Local Government Areas and is characterized by a tropical monsoon climate with an average annual rainfall of over 3,000 mm. Agriculture in the area includes crop cultivation and animal husbandry, particularly poultry production (NPC, 2006). Also, there exist different forms of savings institutions in the Metropolis.

3.2 Sampling Technique and Method of Data Collection

A multistage sampling technique was employed. Six poultry feed dealers were selected across the two local government areas, three from each, from which a list of poultry farmers was obtained. Twenty farmers were randomly selected from each list, resulting in a total sample size of 120 respondents. However, 110 questionnaire were retrieved and used for the analysis.

3.3 Analytical Techniques

Descriptive statistics were used to analyze socioeconomic characteristics and savings and investment patterns.

Multiple regression analysis was employed to identify determinants of savings and investment. The model is specified as:

Y= f (AG, SEX, MST, EDU, FS, HHS, FEX, HAI, MFO) ……………. Implicit form

Y= βo +β1AG + β2SEX + β3MST + β4EDU + β5FS + β6HHS + β7FEX + β8HAI + β9MFO + μ ... Explicit form

Where:

β_o = Constant
$\beta_1 - \beta_9$ = Coefficients of regression
Y= Rural Household Savings and Investments (Naira)
AG = Age (years)
SEX = Sex (Dummy i.e 1 male, 0 otherwise)
MST = Marital status (Dummy i.e 1 married, 0 otherwise)
EDU = Education level (No of years spent in formal school)
FS = Farm size (Hectares)
HHS = Household size (In number)
FEX = Farming Experience (Years)
HAI = Household Annual Income (Naira)
MFO = Membership of farmer's organization (Dummy i.e Yes 1, No 0)
μ = Stochastic error term
Z-test was used to examine differences between amounts saved and invested, which is shown below
Difference in mean model (n=110)

$$z = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$$

Where;

$\bar{x}_1$ = Mean of amount Saved
$\bar{x}_2$ = Mean of amount Invested
σ_1^2 = Standard Deviation of amount Saved in Naira
σ_2^2 = Standard Deviation of amount Invested in Naira
n_1 and n_2 = Sample Sizes of the amount saved and Invested
Decision Rule: If $z_{cal} > z_{tab}$, reject the null hypothesis, otherwise accept…
While Varimax Principal Component Analysis identified constraints to savings and investment.

Results and Discussion

Socio-economic characteristics of the respondents

The results showed that most respondents (51.8%) were female and within the economically active age group, with a mean age of 37 years. The majority were literate and operated small-scale poultry farms. About 74.5% of the farmers saved, mainly through commercial banks and cooperatives, while 70% invested in various activities.

The regression results showed that the explanatory variables jointly explained 63.6% and 54.6% of variations in savings and investment respectively, with both models significant at 1% level, it also indicated that household annual income and farm size had positive and statistically significant effects on both savings and investment. These findings are consistent with Keynesian postulates and earlier studies that emphasize income as a key determinant of savings and investment behaviour (Adeyemo and Bamire, 2005; Nwibo, 2013).

The Z-test revealed a significant difference between the amount saved and the amount invested, with farmers investing more than they saved. Principal Component Analysis identified low literacy level, lack of trusted investors, high bank charges, and inadequate banking infrastructure as major constraints, corroborating findings by Nwibo (2013) and Browning and Lusardi (1996).

Conclusion and Recommendation

The study concludes that poultry farmers in Calabar Metropolis exhibit a relatively high propensity to save and invest, though constrained by institutional and socioeconomic factors. Policies aimed at improving financial literacy, expanding banking infrastructure, reducing transaction costs, and strengthening farmer-oriented financial programs are essential for enhancing savings mobilization and productive investment in the poultry subsector.

Tables

Table 1: Socio-economic characteristics of the respondents

Variable	Frequency(n=110)	Percentage	Mean
SEX			
Male	53	48.2	
Female	57	51.8	
Age(Years)			
21-30	33	30	
31-40	36	32.7	
41-50	28	25.2	37
51-60	11	9.9	
61years and above	2	1.8	
Education Level			
0	3	2.7	
6	3	2.7	
12	22	20.0	17.35
13	4	3.6	
17	78	70.9	

Source: Field survey, (2024)

Table 2a: Different forms of savings patterns adopted by poultry farmers

Forms	Frequency	Percent
None	28	25.5
Commercial bank	40	36.4
Microfinance Bank	2	1.8
Bank of Agriculture	1	0.9
Cooperatives	1	0.9
Esusu	2	1.8
Self	1	0.9

Microfinance Bank and Esusu	1	0.9
Esusu and Self	1	0.9
Commercial bank and Microfinance bank	2	1.8
Commercial bank and Cooperatives	13	11.8
Commercial bank and Esusu	4	3.6
Commercial bank and Self	2	1.8
Commercial bank, Microfinance bank and Cooperatives	5	4.5
Commercial bank, Bank of Agriculture and Cooperatives	1	0.9
Commercial bank, Cooperatives and Esusu	1	0.9
Commercial bank, Cooperatives and Self	2	1.8
Commercial bank, Occupational groups and Self	1	0.9
Commercial bank, Microfinance bank, Bank of Agriculture and Cooperatives	1	0.9
Commercial bank, Cooperatives, Self, Friends and family	1	0.9
Total	110	100

Source: Field survey, (2024)

Table 2b: Different forms of Investments patterns adopted by poultry farmers

Forms	Frequency	Percent
None	33	30
Land	11	10
Jewelry	3	2.7
Stocks	3	2.7
Livestock	15	13.6
Buildings	4	3.6
Vehicle	2	1.8
Motorcycle/tricycle	3	2.7
Jewelry and Livestock	4	3.6
Jewelry and Vehicle	1	0.9

Bonds and Livestock	1	0.9
Stocks and Livestock	3	2.7
Stocks and Motorcycle/tricycle	1	0.9
Livestock and Buildings	3	2.7
Livestock and Motorcycle/tricycle	1	0.9
Land and jewelry	2	1.8
Land and Livestock	5	4.5
Land and Buildings	6	5.5
Jewelry, Vehicle and Livestock	2	1.8
Bonds, Vehicle and Livestock	1	0.9
Land, Stocks and Livestock	2	1.8
Land, Livestock and Buildings	2	1.8
Land, Vehicle and Buildings	1	0.9
Land, Stocks, Livestock and Motorcycle/tricycle	1	0.9
Total	110	100

Source: Field survey, (2024)

Table 3: Multiple Regression Estimates of the factors that determine the level of savings among poultry farmers in the study area

		Functional	Forms	
Variable	Linear	Exponential	Semi-Log	Double-log+
(Constant)	-1316315.705 (-0.877)	12.036*** (11.807)	-16809582.294*** (-3.480)	1.110 (.437)
Age	30148.593 (1.184)	.019 (.947)	1258604.218 (1.141)	.446 (.728)
Sex	-100750.461 (-0.295)	-.081 (-.331)	-153092.087 (-.247)	-.343 (-1.077)
Marital Status	-355537.005 (-0.699)	-.068 (-.190)	-838057.232 (-.724)	-.229 (-.398)
Education Level	-52592.519 (-0.222)	-.267 (-1.504)	44928.080 (.058)	-.540 (-1.172)

Farm size	-340.409 (-0.811)	.001** (2.423)	551.673 (.001)	.226 (.849)
Household Size	59247.012 (0.540)	.035 (.503)	603555.588 (1.210)	.278 (1.220)
Farming experience	-38726.496 (-0.674)	-.006 (-.147)	-700643.874 (-1.533)	-.259 (-1.092)
Household Annual Income	.106*** (5.050)	5.801E-9 (.422)	904494.822** (2.373)	.627*** (3.186)
Membership of farm organization	953985.194** (2.254)	.339 (1.179)	1502481.980** (2.019)	.383 (1.065)
R^2	0.543	0.547	0.302	0.636
Adjusted R^2	0.502	0.490	0.239	0.591
F-value	13.216 ***	9.651***	4.813	13.982***

*Source: field survey, 2024. ***, **, variables statistically significant at 1.0%, 5.0% levels respectively. Figures in parenthesis are t-ratio. + = lead Equation*

Table 4: Multiple Regression Estimates of the factors that determine the level of investment among poultry farmers in the study area

Variable	Linear+	Functional Exponential	Forms Semi-Log	Double-log
(Constant)	-126945.221 (-.062)	12.788*** (6.410)	-25300624.317*** (-3.994)	-5.636 (-1.085)
Age	40605.910 (1.161)	.048 (1.453)	2325908.136 (1.607)	2.030* (1.809)
Sex	-707442.070 (-1.507)	.230 (.527)	-1434315.466* (-1.768)	.180 (.295)

Marital Status	-647517.520 (-.928)	-.292 (-.449)	-1403719.446 (-.925)	-.477 (-.429)
Education Level	-4991.295 (-.015)	-.481 (-1.257)	260091.613 (.256)	-1.043 (-.855)
Farm size	1322.802** (2.295)	.001 (1.440)	581378.963 (.924)	.051 (.111)
Household Size	75230.415 (.500)	.096 (.785)	759835.952 (1.162)	.403 (.911)
Farming experience	76443.405 (.969)	-.053 (-.783)	-298141.169 (-.498)	-.894 (-1.958)
Household Annual Income	.043* (1.489)	6.575E-9 (.283)	1010801.740* (2.023)	.892** (2.411)
Membership of farm organization	-95666.354 (-.165)	-.301 (-.577)	98652.223 (.101)	-.617 (-.867)
R^2	0.584	0.321	0.420	0.371
Adjusted R^2	0.546	0.230	0.368	0.287
F-value	15.591***	3.525	8.041***	4.397

*Source: field survey, 2024. ***, **, *: variables statistically significant at 1.0%, 5.0% and 10.0% risk levels respectively. Figures in parenthesis are t-ratio. + = lead Equation*

Table 5: Z-test showing the difference between amount saved and amount invested by poultry farmers

Z-Value	Df	Sig.
36.518	1225	0.016

Table 6: Constraints to savings and investments among poultry farmers in Calabar Metropolis

Challenges	PCA_1	PCA_2	PCA_3	PCA_4
Heavy consumption	0.234	-0.107	0.429	0.672
Risk of capital loss	0.304	0.483	0.459	-0.077
Lack of bank branches	0.143	0.101	0.896	0.041
High bank charges	0.273	0.618	0.396	-0.163
Fear of taxation	0.507	0.558	0.193	0.101
Household size	0.699	0.125	0.390	0.014
Lack of trusted investors	-0.088	0.802	0.152	0.101
Lack of information	0.607	0.426	-0.032	0.012
Low literacy level	0.814	-0.097	-0.108	0.248
Poor market structure	0.735	0.218	0.320	0.142
Lack of agents for collection	0.078	0.394	0.754	0.015
Sickness or health issues	0.046	0.159	-0.217	0.766
Low income	0.500	0.397	0.216	0.448
Misuse of income	0.644	0.328	0.470	-0.036
Risk of theft	0.341	0.736	0.092	0.207

Source: Field survey, (2024)

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DETERMINANTS OF THE FACTORS THAT INFLUENCE THE CHOICE OF CLIMATE CHANGE ADAPTATION STRATEGIES ADOPTED BY FOOD CROP FARMERS IN DELTA STATE, NIGERIA

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Abstract

Climate change effects have in recent times, challenged the genuine efforts of food crop farmers in the quest for sustainable production, necessitating the engagement of appropraite strategies.This study determined food crop farmer's choice of climate change adaptation strategies used in Delta State Nigeria, specifically, it identified climate change adaptation strategies adopted by the farmers and determined the factors that influence the choice of climate change adaptation strategies adopted by the farmers in the study area.A multi-stage random sampling technique was used in selecting 324 for the study. Data were collected using questionnaires and personal interview. and analyzed using statistical tools such as tables, frequency, percentage means and the multinomial logistic regression model .. . The result revealed that age, household size, level of education, sex, farm size, distance, extension contact, access to credit, household income, years of climate change awareness, tenure security and access to weather information are major determinants of the choice of climate change adaptation strategies used by farmers in the study area. Based on the , results, it was therefore recommended that there is need for government and nongovernmental organizations to invest in climate resilient projects and improve on climate monitoring and reporting stations towards sustainable agricultural and rural development.

Keywords : Climate Change, Adaptation Atrategies, Multinomial Logistic

Introduction

Climate change, as defined by the Intergovernmental Panel on Climate Change (IPCC, 2007), refers to any long-term alteration in climate, whether resulting from natural variability or human activity. It encompasses measurable changes in the mean or variability of climatic properties that persist over decades or longer. Over the past few decades, anthropogenic activities including urbanization, deforestation, population growth, industrialization, and the emission of greenhouse gases (GHGs) have emerged as major drivers of global warming and climate change (Buba, 2004 and Odjugo, 2007). Elevated concentrations of carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4) have intensified the greenhouse effect, leading to altered precipitation patterns and rising global temperatures. These climatic changes have profound impacts on both natural and human systems. Sectors that depend heavily on weather conditions, particularly agriculture and fisheries, are increasingly vulnerable (IPCC, 2012). In Nigeria, climate change has been linked to reduced crop yields, declining food production, and shifts in precipitation and temperature patterns. Higher temperatures exacerbate pest infestations and weed proliferation, while increased occurrences of floods and droughts threaten both short-term crop outputs and long-term agricultural productivity (IFPRI, 2009). Without intervention, climate change is projected to reduce global per capital GDP and poses a serious threats to food security (Stern, 2006). Responding to climate change requires both mitigation and adaptation measures. Adaptation refers to adjustments in human or natural systems in response to actual or anticipated climate stimuli to reduce harm or exploit potential benefits (Ngigi, 2009; Oladipo, 2010), while mitigation involves strategies that reduce GHG emissions or enhance their absorption.

Despite the significant focus on the impacts of climate change, there is comparatively less research on how farmers' adaptation strategies influence agricultural income and rural livelihoods. Understanding these strategies is crucial, as they shape farm production, income patterns, and overall household well-being. This study therefore seeks to identify climate change adaptation strategies adopted by food crop farmers and determine the factors that influence the choice of climate change adaptation strategies used by food crop farmers in the study area.

Hypothesis of the study

There is no significant relationship between selected socio-economic and institutional variables and the choice of climate change adaptation strategies adopted by food crop farmers.

Methodology

The study was conducted in Delta State of Nigeria. Delta State is located in the South South of Nigeria and one of the 36 States constituting the Nigeria Federation. The State was created in August 27, 1991 out of the formal Bendel State. The State comprises Twenty-five (25) Local Government Areas (LGAs). Delta State is located between longitude 50 001 and 60 451 East and latitude 50 001 and 6 0 301 North. It is bounded on the North by Edo State, on the Northwest by Ondo State, Anambra State on the East and Bayelsa State on the South East. On the Southern flank is the Bight of Benin, which covers approximately 160 kilometers of the State's coastline The 2006 population census puts the population of Delta State at 4,098,391 made up of 2,074,306 males and 2,024,085 females, with a land area of 17,011sq kilometres (NPC, 2006). The State has a tropical climate marked by two distinct seasons: the dry and rainy seasons. The dry season occurs between November and April, while the raining season begins in April and last till October. There exists a brief dry spell in August commonly referred to as 'August break'. The average annual rainfall is about 2667mm in the coastal areas and 1905mm in the Northern areas. Rainfall is heaviest in July. Delta State has a high ranging between 290 C and 44 0 C with an average of 300 C (Delta State main fact, 2018). Common crops and livestock grown include cassava, plantain, banana, vegetables and fruits, poultry, piggery and fish farming,

Sampling Procedure, Data Collection and Analysis

The sample size was calculated using the Confidence Level Approach (CLA) by Kothari and Gary 2014. the formula is stated as follows

$$n=\frac{Z^2\,\alpha/2p.q}{e^2}$$

Where

n=size of sample
$Z^2 \alpha/2$= the value of the standard variate at a given confidences level
Sample proportion, q=1-p
e=acceptance error or the precision or the estimation error
For this study, $Z^2 \alpha/2$ is assumed to be 1.80 (as per table of area under normal curve for a given confidence level of 95%), p=0.5, e=0.05
Therefore, the sample for this study was

$$n = \frac{(1.80)^2 .(0.5)\,(1-0.5)}{(0.05)} = \frac{0.81}{0.0025} = 324$$

A multi-stage sampling techniques was employed in the study. First, four local Government Areas LGAs most prone to climate variability were purposively selected from each of the three agricultural zone respectively, giving a total of (12) LGAs. The second stage involves the random selection of three (3) communities each from the LGAs using the proportionate sampling method, this gave a total of (36) thirty six communities. In the last stage, (9) nine farm households were randomly selected from each of the (36) communities giving a total of 324 respondents for the study.

Primary data were collected using structured questionnaires and analyzed using. both descriptive and inferential statistics, such as tables, frequencies, percentages, means, and the multinomial logit regression analysis.

Model specification

The multinomal logit model was used in determining the factors that influcence the choice of climate change adaptation strategies adopted by farmers in the study area and it is stated as follows.

$Yi = \ln (Pi\backslash 1\text{-}Pi) = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + \beta_{10}X_{10} + \beta_{11}X_{11} + \beta_{12}X_{12} + \beta_{13}X_{13} +$

U_t……………………………equ (1)The Y_i is the probability of choosing a climate change adaptation strategy. The following are the main climate change adaptation strategies used among the food crop farmers (measure in number using the likert scale):

1. Soil conservation -: Use of cover crop planting, mulching, fertilizer application, organic manure, irrigation and water conservation.
2. Multiple planting dates -: Use of early planting, late planting and altering the time of planting.
3. Crop diversification -: Trees planting, crop rotation, intercropping, mixed cropping and minimum tillage.
4. Diversify avenues of employments -: Off-farm employment opportunities.
5. Portfolio diversification-: Use of resistant varieties and livestock diversification.
6. No adaptation strategy category used as the reference or base category.

While Xi which includes socio-economic and agricultural variables that formed the independent variables and includes the following:

X_I = Age of Household head (in years)

X_2 = Household size (Numbers of individuals)
X_3 = Educational Status (years)
X_4 = Sex Gender of Household head (Male 1, Female 0)
X_5 = Farm Size in (hectare\numbers)
X_6 = Extension Contact (1yes, 0 No)
X_7 = Average distance (kilometers
X_8 = Access to Credit (Access 1, 0 No)
X_9 = Household Income (in Naira)
X_{10} = Years of climate change awareness (no of years)
X_{11} = Tenure security (1= the right of the farmer to transfer the land to the next generation, 0= otherwise)
X12 = Access to weather information (1 yes, 0 No)
β_1- β_{13} = coefficients of independent variables
β_0 = intercept

Results and Discussion

Climate Change Adaptation Strategies adopted by Food Crop Farmers.

The foremost reponse of food crop farmers in the study area to the negative effects of climate change is the adoption of crop rotation (94.3%)as shown on table 1, other actions taken by farmers in response to the negative effect of climate change were: , intercropping (91.3%), increasing use of irrigation (66.9%), use of resistant varieties (61.9%), planting of cover crops (47.7%), use of mixed cropping (89.7%), mulching (65.7%), minimum tillage (60.9%),planting of trees (15%),water conservation(42.3%), early planting (70.1%), crop diversification (64.3%), late planting (74.9%), application of farm yard manure(57.7%), fertilizer application (97.9%), soil conservation (60.7%), livestock diversification(42.3%) and off farm employment (63.3%). As observed in table 1, majority of the farmers who implemented adaptation measure have a propensity of implementing multiple adaptation strategies in combination and only 2% of the respondents did not use any adaptation methods.

Table 1- Climate change Adaptation strategies used by food crop farmers

Adaptation strategies	Frequency	Percentage
Crop rotation	283	94.3
Intercropping	273	91.3
Irrigation	201	66.9
Use of resistant varieties	186	61.9
Plant cover crops	143	47.7
Mixed cropping	269	89.7
Mulching	197	65.7
Minimum tillage	183	60.9
Planting trees	45	15
Water conservation	127	42.3
Early planting	210	70.1
Crop diversification	193	64.3
Late planting	225	74.9
Application of farm yard	173	57.7

manure		
Fertilizer application	294	97.9
Soil conservation	182	60.7
Livestock diversification	127	42.3
Off- farm employment	190	63.3
No adaptation	6	2

Multiple choice responses recorded. Source: Computation from field survey data 2020

Determimants of the Factors that Influence the Choice of Climate Change Adaptation Strategies Adopted by Crop Farmers in Delta State

Table 2 presents the results of the parameter estimates from the multinomial logit model to determine the factors that influence the choice of adaptation strategies adopted by the farmers in the study area. No adaptation option was used as the base category.The result of the multinomial logit model indicates that different socio-economic, farm specific and institutional factors affects the farmers choice of climate change adaptation strategies of food crop production in Delta State. The likelihood ratio statistics as indicated by X_2 statistics were highly significant ($P< 0.000$), suggesting the model has a strong explanatory power. Also, the pseudo (Negalkerke) R^2 was 89.9 % thus confirming households' choice decision making process was highly attributed to fitted covariates. In terms of consistency with *a priori* expectations on the relationship between the dependent and the independent variables, the model appeared to have performed well

Age of the household head: from the result of the multinimal logit model, it was revealed that age is significantly and positively related to the probability of choosing and using soil conservation, multiple planting dates and portfolio diversification and negatively related to the probability of choosing and using crop diversification and off farm operations as adaptation strategies to Climate change in Delta State compare to no adaptation methods used. This implies that as the age of the farmers increase, they are likely to adopt soil conservation, multiple planting date and portfolio diversification and as younger farmers are not likely going to use crop diversification and off farm operations. A unit change in the age of the farmer has a direct effect on the farmers ability to adopt climate change adaptation strategies the marginal effects or magnitude of change are captured in the results as shown in appendix. These findings are consistent with Hassan and Nhemachena (2008) and Maddison (2008), who also reported a positive relationship between farmers' age and the adoption of various agricultural and soil management practices.

Household size- The results of the multinomal logit model indicate a significant positive relationship between household size and the likelihood of adopting soil conservation, crop diversification, off-farm employment, and portfolio diversification, among food crop farmers in Delta State, compare to the base category of no adaptation measure used.This implies that larger households are more likely to choose these strategies compared to smaller ones. The marginal effect analysis shows that an increase in the number of economically active members of a household raises the probability of adopting the above adaption strategies, except for multiple planting dates. This finding supports Gbetibouo (2009), which suggests that larger households are more inclined to adopt labor-intensive measures. A larger household size generally provides greater resources, helping farmers manage agricultural tasks during peak seasons (Deressa *et a*l., 2010). Similar results were observed in studies by Okon and Enete (2009), Hassan and Nhemachena (2008), and Nhemachena (2009).

Educational status: The results from the estimation of the multinomal logit model shows that the education level of the household head has a positive and significant influence on the adoption of all climate change adaptation strategies. Higher educational attainment increases the likelihood of using soil conservation, multiple planting dates, portfolio diversification, crop diversification, and off-farm employment compared with no adaptation. This suggests that additional years of schooling marginally raise the probability of adopting these strategies, as educated household heads are generally better informed and more capable of making effective livelihood decisions in response to climate variability. These findings are consistent with Birkann and Fernando (2008), who identified education and skill development as key adaptive strategies, and with Temesgen, Yehualashet, and Rajan (2015), who reported a strong link between education and the adoption of multiple adaptation measures.

Sex of household head: The results of the multinomal logit model indicate that male-headed households are more likely to adopt and intensify soil conservation, multiple planting dates, off-farm employment, and crop diversification, but are less likely to engage in portfolio diversification compared with no adaptation. In contrast, female-headed households show a higher likelihood of adopting and intensifying portfolio diversification than their male counterparts. This implies that an increase in male-headed households raises the probability of adopting most adaptation strategies except portfolio diversification, while an increase in female-headed households increases the likelihood of choosing portfolio diversification. These findings are consistent with previous studies showing a positive association between male household heads and the adoption of labor- and technology-intensive practices (Senait, 2002; Deressa *et al*., 2008), while other evidence suggests that female-headed households may be more inclined toward certain climate change adaptation strategies (Hassan and Nhemachena, 2008).

Farm size: The results of the multinomal logit model indicate that farm size has a positive and significant effect on the adoption of soil conservation, portfolio diversification, crop diversification, and off-farm employment, but a negative relationship with multiple planting operations compared with no adaptation. This suggests that farmers with larger landholdings are more likely to adopt most adaptation strategies, except multiple planting dates. Larger farm sizes also enhance the capacity to expand cultivated land and adopt practices such as shifting cultivation and fodder tree planting to mitigate climate change impacts. These findings align with Gbetibouo (2009), who reported a positive and significant relationship between farm size and climate change adaptation, including irrigation. However, they contrast with Deressa et al. (2010), who found a negative association, arguing that adaptation decisions are often plot-specific rather than determined by overall farm size.

Extension contact: The results of the multinomal shows that extension services have a positive and significant influence on the adoption of soil conservation, multiple planting dates, off-farm employment, portfolio diversification, and crop diversification compared with no adaptation as the base category. This implies that an increase in extension contact raises the likelihood of adopting these climate change adaptation strategies, indicating that farmers benefit from information and guidance provided by extension personnel. This finding supports innovation theory and suggests that farmers' adoption decisions are shaped by advice and knowledge gained through extension services. The result is consistent with Maddison (2008), who reported a positive link between extension services and fertilizer adoption in Uganda, Hassan and Nhemachena (2008), who found that extension contact enhanced the adoption of irrigation-based and mixed farming strategies

Average distance: The results of the multinomal logit model indicates that the distance between farmers' residences and their farms has a negative and statistically significant effect on the adoption of all climate change adaptation strategies. An increase in distance reduces the likelihood of using soil conservation, multiple planting dates, crop diversification, off-farm employment, and portfolio diversification, thereby increasing the probability of no adaptation. This suggests that remoteness discourages farmers from adopting adaptation measures. The finding is consistent with Maddison (2008), who reported a negative relationship between distance and adaptation, as well as studies by Deressa *et al*. (2008) and Yehualashet and Rajan (2014).

Access to credit: The results of the multinomal logit model confirm that access to credit has a positive and significant influence on the adoption of soil conservation, multiple planting dates, crop diversification, portfolio diversification, and off-farm employment, compared with no adaptation. Greater availability of usable farm credit increases the likelihood that food crop farmers will adopt these strategies, as credit helps ease financial constraints and enables investment in improved agricultural practices. The marginal effects show that an increase in credit availability raises the probability of adopting the various adaptation options. This finding is consistent with earlier studies (Deressa *et al.*, 2008; Gbetibouo, 2009, Nhemachena, 2009), which highlight the important role of credit access in farmers' adaptation decisions, particularly in promoting portfolio diversification and other risk-management strategies.

Household income: The results of the multinomal logit model show that household income has a positive and statistically significant effect on the adoption of soil conservation, multiple planting dates, crop diversification, portfolio diversification, and off-farm employment, compared with no adaptation. An increase in household income raises the likelihood of adopting these strategies, while lower income levels are associated with non-adaptation. This suggests that greater financial resources provide farmers with stronger incentives and capacity to respond to climate variability. The finding is consistent with previous studies showing that higher farm and non-farm income enhances farmers' ability to adopt soil conservation, adjust planting dates, diversify crops, and implement other adaptation measures (Deressa *et al*., 2008; Temesgen et al., 2014). .

Years of climate change awareness: The results of the multinomal logit model indicate that years of climate change awareness have a positive and statistically significant effect on the adoption of climate change adaptation strategies compared with no adaptation. An increase in farmers' awareness over time raises the likelihood of choosing any adaptation option, thereby reducing non-adaptation. This finding is consistent with Senait (2002), who reported that greater climate change awareness increases the use of multiple crop varieties and multiple planting dates among African farmers.

Tenure security: The results of the multinomal logit model show that tenure security has a positive and statistically significant influence on the adoption of climate change adaptation strategies, including soil conservation, multiple planting dates, off-farm employment, portfolio diversification, and crop diversification, compared with no adaptation. Farmers who own or have secure rights to their land are more likely to adopt these measures than tenants, who may be discouraged from investing in practices whose benefits are uncertain or long term. An increase in land tenure security therefore raises the likelihood of adopting various adaptation strategies. This finding is consistent with earlier studies, which report that secure land tenure encourages investment in land management and climate-related farm technologies (Maddison, 2008; Nhemachena, 2009).

Access to weather information The result of the multinomal logit model shows that access to weather information has a positive and significant effect on the adaption of adaptation strategies and reducing the likelihood of no adaptation, this conforms with *a priori* expectations, . An increase in the availability of weather information directly enhances farmers response to climate variability. A marginal increase in the amount of weather information received by the farmers in the study area will directly increase the response to climate change. Farmers with better access to climate information are more likely to adopt multiple adaptation measures, such as using diverse crop varieties, borrowing lost local crops, applying fertilizers, implementing soil and water conservation, and planting trees. These findings align with previous studies by Maddison (2006) and Nhemachena and Hassan (2007), which show that access to information significantly increases the probability of adopting climate change adaptation practices.

Table 2: Multivariate Analysis of the Influence of Socio-economic, Farm specific and Institutional Factors on the Choice of Climate Change adaptation Strategies used by Farmers

Variables	Soil Conservation	Multiple planting dates	Crop diversification	Employment Diversification	Diversify Portfolio
Age	169(7.458) 082*	0.745(7.193) 007***	-.439(5.992) 042**	-.729(6.722) .014**	.1.000 (6.681) .081*
House hold size	.097 (.823) .006***	.101(.772) .005 ***	.120(.661) .056*	.144(.742) .046**	.083 (.009) .009 ***
Educational status	.004 (1.679) .098*	.014(1.439) .092*	235(1.287) .005***	.196(1.569) .001***	168 (1.529) .012***
Sex	.124 (1.953) .049**	212(1.761) .004***	.269(1.612) .067**	.350(1.832) .049**	-144 (1.760) .03**
Farm size	.136 (1.625) .003***	-.219(1.404) .076*	.009(1.252) 004***	.026(1.442) .085*	.035 (1.433) .004***
Average distance	-.030 (1.519) .004**	-.254(1.438) 0.86	-.156(1.301) .005***	-.278(1.505) .053**	-.180 (1.451) .001***
Access to extension	.184 (.897) .037**	.192(.823) .016**	213(.737) .073*	.169(.902) .051**	.198 (.804) .005***
Access to credit	2.441(11.813) .036**	3.744(11.373 .042**	3.932(8.832) .056*	1.511(11.325) .094*	2.325(10.725) .028**

Marital status	.000 (.000) 0.91	.000 (.000) 0.876	.000 (.000) 0.883	.000 (.000) 0.919	.000 (.000) 0.919
House hold income	.123 (.931) .095*	.214 (827) .006***	303(.707) .068*	.113(.888) .009***	.265(790) .038**
Years of awareness	2.636(14.857) .059**	2.956 (13.933) .032**	1.651 (12.576) .006***	2.696 (12.714) .033**	1.620 (12.171) .094*
Tenure security	.157(13.107) .090*	.955 (12.497) .039**	.580 (11.393) .059*	.774 (11.487) .046**	1.594 (10.887) .084*
Access to weather information	.026 (.737) .071*	.132 (.726) .005***	.014 (.588) .001***	.063 (.696) .028**	.048 (.646) .040**
Constant	5.908 (82.978) .043**	-2.356 (71.298) .037**	-6.558 (82.709) .004***	-4.863 (82.465) .003***	.913 (82.103) .001***

Chisquare=680.273; -2 loglikelihood =1204.960; NagelkertkeR-square=.898; Coxand Snell=.896; Mcfadden= .361; No. of Observations= 324*** ;**; * means significant at 1, 5 and 10% probability level, respectively, while first figures are the betas; the bracket are the standard errors and the last figures shows the level of significance. Source: computation from field survey data 2020.

Conclusion and Recommendations

Climate change is a threat that is already having tangible impacts on farming activities in Delta State, Nigeria.. Reports have shown that the impacts of climate change on livelihoods and agriculture are inversely proportional to the nation's responsibility for the problems. The observable impacts include: low agricultural productivity, food insecurity, water stress, low income due to changes in earning patterns of various farm assets, poverty, unemployment, resource conflicts, environmentally induced mitigation, hunger and starvation, health problems, violence and the ultimate price- death.. Based on the findings of this result, it was recommended therefore that:

- Farmers should be granted incentives such as farm inputs, credit facilities and innovative technologies that will place them in an advantage position.
- There is need for government and non-governmental organizations to invest in climate resilient projects and improving on climate monitoring and reporting stations.
- The determinants which influence farmer's likelihood of adopting climate change adaptation strategies should be harnessed and properly utilized.

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EFFECT OF LAND FRAGMENTATION ON SMALLHOLDER MAIZE FARMERS' PRODUCTIVITY IN OBUDU LOCAL GOVERNMENT AREA OF CROSS RIVER STATE, NIGERIA: AN ANALYSIS

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Abstract

This study analyzed the effect of land fragmentation on smallholder maize farmers' productivity in Obudu Local Government Area of Cross River State, Nigeria. A multi-stage sampling technique was used to select 120 maize farmers, out of which 110 valid responses were analyzed. Descriptive statistics and the Cobb-Douglas production function were employed for data analysis, while the Simpson Index was used to measure the degree of land fragmentation. Results revealed that inheritance practices (81.8%) and population growth (79%) were the major causes of land fragmentation. The mean Simpson Index of 0.56 indicated a moderate level of fragmentation among farmers. Regression results showed that land fragmentation had a negative and statistically significant effect on maize productivity at 1% level, implying that increased fragmentation reduces yield through inefficiency, increased labour cost, and poor supervision. Fertilizer use, labour, education, extension contact, and access to credit positively and significantly influenced maize yield, while distance to farm plots negatively affected productivity. The model explained 71% of the variation in maize output ($R^2 = 0.71$). Farmers adopted strategies such as land consolidation and improved seed varieties to mitigate fragmentation effects, though access to credit and extension services remained low. The study recommends land tenure reforms, promotion of consolidation policies, improved access to credit and extension services, and strengthened agricultural support programs to enhance maize productivity in the study area.

Keywords: Land Fragmentation, Maize Productivity, Smallholder Farmers

Introduction

Agriculture contributes 32% to Africa's GDP and provides employment to 65% of the labour force on the continent (World Bank, 2018). Maleye (2024), posits that in many countries in Africa, up to 85% of the workforce is employed in the agriculture sector. An estimated 38% of Africa's working youth is presently employed in the agriculture sector (Klynveld Peat Marwick Goerdeler (KPMG), 2023).

In Nigeria, agriculture remain a cornerstone, contributing approximately 23% to the nation's Gross Domestic Product (GDP) and providing employment for over 70% of the rural population (National Bureau of Statistics (NBS), 2021). Within the agriculture sector, maize stands out as one of the most significant cereal crops due to its versatility and economic value. Maize is a staple food for millions of Nigerians, used as a primary ingredient in various food products and livestock feed. Additionally, it serves as an essential raw material for industries involved in the production of flour, starch, and ethanol (Food and Agriculture Organization (FAO), 2020).

Cross River State, is renowned for its fertile lands and conducive climate, making it a significant hub for maize production. However, despite these favorable conditions, maize productivity in the region has not reached its full potential. In 1986, maize production was 36 metric tonnes. Production increased to 413.2 metric tonnes in 2015, a 1,047% increase (NBS, 2020). However, there has been a decline in maize production in recent years, posing a significant threat to food security and rural livelihood. Among the numerous challenges facing maize production in Cross River State, land fragmentation remains a critical issue.

Land fragmentation is a common phenomenon in rural Nigeria, driven by population growth, inheritance systems, and traditional land tenure practices (Igwe *et al.*, 2022). As families grow, land is frequently subdivided among heirs, leading to smaller, fragmented plots that hinder mechanized farming, increase production costs, and reduce overall efficiency. The effect of land fragmentation is evident in the declining efficiency of farming operations. Farmers face challenges such as increased labor requirements, difficulties in implementing modern farming techniques, and reduced access to farm inputs and credit facilities. Moreover, fragmented plots often lead to disputes over land boundaries, further complicating farm management (Eze *et al.*, 2020).

Maize production in Obudu LGA is a significant agricultural activity, with the majority of the population engaged in farming. The region's climate and soil conditions are conducive to maize cultivation, making it a staple crop for both consumption and income generation. However, recent studies have highlighted challenges affecting maize yield in Obudu LGA. A notable issue is land degradation, which has been shown to adversely impact agricultural productivity. Osuafor *et al.* (2021), identified erosion, flooding, and desertification as prevalent forms of land degradation in the area. Other studies such as Obayelu *et al.* (2019), suggest that land fragmentation often results in underutilization of agricultural resources and negatively impacts crop yields, resulting in decline in productivity. This decline in productivity underscores the need for targeted interventions to address factors such as land fragmentation for sustainable agricultural practices.

Existing government interventions have primarily focused on increasing access to farm inputs without addressing the underlying structural issues affecting land use. Moreover, there are limited number of studies addressing land fragmentation as a consequence of decline in agricultural productivity. Among these are Danquah (2019), and Twumasi and Asiamah (2024), who posits that land fragmentation resulted in inefficiency of maize productivity, and affected operational efficiency of maize farmers in Ghana. Siddilk (2022), notes that population growth results to land fragmentation, which adversely affects agricultural productivity in the coastal area of Bangladesh. Similarly, Mayelle *et al.* (2024), also notes that land fragmentation negatively affected maize productivity in east African countries. Dube and Abebe (2022), also posits that maize productivity is adversely affected by factors such as soil fertility and over cultivation of land, which are a consequence of land fragmentation. Tesfaye and Enyew (2017), have primarily focused on land tenure systems, land certification, etc, while ignoring the critical issue of land fragmentation, despite its significant impact on crop productivity. Studies on the consequences of land fragmentation on crop productivity are lacking in Cross River State vis-à-vis Obudu LGA, hence there is a dearth of knowledge. Therefore, the need for an investigation into the effect of land fragmentation on smallholder maize farmers’ productivity is imperative in order to fill the knowledge gap. In view of this, the study set out to; identify the causes of land fragmentation, determine the effect of land fragmentation on maize yield and examine the strategies adopted by farmers to mitigate the effect of land fragmentation on maize productivity in the study area.

Materials and methods

Study area

The study was carried out in Obudu LGA of Cross River State, Nigeria. Obudu LGA is in the northern part of Cross River State, in the Ogoja Agricultural Zone, with its headquarters in Obudu, the home of the Obudu Cattle Ranch, the foremost tourist Centre in Nigerian. The area is located between latitude 6˚20″ - 6˚40″ North of the equator and longitude 8˚4″ - 9˚0″East of Greenwich Meridian. It covers a land mass of 379,164 square meters to the west and has a population of well over 161,457 people (National Population Commission (NPC), 2006). Obudu is bordered to the North by Vandeikya in Benue State, to the East by a community of Akwaya in the Republic of Cameroon, and to the South and West by Boki and Bekwarra LGAs, respectively. There are ten wards in Obudu LGA, namely; Alege, Ubang, Angiaba/Besiaka, Begiading, Ipong, Obudu-urban 1, Obudu-urban2, Utugwang central, Utugwang North, and Utugwang South. It is home to six clans: Bette, Obanlikwu, Bendi, Utuwang, Ukpe-Alege and Utanga-Becheve, all of which thrived as independent villages with the headquarters in Bette clan. Obudu is dominated by undulating terrain with much of the area below 183m (600ft) above sea level. Surface drainage is generally good with almost all the rivers being seasonal. The climate is tropical sub humid with the mean annual rainfall between 1,200 and 2000mm (Uyang *et al.*, 2013). Agriculture is the mainstay of the people with available land for livestock rearing. Over 90% of the population are directly engaged in peasant farming of virtually all kinds of food crops with concentration on yam, maize, groundnut, cassava, sweet potatoes, citrus, rice and millet. The main tree crops in the area include oil palm, cocoa, rubber, and kola nut. Other occupations engaged in by the people in the area include fishing, blacksmith, building, carpentry, trading, etc.

Sampling procedure

The Taro Yamen formula was used to draw a total sample population of 120 smallholder maize farmers from a population of 1,800 farmers contain in a list provided by Cross River State Agricultural Programme (CRADP) for the study. The study adopted a multi-stage sampling method to select the farmers. The first stage involved a purposive selection of five (5) wards based on the concentration of maize farmers. The wards selected were Ipong, Obudu-urban 1, Obudu-urban 2, Utugwang Central, Utugwang North. Secondly, six (6) farming communities were randomly selected from each of the selected wards. Thirdly, twenty (20) smallholder maize farmers were randomly selected based on the number of hectares of land cultivated, from each of the selected communities, giving a total of 120 maize farmers. Data were collected on household variables such as socio-economic variables, land use and ownership, distance to farmlands, maize yield, etc. A total of 110 maize farmers correctly filled and returned their questionnaire with the help of the authors, and these were used in the analysis, while 10 farmers failed to turn in their questionnaire.

The Taro Yamen formula is given as:

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

Where:

n = Sample size

N = Population size

e = error term @ 5% (0.05)

Analytical technique

Descriptive statistical tools such as means, frequency, percentages and standard deviation were used to identify the causes of land fragmentation and examine the strategies adapted to mitigate the effect of land fragmentation on maize productivity, while regression analysis using the Cobb-Douglas production function model was carried out to determine the effect of land fragmentation on productivity of maize. The

Simpson fragmentation Index (SI) was used to compute land fragmentation index.

Simpson fragmentation Index (SI) is given as:

$$SI = 1 - \sum_{i=1}^{n} \left(\frac{ai}{A}\right)^2$$

Where:

a_i = Size of each plot

A = Total farm size

n = number of plots

Decision rule: SI = 0, implies that there is no fragmentation (single plot), SI = 1, means that there is high fragmentation.

Model specification

The regression model involving the Cobb-Douglas production function was used to capture the effect of some variables on maize production. These include land fragmentation index (SI), farmers' education level, extension contact, access to credit and distance to farm land. Inputs such as fertilizer and labour were also included in the model.

The Cobb-Douglas production function model is written as:

$$InY = \beta_0 + \beta_1 SI + \beta_2 InFERT + \beta_3 InLAB + \beta_4 EDU + \beta_5 EXT + \beta_6 CREDIT + \beta_7 DIST + \mathcal{E}_i$$

Where:

InY = Maize yield (kg/ha)

SI = Land fragmentation index

InFERT = Quantity of fertilizer (kg/ha)

InLAB = Quantity of labour (Man-days)

EDU = Years of schooling

EXT = Access to extension contact (No = 0, Yes = 1)

CREDIT = Access to credit (No = 0, Yes = 1)

DIST = Distance to plots (km)

$\mathcal{E}_i$ = Error term

$\beta_0 - \beta_7$ = Coefficients of elasticities

Results and discussion

Causes of land fragmentation

The causes of land fragmentation are shown in table 1. Majority (81.8%) of the farmers identified inheritance practices as the primary cause of land fragmentation. The inheritance system leads to subdivision of farmland into small and scattered plots. This negatively affects maize productivity. A good number (79%) of the maize farmers recorded population growth as a cause of land fragmentation. Rapid population increase exerts pressure on available agricultural land. As family sizes grow, available land is subdivided to accommodate new households, leading to smaller farm plots. Population growth limits farmers to continuous cultivation of a particular plot of land without fallow period leading to declining soil fertility, which directly lowers maize yield unless compensated with improved inputs, which many smallholder farmers cannot afford. This finding corroborates Igwe *et al.* (2022), study who found that population growth resulted in land fragmentation which negatively affected crop productivity. Urban expansion and infrastructure development constitutes 70.9% of the causes of land fragmentation in the study area. Expansion of towns, roads, schools, and other infrastructure reduces continuous farmland into separated plots. This reduces available fertile land, leading to decline in maize yield per hectare. Most (70%) farmers attributed cultural attachment to ancestral land, to land fragmentation. Cultural attachment discourages land consolidation. Even when consolidation could improve efficiency, most farmers prefer holding unto scattered plots, resulting in poor farm layout, increased labour costs, etc. These factors may contribute to lower maize productivity.

Table 1: Farmers' responses on causes of land fragmentation in Obudu LGA, (n = 110)

Causes	Frequency	Percentage
Inheritance system (land tenure)	90	81.8
Population growth	87	79
Sale of land in small parcels	74	67.27
Urban expansion and infrastructure development	78	70.9
Family disputes and land sharing	66	60
Government land acquisition policies	59	53.64
Migration and resettlement patterns (internally displaced persons (IDPs))	40	36.36
Cultural attachment to ancestral land	77	70

Source: Field Survey, 2025. Multiple responses by maize farmers.

Many (67.27%) farmers reported sale of land in small parcels as one of the causes of land fragmentation. Financial pressures may compel landowners to sell portions of land in bits. This gradual sale process contributes significantly to fragmentation, leading to reduced operational farm size. Thus, farmers with fragmented land reported lower total maize harvest compared to farmers with relatively larger and continuous plots.

Also, some (60%) of the farmers identified family disputes and land sharing as one of the causes of land fragmentation. Conflicts among heirs sometimes result in physical partitioning of land into distinct parcels. Family disputes may create uncertainty in land ownership leading to farmers unwillingness to invest in soil conservation practices. Low investment results in lower productivity levels. Eze *et al.* (2020), reported similar result. A moderate (53.64%) number of farmers attributed government land acquisition policies to land fragmentation, while 36.36% of the farmers reported migration and resettlement patterns (Internally Displaced Persons (IDPs) as one of the causes of land fragmentation. Land acquisition for public projects often divides communities' farmland, creating discontinuous holdings. On the other hand, movement of people into and out of communities alters land ownership patterns and may result in irregular land subdivision. The effect of this, is reduced soil fertility which may adversely affect maize productivity.

Determinants of effect of land fragmentation on maize productivity
Summary statistics of descriptive analysis of maize production

The key variables used in the analysis are presented in table 2. The average maize productivity was 2,385 kg/ha, indicating moderate productivity among smallholder maize farmers. The mean Simpson Index of 0.56 suggests a moderate level of land fragmentation in the study area. Some farmers had no fragmentation (SI = 0), while others experienced high fragmentation (SI = 90). Fertilizer use averaged 148 kg/ha, which is within recommended levels but still varies significantly among farmers. The average education level of 9 years indicates that most farmers had at least basic education, which may influence technology adoption. The result also shows that 22% of the farmers operated single consolidated plots, 48% operated between 2-4 plots, while 30% of the farmers operated 5 plots or more. Farmers with more fragmented plots spent more time moving between plots, which reduced supervision efficiency and increased labour cost.

Table 2: Summary statistics of descriptive analysis of variables in maize production

Variable	**Coefficient**	**Standard error**	**t-value**	**Sig.**
Variable	Mean	Min	Max	Std Dev
Maize yield (Kg/ha)	2385	1400	3500	520
Simpson index (SI)	0.56	0.00	0.90	0.24
Fertilizer (kg/ha)	148	70	220	36
Labour (man – days)	49	35	65	8
Education (years)	9	0	15	4
Distance to plot (km)	1.6	0.2	3.5	0.9

Source: Field Survey, 2025.

Regression results to determine the effect of the selected variables on maize productivity

The Cobb-Douglas production function was estimated using Ordinary Least Squares (OLS) as shown in table 3. The Simpson Index has a negative and statistically significant coefficient (-0.452) at 1% level. This implies that increased land fragmentation significantly reduces maize productivity. A rise in fragmentation reduces efficiency due to: increased time loss, higher transportation cost and poor supervision. This supports economic theory that consolidated land enhances scale efficiency, and corroborates Danquah (2019), and Twumasi and Asiamah (2024), who reported that land fragmentation results in inefficiency in maize productivity. Fertilizer use, labour, education, extension contact and access to credit, were positive and significant. Whereas, fertilizer use and labour were significant at 1% level, education, extension contact and access to credit were significant at 5% level. This implies that a 1% increase in any of the variables will increase maize yield by approximately 0.28%, 0.19%, 0.18%, 0.12% and 0.9% respectively. Increase in maize yield as a result of increased fertilizer use confirms that input intensification improves productivity. Also, increased labour improves weed control, timely planting, and harvesting efficiency. The positive influence of education implies that farmers are likely to adopt improved seed varieties, apply inputs at recommended levels and access extension services for increased maize productivity. Farmers with extension access and credit facilities will record higher productivity in maize production, because extension improves technical knowledge, while credit enables purchase of inputs.

Table 3: Regression result (Cobb- Douglas model) to determine effect of selected variables on maize productivity

Variable	Coefficient	Standard error	t-value	Sig.
Constant	6.102	0.210	2905	***
Simpson index (SI)	-0.452	0.083	-5.44	***
In (Fertilizer)	0.284	0.051	5.57	***
In (Labour)	0.192	0.047	4.08	***
Education	0.018	0.006	3.00	**
Extension	0.121	0.042	288	**
Credit	0.097	0.039	2.49	**
Distance	-0.065	0.021	-3.10	**
R2 = 0.71 **F = Statistics = 38.36** **n= 110**				

Source: Computed by the author. Note: *** = significant at 1% level, ** = significant at 5% level.

Furthermore, distance to plot had a negative and significant effect at 5% level, implying that increase in distance will reduce maize productivity due to increase in transportation cost, monitoring difficulty and post-harvest losses. The diagnostic analysis shows that $R^2 = 0.71$, indicating that 71% of the variation in maize productivity is explained by the model. F- statistics is significant, confirming overall fitness of the model.

Strategies adopted by farmers to mitigate effect of land fragmentation

The strategies adopted by smallholder maize farmers to mitigate effect of land fragmentation on maize productivity is shown in figure 1. The findings indicates that farmers mainly relied on land consolidation and improved seed varieties to mitigate land fragmentation effects. However, low adoption of credit and extension services suggests financial and institutional constraints. Land fragmentation remains a major constraint to maize productivity in the study area. While farmers are making efforts to adopt, government and stakeholders need to strengthen; access to affordable credit, agricultural extension services, land policy reforms encouraging consolidation, subsidies for improved inputs and mechanization.

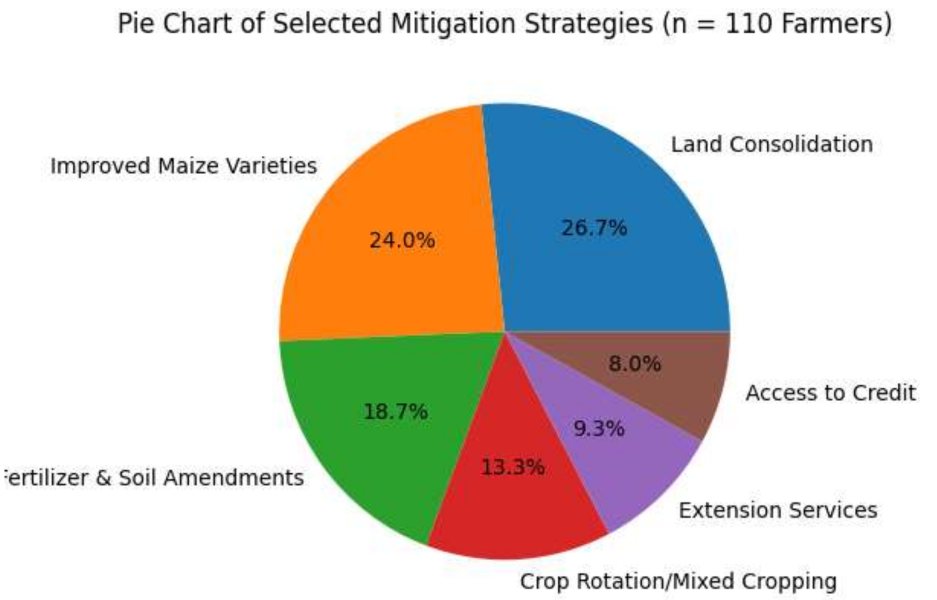

Figure 1: Strategies adopted by smallholder maize farmers to mitigate effect of land fragmentation.

Conclusion and recommendations

This study establishes that inheritance practices and population pressure are the dominant drivers of land fragmentation, reducing maize productivity through reduced farm size, increased production cost, soil degradation and reduced investment incentives. Socioeconomic and institutional factors also play significant roles. Therefore, land tenure reforms and consolidation policies, and awareness programmes should be strengthened to reduce fragmentation and improve productivity.

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EMERGING TECHNOLOGIES IN NIGERIAN AGRICULTURE: TRENDS, EMPIRICAL EVIDENCE, AND POLICY GAPS

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Abstract

Emerging digital and data-driven technologies are transforming agricultural systems worldwide, offering opportunities to enhance productivity, strengthen market integration, improve climate resilience, and increase supply chain transparency. In Nigeria, where agriculture plays a vital role in employment, food security, and rural livelihoods, the adoption of digital platforms, precision agriculture tools, artificial intelligence (AI), Internet of Things (IoT), agri-fintech innovations, and blockchain technologies presents significant potential for structural transformation. This paper provides a systematic narrative review of empirical and policy-oriented literature published between 2015 and 2025 to examine technological trends across Nigeria's agricultural value chain and identify institutional, infrastructural, and regulatory constraints limiting adoption. Global evidence suggests that digital technologies can increase farm productivity by 10–30% where enabling conditions exist (FAO, 2022; World Bank, 2023). In Nigeria, mobile-based advisory services and digital financial solutions are expanding and have improved farmers' access to agronomic information, financial services, and markets (Izuogu et al., 2023). However, advanced technologies such as AI-driven predictive analytics, drone-based remote sensing, smart irrigation systems, and blockchain traceability platforms remain largely at pilot stages. Major barriers to widespread adoption include inadequate rural broadband infrastructure, unreliable electricity supply, high capital costs, low digital literacy, fragmented policy coordination, and weak agricultural data governance frameworks. Gender and regional disparities further limit inclusive digital transformation. The paper argues that technological innovation must be embedded within coherent institutional reforms and coordinated policies to achieve sustainable impact. It recommends strengthening of Nigeria's

digital agriculture ecosystem through improved infrastructure, inclusive financing, human capital development, and regulatory modernization.

Keywords: Digital agriculture; Precision agriculture; Artificial intelligence; Agri-fintech; Blockchain; Policy gaps; Trends, Nigeria.

1. Introduction

Agriculture remains a foundational pillar of Nigeria's economy, contributing substantially to employment, rural livelihoods, and national food security (FAO, 2024). Despite its importance, productivity remains below global averages due to structural constraints including limited mechanization, low irrigation coverage, weak extension systems, post-harvest losses, and climate variability (FAO, 2024). According to the World Bank (2023), Sub-Saharan Africa's agricultural productivity gap is closely linked to technological adoption deficits and infrastructural limitations.

Digital agriculture defined as the integration of Information and Communication Technologies (ICTs), big data analytics, automation, and smart devices into agricultural production and value chains has emerged as a strategic modernization pathway (FAO, 2022). Empirical studies: Aker & Fafchamps (2015) and IFPRI, (2022) show that digital advisory platforms improve input-use efficiency, reduce transaction costs, and enhance resilience to climate shocks. In Nigeria, digitalization efforts are expanding; however, adoption remains uneven across regions and farm sizes (Izuogu et al., 2023).

x`This study integrates empirical evidence with institutional analysis to provide a comprehensive policy-oriented review of emerging technologies and structural constraints in Nigerian agriculture.

2. Conceptual Framework: The Digital Agriculture Ecosystem

Digital agriculture operates within an interconnected ecosystem composed of four mutually reinforcing layers:

i. **Digital Infrastructure Layer**: This entails broadband connectivity, electricity access, cloud computing, and data architecture.

ii. **Technology Application Layer**: Technology application layer involves mobile advisory systems, geospatial tools, AI models, IoT sensors, drones, and blockchain platforms.

iii. **Service Integration Layer**: Here extension delivery, financial services, insurance products, logistics, and market aggregation are involved

iv. **Institutional and Policy Layer**: governance structures, regulatory frameworks, data protection regimes, and public–private partnerships.

Sustainable transformation requires alignment across these layers. Weak infrastructure or regulatory uncertainty reduces innovation scalability and private investment incentives.

3. Empirical Trends in Emerging Technologies

Digital Advisory and Mobile Platforms

Empirical studies indicate that mobile-based extension services significantly reduce information asymmetry and improve farmer decision-making. Izuogu et al. (2023) found that digital advisory platforms in Nigeria enhance timely access to agronomic information and price signals, contributing to improved productivity outcomes among adopters. Findings in Sub-Saharan Africa show that SMS-based services increase fertilizer use efficiency and output market participation (Aker & Fafchamps, 2015). Other platforms such as EZ Farming, and Farmcrowdy enable smallholder engagement and access to investment and market data (Akinwale et al., 2023)

Digital investment platforms and contract-farming applications have also improved credit access by leveraging alternative data for credit scoring. Evidence suggests positive effects on farmer liquidity and input acquisition, though impacts vary across regions.

Precision Agriculture and Remote Sensing

Precision agriculture (PA) refers to the implementation of hardware and software technologies that enable farmers to make informed and customized decisions about various agricultural activities, including planting, fertilizing, pest control, and harvesting (Dutta et al., 2021).

Precision agriculture enhances resource allocation efficiency and overall farm management effectiveness (Liaghat and Balasundram, 2010). Precision agriculture techniques, including drone imaging and spectral data analysis, support field-level insights such as soil and crop health assessment. Technologies capture high-resolution imagery to inform input application and yield predictions, reducing waste and improving productivity. Although adoption is growing, cost and infrastructure remain barriers for many smallholders (Onu and Echebiri, 2025). Adoption in Nigeria has increased over the past decade, significantly improving productivity where infrastructure allows, but still hindered by high costs and limited farmer capacity (Sarah et al., 2025).

Artificial Intelligence (AI) and Predictive Analytics

AI-driven analytics support pest prediction, weather forecasting, and crop performance modeling. Globally, machine learning models have improved yield forecasting precision and climate adaptation planning (FAO, 2022). In Nigeria, however, AI deployment remains constrained by limited localized datasets and insufficient algorithmic training capacity. Also, high implementation costs and limited digital literacy constrain effective use among traditional farmers (Harma, 2023). Empirical validation studies remain sparse, indicative of the need for context-specific model development.

Internet of Things (IoT) and Smart Irrigation

IoT-enabled soil moisture sensors and automated irrigation systems contribute to water-use efficiency and climate-smart agriculture. Evidence from pilot projects indicates improved irrigation scheduling accuracy and reduced input wastage. Nevertheless, rural connectivity gaps and maintenance costs limit scalability.

Agri-Fintech and Digital Financial Inclusion

Digital financial platforms have expanded access to credit, savings, and insurance products. World Bank (2023) link mobile money adoption to increased agricultural commercialization and resilience to income shocks In Nigeria, agri-fintech platforms are bridging financing gaps, particularly for youth-led agribusinesses, though credit depth remains limited.

Blockchain and Supply Chain Transparency

Blockchain platforms offer opportunities for enhancing traceability and transparency in agricultural supply chains, addressing post-harvest losses and strengthening trust among actors. Early research indicates potential for reducing waste and improving market compliance (Adeyemi et al., 2025). Although still at pilot stages, blockchain applications demonstrate potential for quality assurance and compliance for export-oriented crops.

4. Policy Gaps and Structural Constraints

Some of the notable the policy gaps and structural deficits in these regards are discussed below:

Infrastructure Deficit

Infrastructure remains the most binding constraint to digital transformation. Rural broadband penetration in Nigeria remains significantly below urban levels, limiting the functionality of cloud-based and real-time agricultural applications (World Bank, 2023). Electricity access gaps further constrain the deployment of IoT devices, automated irrigation systems, and cold-chain technologies. Empirical evidence shows that digital agriculture yields positive returns only where connectivity and power infrastructure are reliable (FAO, 2022). Without foundational infrastructure, technological investments risk remaining pilot-based and donor-dependent rather than scalable.

Human Capital and Digital Literacy Gaps

Low digital literacy among farmers and extension personnel reduces the effective utilization of advanced technologies. GSMA (2023) highlights persistent digital skill disparities in rural Sub-Saharan Africa, particularly among women and older farmers. In Nigeria, extension systems are under-resourced, limiting their capacity to support AI-based advisory tools or precision platforms. Human capital deficits create adoption asymmetry, where technologically capable commercial farms benefit disproportionately relative to smallholders.

Financing Constraints and Investment Risks

High upfront costs associated with drones, sensors, AI analytics platforms, and precision equipment limit adoption among smallholders. Although agri-fintech platforms have expanded access to digital credit, lending volumes remain insufficient relative to demand (IFPRI, 2022). Private investors also face regulatory uncertainty and infrastructure risks, reducing long-term capital commitments. Blended finance models remain underdeveloped, and public guarantee schemes are limited in scope.

Regulatory Fragmentation and Weak Data Governance

Institutional overlap across ministries responsible for agriculture, ICT, and innovation weakens policy coherence. Regulatory uncertainty around data ownership, privacy protection, cross-border data flows, and AI accountability reduces investor confidence. The absence of interoperable agricultural data systems constrains large-scale analytics and predictive modeling. FAO (2022) emphasizes that effective digital agriculture requires robust data governance frameworks ensuring transparency, cybersecurity, and equitable data access.

Inclusion and Gender Inequality

Digital transformation risks widening existing inequalities. Women farmers, who constitute a significant share of Nigeria's agricultural workforce, often face limited access to smartphones, digital finance, and technical training (GSMA, 2023). Regional disparities also persist, with northern and remote communities facing deeper connectivity challenges. Inclusive innovation requires deliberate gender-responsive and regionally targeted policy design.

5. Strategic Policy Recommendations

From the foregoing, this analytical review therefore recommends the following:

Development of a Harmonized National Digital Agriculture Strategy

Nigeria requires an integrated national framework aligning agricultural policy with ICT, innovation, and financial inclusion strategies. Such a strategy should define clear institutional mandates, performance benchmarks, interoperability standards, and public–private partnership mechanisms. International experience shows that coordinated national strategies accelerate digital adoption and reduce duplication of initiatives (World Bank, 2023).

Investment in Rural Digital Infrastructure and Energy Systems
Public investment in broadband expansion, fiber-optic backbone networks, and 4G/5G rural connectivity is critical. Complementary investments in decentralized renewable energy mini-grids can support IoT devices and cold-chain systems. Infrastructure investment should prioritize underserved regions to reduce spatial inequalities.

Institutionalization of Digital Capacity Development
Digital literacy programs should be embedded within agricultural extension systems and tertiary agricultural education curricula. Capacity-building must include AI literacy, data interpretation skills, and digital financial management. Partnerships with universities and innovation hubs can strengthen research-to-farm knowledge transfer.

Promotion of Inclusive and Blended Financing Mechanisms
Government-backed credit guarantees, concessional loans, and risk-sharing instruments can crowd in private investment. Blended finance approaches combining public capital, development finance, and private sector participation can reduce perceived risk. Micro-leasing models for precision equipment can enhance affordability for smallholders.

Establishment of a Comprehensive Agricultural Data Governance Framework
A national agricultural data policy should clarify ownership rights, privacy protections, interoperability standards, and cybersecurity protocols. Ethical AI guidelines tailored to agricultural applications are also necessary to ensure accountability and transparency.

Strengthening of Monitoring, Evaluation, and Impact Assessment Systems
Robust monitoring frameworks are essential for assessing the productivity, income, and resilience impacts of digital interventions. Impact evaluations should use randomized and quasi-experimental methods where feasible. Evidence-based policy adjustment will enhance sustainability and long-term effectiveness.

6. Conclusion

Emerging technologies offer transformative potential for modernizing Nigerian agriculture. While digital advisory services and fintech solutions show promising adoption trends, advanced technologies remain constrained by infrastructural, institutional, and governance challenges. Sustainable digital transformation requires coordinated policy alignment, long-term infrastructure investment, inclusive financing mechanisms, and regulatory modernization. Future research should prioritize rigorous impact evaluations and context-specific scaling models for smallholder farmers.

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ENTREPRENEURIAL ORIENTATION AND PERFORMANCE OF POULTRY AND FISHERIES BUSINESSES IN CROSS RIVER STATE, NIGERIA.

Assessing the Influence of Entrepreneurial Orientation on Poultry and Fisheries Enterprise Performance in Cross River State.

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Abstract

The study was carried out to analyse entrepreneurial orientation and performance of poultry and fisheries businesses in Cross River State, Nigeria. The specific objectives of the study include to; highlight the entrepreneurial orientation dimensions; determine the cost and returns as well as profit of poultry and fisheries operators in the study area; investigate the influence of the dimensions of entrepreneurial orientation on the performance of poultry and fisheries firms in the State. Multistage sampling procedure was employed to select 301 respondents across the three agricultural zones of the State. Structured questionnaire was used to collect data from business owners. Analytical techniques include; descriptive statistics, cost and returns and gross margin analysis, profitability analysis and regression analysis. The study revealed that majority of the agribusinesses in the study area were predominantly micro enterprises and that agribusinesses were moderately entrepreneurial in their behaviours. The findings of the study further revealed that the bulk of the cost of running agribusinesses was variable cost of production. The gross margin, net farm income, rate of return, profitability index, profit margin and operating expense ratio all show that agribusinesses were viable and profitable in the starting and current year in poultry and fisheries enterprises. It was revealed that autonomy was negatively significant to profitability at 10 percent level while risk-taking was positively significant at 5 percent level. The study concluded that agribusinesses were moderately entrepreneurial in their behaviours and operational expense ratio shows that a greater percentage of the earnings from the agribusinesses is used to service variable cost of production. The study recommended that agribusiness owners should

improve on their entrepreneurial behaviours and adopt measures to minimize cost of operations.

Keywords: Entrepreneurial orientation, performance, autonomy, risk-taking, profitability.

Introduction

In view of the dynamic environment of business characterized by unpredictable change in environmental conditions, rapid changes in production and service technology, customer taste and preferences, legal regulations and competitor actions, they key competitive success factor will be the ability of a business to continuously develop new products, processes or services and achieve increased consumer satisfaction. As a result businesses that are not continually innovative may be making the unintentional strategic decision of being out of business in a short time. Following, entrepreneurial orientation may be defined as the processes, practices, and decision-making activities that leads to the development and delivery of new innovative products, services and processes and is seen as the key to business success and performance (yamada and Eshima, 2009).

According to Wantao (2011) firm performance can be assessed in many ways depending on the types of goals set. These goals can be categorized into four areas:

i. Market share; sales volume.
ii. Product quality; new and improved product introduction; productivity; ability to improve.
iii. Economic in terms of annual earnings; profitability; return on investment.
iv. Improvement in employee skills; employee flexibility.

This categorization represents an attempt to capture a broad range of outcomes that are important to firms. A company's market share and financial performance are vital to its existence. According to Lotz and Van der Merwe (2013), there is no consensus on the appropriate measures of performance. Performance may therefore depend on the indicators used to assess the performance. Usually, there exist a distinction between financial and non-financial measures of performance. Financial measures includes, sales growth, profit growth, cash growth, return on assets, and growth in market share. Financial indicators tend to provide a basis from which to draw inferences on the success and effectiveness of the business. Non-financial measures of performance may include growth in employment, new products/services/process and customer service etc.

According to Covin and Wales (2019), entrepreneurial orientation describes a consistent set of related activities or processes and provides a useful framework for researching entrepreneurial activity. Entrepreneurial orientation is conceptualized as a firm-level strategy-making process that firms use to enact their organizational purpose, sustain their vision, and creates competitive advantages.

Autonomy refers to the independent actions of an individual or a team in bringing forth an idea or a vision and carrying it through to completion (Lumpkin and Dess, 2016). Autonomy connotes the independence of actions and decision-making by individuals or teams towards bringing forth a concept or vision and carrying it through to completion. It is the independent spirit that seeks the freedom to explore new opportunities by taking risks to create new ventures. However, entrepreneurial individuals and teams could not operate in this manner without an environment that promotes independent economic behaviour and opportunity-seeking actions (Lumpkin *et al*., 2009).

Innovativeness is the tendency to pursue creativity and experimentation aimed at developing new products, services and processes. According to Prajogo (2016) businesses operating in dynamic environments are more likely to benefit from new product innovation than those operating in stable environments. Also, it has been observed that changes demanded by markets typically instigate innovation, for example, demand affects a business's disposition to develop and introduce innovations. When market demand is high or growing, businesses are more willing to invest in innovation as they perceive that there is a better chance of higher returns on such investments. In turn, these innovations increase consumer expectations and concurrently trigger competitors into responding with similar or improved innovations.

Dynamism in the environment may be associated with organisational risk-taking as businesses that are risk-aversed under such conditions lose market share and will not be able to maintain a strong industry standing relative to their risk-tolerant counterparts. Petrus (2019) confirmed the role of dynamism in top management risk-taking, although they found that the benefit of risk-taking was reduced in more dynamic environments. Mason *et al.* (2015) defined risk as the extent to which there is uncertainty about whether potentially significant and/or disappointing outcomes of a decision will be realised. Risk is either the potential to act too quickly on an unverified opportunity (sinking the boat) or the potential to wait for too long before acting (missing the boat). Risk is inherent in the operations of any business and almost every decision taken by managers involves risk (Mason *et al.*, 2015).

Rosenbusch *et al.* (2013) observed that the proactive introduction of new products and services makes businesses less vulnerable to the danger of obsolescence. Firms in dynamic environments can be viable in the long run only if they manage to retain a highly flexible resource base. Madsen *et al.* (2015) defines pro-activeness as a posture of anticipating and acting on future wants and needs in the marketplace, thereby creating a first-mover advantage vis-à-vis competitors. First-mover, businesses are likely to control access to markets by dominating distribution channels, charge high prices and skim the market ahead of competitors, secure access to rare resources, gain new knowledge of key factors and issues, carve out market share and be in a position that is easy to defend and costly for rivals to overtake.

According to Madsen *et al.* (2015), competitive aggressiveness requires firms to challenge their competitors directly and intensely to achieve entry or improve their positions. This entails the display of a combative and forceful approach towards rivals through pre-emptive actions and aggressive responses. Strangely though, they also argue that competitive aggressiveness is consistent with exploitation; however, it is more feasible in stable environments than in dynamic settings. Nadkarni *et al*. (2016) examined the relationship between industry velocity competitive aggressiveness and firm performance and found that it positively affected performance in a stronger manner in high-velocity industries compared with low-velocity. Madsen *et al*. (2015) defines competitive aggressiveness as a business's propensity to directly and intensely challenge its competitors in an attempt to improve position in the market place.

The specific objectives of the study were to;

i. show the entrepreneurial orientation dimensions
ii Determine the cost and returns as well as profit of poultry and fisheries operators in the study area.
iii Investigate the influence of the dimensions of entrepreneurial orientation on the success of poultry and fisheries firms in the State.

Materials and Methods

Cross River state is located within the tropical rainforest belt of Nigeria and lies between longitudes 7º 50' and 9º 28' east and latitudes 4º 28'and 6º 55' north. It shares common boundaries with the Republic of Cameroun in the east, Benue State in the north, Ebonyi and Abia States in the west, Akwa Ibom State in the south west and Atlantic Ocean in the south (McKenna, 2025). Its international boundaries make it a security hotspot and an axis of international trade. As presently constituted, the capital of Cross River State is Calabar and the State has 18 local government areas namely; Abi, Akamkpa, Akpabuyo, Bakassi, Bekwara, Biase, Boki, Calabar Municipal, Calabar South, Etung, Ikom, Obanliku, Obubra, Obudu, Odukpani, Ogoja, Yakurr and Yala. The state is divided into three agricultural zones, namely, Calabar, Ikom and Ogoja.

The study population consisted of all poultry and aquaculture businesses in the three agricultural zones of Cross River State both registered and unregistered. Primary data were collected with the aid of structured questionnaire with closed ended statements on the constructs under study. The questionnaire were self-administered and retrieved in collaboration with trained assistants.

A total of 358 of questionnaire were distributed and 309 (86.3 percent) were retrieved, while 49 (13.7 percent) were not returned. Of the 309 (86.3 percent) that were retrieved, 8 (2.2 percent) were discarded and removed from the data set because of incorrect filling. The number of questionnaire that were suitable for further studies were 301 (84.1 percent).

Taro Yamane formula (1967) was used as cited by Ogbaini *et al.* (2024) to determine the sample size. The formula is stated as follows:

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

Where;

n	=	sample size
N	=	population size (Total registered population of poultry and fisheries businesses in the State = 3406)
1	=	unity of constant
e	=	tolerable error (0.05)

$$n = \frac{3406}{1 + 3406(.05)^2}$$

$$= \frac{3406}{9.515^2}$$

= 358

Calabar, Ikom and Ogoja agricultural zones have 7, 6 and 5 LGAs respectively. Since LGAs are not evenly distributed among the zones, accordingly 4, 3 and 2 LGAs were selected from Calabar, Ikom and Ogoja zones respectively making a total of 9 LGAs. Multistage sampling method was used to determine the total sample size. Cluster sampling technique was used in selecting Calabar municipality, Calabar south, Akamkpa and Odukpani from Calabar zone, Ikom, Obubra and Yakurr from Ikom zone, Ogoja and Obudu from Ogoja zone. Proportionate sampling was used to select 358 agribusinesses according to MSMEs classification. Enterprises were then randomly selected using a list of registered businesses from Cross River State Ministry of Agriculture.

Descriptive statistical techniques such as frequency counts, percentages, arithmetic means, gross margin and profitability analysis and multiple regression analysis were used in analysis.

Cost and return analysis was used to determine the cost and revenue structure of agribusinesses.

TC = TFC+ TVC

Where;
TC = Total cost
TFC = Total fixed cost
TVC = Total variable cost

Total variable cost (TVC) comprise of all the operating cost incurred by the firm from stocking to point of sale times the number of production cycles in a year.

Total revenue (TR) consist of receipts from total sales (Gross revenue = Quantity produced × price per product in (N).

Fixed cost are costs which do not vary with output and included depreciated values of items used in production.

Revenue refers to all cash receipts from the sale of poultry products and fish products.

The gross profit margin reflects the efficiency with which management produces each unit of agribusiness products. A high gross profit margin is a sign of good management. A low ratio reflects high cost of goods sold due to firm's inability to purchase inputs at favorable terms, inefficient use of fixed and variable resources.

Gross margin was obtained by subtracting the total variable cost from the total revenue.

GM = TR – TVC
Where;
GM = Gross margin (N)

TR	=	Total revenue (N)
TVC	=	Total variable cost (N)
NI	=	GM- FC

Profitability ratios calculated included rate of return on investment (ROI), rate of return on variable cost, profit margin and operating expense ratio.

Results and Discussion

Entrepreneurial orientation of agribusinesses

Table 1 shows the descriptive statistics for entrepreneurial orientation (EO) dimensions and overall EO index. The mean values of all the measures of entrepreneurial orientation clustered around a common range with competitive aggressiveness and innovativeness having a mean of 3.2 and risk-taking having a mean of 2.9. The standard deviation of the data suggests the existence of homogeneity of variance as the deviation converged between 0.89 and 1.05. The mean for the seven measures of competitive aggressiveness is 3.2 and is in line with Dafel (2012) who got 3.304. This result suggests that agribusinesses in the study area are moderately combative and do not intensely and directly challenge competitors and rivals. Also, the mean for autonomy is 3.1 depicting that people moderately enjoy freedom and independence in developing and bringing new ideas to fruition. Innovativeness factor had an index of 3.2 from the six measures showing that agribusinesses are moderate in adopting new technologies. This is consistent with the findings of Alarape (2013) and Neneh and Van Zyl (2023) who established that SMEs are moderately innovative in terms of launching new products lines or modifying existing product lines. Risk-taking had a mean of 2.9 from the five measures showing that the respondents do not consider the term risk-taking to be a positive attribute for business performance, again, in line with Alarape (2013).

Furthermore, agribusinesses are reluctant in taking actions that are neither extensively planned nor driven by intuition before implementation. Pro-activeness had an index of 3.1 from five measures showing that agribusinesses moderately considered environmental scanning as a continuous exercise to stay in business and identifying new opportunities to stay ahead of competitors. This suggests that most agribusinesses are followers and not market leaders since they prefer to be reactive rather than being proactive. This also aligns with Alarape (2013) and Neneh and Van Zyl (2023) that established that agribusinesses are followers and reactive instead of market leaders. The mean for the overall EO index is 3.1 showing that the overall level of EO in agribusinesses in Cross River State is moderate. This agrees with Fatoki (2012) and Yoon (2012) who also revealed that overall level of EO amongst South African and South Korean SMEs is moderate.

Table 1: Dimensions of entrepreneurial orientation of agribusinesses

Dimensions of EO	Labels	Items	N	Mean	SD
Competitive	ECA1	Our business typically focuses on producing high quality products.	301	4.1	0.6
Aggressiveness	ECA2	Our business has a well-planned marketing and distribution strategy.	301	3.6	0.73
	ECA3	Our business provide fast deliveries/meet all delivery promises	301	3.3	0.77
	ECA4	Our business typically adopts competitive pricing.	301	3.2	0.89
	ECA5	Our business has gained operational efficiency through technical know-how.	301	3.2	1.03
	ECA6	High sanitary conditions in our business prevent disease outbreak/pollution/guarantees quality products.	301	3.3	1.0
	ECA7	Our business enjoys competitive advantage through alternative feeds and methods of production.	301	2.8	1.22
CA index				**3.2**	**0.89**
Autonomy	EA1	Our business allows room for initiative and creativity in carrying out duties.	301	3.5	1.06
	EA2	Operational activities are	301	3.1	1.19

		carried out with minimum supervision.			
	EA3	Decisions are taken without undue and elaborate approval procedures.	301	2.9	1.21
	EA4	Our business allows flexibility in resolving problems.	301	3.2	0.89
	EA5	Our business encourages ability to be self-directed in the pursuit of opportunities.	301	3.0	0.9
Autonomy index				**3.1**	**1.05**
Innovativeness	EIN1	Our business is creative in introducing alternative feed options.	301	3.2	1.1
	EIN2	Our business seeks new ways of doing things (practices/processes) through research.	301	3.3	0.97
	EIN3	Our business is committed to sustainable ethical practices.	301	3.1	0.95
	EIN4	Our business places strong emphasis on continuous improvement in products/service delivery/ processes.	301	3.3	0.99
	EIN5	Our business is continually chasing new opportunities.	301	3.2	1.05
	EIN6	Our business possess the ability to adapt to changing consumer preferences.	301	3.1	0.98
Innovativeness index				**3.2**	**1.0**
Risk-taking	ERT1	Our business has a high taste for low risk projects (with normal/certain rates of return).	301	3.0	1.06
	ERT2	Our business has a high taste for high risks projects (with chances of very high returns).	301	3.0	0.97

	ERT3	Our business believes that bold, wide-ranging acts are necessary to achieve the business objectives.	301	2.8	0.93
	ERT4	Risk-taking is powered by intuition: actions are taken without recourse to forethought and research.	301	2.9	1.13
	ERT5	The term risk-taker is considered a positive attribute for business performance and growth.	301	3.2	1.01
Risk-taking index				**2.9**	**1.02**
Pro-activeness	EP1	Our business is very often the first to introduce new practices/services/processes.	301	3.2	0.94
	EP2	Our business typically initiate actions that competitors respond to.	301	3.1	0.91
	EP3	Our business continuously seeks out new practices/services/processes.	301	3.1	0.93
	EP4	Our business continuously monitors market trends and identifies future needs of customers.	301	3.0	0.85
	EP5	Our business control access to markets by maintaining good relations with hotels, restaurants, vendors etc.	301	3.1	0.81
Pro-activeness index				**3.1**	**0.89**
Overall EO index				**3.1**	**0.97**

Rating of EO index: <3 = low, 3 = moderate, >3 = High

Source: Field survey (2024).

Profitability of poultry and fisheries businesses in the study area

Cost and returns analysis for poultry agribusinesses

The estimate of average costs and returns of the enterprises per production cycle of a batch of 1115 broiler birds at starting and 2955 birds at current year is presented in Table 2. The table shows that the variable costs constituted the bulk of the costs of production and was estimated to be ₦820,354.53 and ₦3,938,900.69 on the average for the starting and current year, respectively and represented 96.92 percent and 99.11 percent of the total costs of production for the starting and current year, respectively, while average fixed costs were ₦26,034.09 and ₦35,416.48 for the starting and current year, respectively, representing only 3.08 percent and 0.89 percent for the starting and current year. This result is in consonance with the reports of Aminu and Hermanns (2021) that variable inputs account for most of the cost incurred in poultry business. Cost of feeds accounted for the highest subhead (36.26 percent) of the total cost for the starting year, and 47.20 percent in the current year.

The gross margin and net income for a batch of 1115 birds were ₦2,302,970.27 and ₦2,276,938.23 respectively for the starting year, while for the current year it was ₦20,758,398.31 and ₦20,722,981.82 for a batch of 2955 birds, respectively. The positive values of gross margin and the net farm income implies that the enterprise is viable and worthwhile. The rate of return on investment of 2.69 and 5.21 implies that for every one naira invested in poultry enterprise, a return of ₦2.69 and ₦5.21 is earned for the starting and current year respectively.

Operating ratio was 0.26 and 0.16 for the starting and current year, meaning that 26 percent and 16 percent of the gross income were used to pay for the variable costs during the starting and current year, respectively. The rate of return on variable cost were 3.77 and 6.26 for the starting and current year, respectively, which means that for every naira of cost incurred, N3.77 kobo and N6.26 was returned to the broiler enterprise. The profit margin of 0.73 and 0.84 for the starting and current year respectively show that each N1.00 of revenue earned, the enterprise earns N0.73k and N0.84k in net income. Therefore, from the study, it can be concluded that poultry business enterprise in the area is profitable. This is in congruence with the findings of Yusuf *et al.*, (2016) and Olurunwa (2018).

Table 2: Average cost and return of poultry enterprises per production cycle per 1115 birds for starting year and 2955 birds for current year

Item	First year Average Amount (₦)	percent of total Cost	Current year Average Amount (₦)	percent of total Cost
Variable cost				
Day old chicks	241607.89	28.55	1430932.76	36.00
Feeds	306906.51	36.26	1876001.70	47.20
Medication/vaccines	36526.27	4.32	226141.61	5.69
Water	147243.20	17.40	123502.90	3.11
Electric bill	21060.67	2.49	45162.41	1.14
Transport	23801.77	2.81	82411.07	2.07
Labour	29503.87	3.49	86883.72	2.19
Sawdust	13704.35	1.62	67864.53	1.71
Total variable cost (TVC)	820354.53	96.92	3938900.69	99.11
Fixed cost (FC)				
Housing	18963.50	1.03	21830.96	0.55
Drinkers	2791.29	0.15	3303.97	0.08
Feeders	2470.69	0.13	8101.02	0.20
Lantern	1587.93	0.09	1730.20	0.04
Scale	220.67	0.01	450.33	0.01
Total fixed cost (TFC)	26034.09	3.08	35416.48	0.89
Total cost (TC)	846388.62	100.00	3974317.18	100.00
Revenue (₦)				
Numbers of mature broiler/Enterprise unit	1115		2955	
Average price per broiler	2801.19		8357.80	
Total revenue	3,123,326.8 5		24,697,299	
Gross Margin (GM)	2,302,970.2		20,758,398.	

= TR –TVC	7	31
Net Income (NFI) = TR-TC	2,276,938.23	20,722,981.82
Financial ratio		
Rate of return per naira investment (NI/TC)	2.69	5.21
Rate of return on variable cost (TR-TFC/TVC)	3.77	6.26
Profit margin = NI/TR	0.73	0.84
Operating expense ratio = TVC/TR	0.26	0.16

Source: Field survey (2024)

Cost and returns analysis for fisheries agribusinesses

The summary of average costs and returns from fisheries enterprises in Cross River State for starting year and current year are presented in Table 3. The profitability of fisheries enterprise was examined using cost and return analysis. The table shows that the variable costs constituted the bulk of the costs of production and was estimated to be ₦5,466,243.96 and ₦25,703,326.28 on the average for the starting and current year, respectively and represented 84.81 percent and 94.49 percent of the total costs of production for the starting and current year, respectively, while fixed cost were ₦979,237.07 and ₦1,479,923.05 on the average for the starting and current year, respectively representing only 15.19 percent and 5.44 percent for the starting and current year. Cost of feeds constituted the biggest subhead (51.48 percent) of total cost for the starting year. Similarly, for the current year, cost of feed accounted for the biggest subhead (56.63 percent) for cost. This finding is in agreement with Oluseye and Damilola, (2019) whose findings indicated the cost of feed to account for the largest proportion of the total cost of fishery enterprise.

The gross margin and net farm income per entrepreneur were ₦6,311,609.59 and ₦5,332,372.51, respectively for the starting year, while for the current year it was ₦ 21,476,149.86 and ₦19,996,226.81, respectively. The positive values of gross margin and the net farm income implies that the enterprise is a viable one and worth investing in. Average total cost per kg of fish was N1, 044.78 while average revenue of a kg of fish was N1909.13 giving a net income of N864.35 per kg of fish produced in the starting year. Similarly, the average total cost per kg of fish produced in the current year was N1, 627.35 while the average total revenue was N2, 822.60 giving a net income of N1, 195.25. The rate of return on investment of 0.83 and 0.73, suggest that for every one naira invested in fisheries enterprise, a return of ₦0.83 and ₦0.74 is earned for the starting and current year, respectively.

The operating ratio of 0.46 and 0.54 for the starting and current year suggest that 46 percent and 54 percent of the gross income were used to pay for the variable costs during the starting year and the current year, respectively. The rate of return on variable cost were 1.98 and 1.78 for the starting and current year, respectively, which means that for every naira of cost incurred, N1.98 and N1.78 were returned to the fishery enterprise. This is an indication that the fishery enterprise in the study area is profitable. The profit margin of 0.45 and 0.42 for the starting and current year respectively shows that for each N1 of revenue, the enterprise earns N0.45 and N0.42 in net income. The foregoing therefore suggested that fishery enterprise in the study area is a profitable.

Table 3: Average cost and return of fisheries enterprises per production cycle per kg of fresh fish

Item	First year Average Amount (₦)	First year Percentage of total Cost	Current year Average Amount (₦)	Current year Percentage of total Cost
Variable cost(VC)				
Fingerlings	1483716.22	23.0	9034068.97	33.21
Feeds	3318036.05	51.48	15402726.53	56.63
Medication_vaccines	21904.11	0.33	38242.86	0.14
Transport	60062.50	0.93	335932.14	1.24
PHCN /Fuel bills	128573.36	1.99	100314.69	0.37
Labour	453951.72	7.04	792041.10	2.91

Total variable cost (TVC)	5466243.96	84.81	25703326.28	94.49
Fixed cost (FC)				
Housing	197323.89	3.06	65955.56	0.24
Scale	50302.82	0.78	77778.89	0.29
Hand net	9594.26	0.15	14605.26	0.05
Drag net	102200.00	1.59	127333.33	0.47
Pumping machine	120375.00	1.87	153280.90	0.56
Netting	68510.42	1.06	112266.67	0.41
Borehold	421238.10	6.54	928702.44	3.41
Bowl	9692.59	0.15	17712.88	0.07
Total fixed cost (TFC)	979237.07	15.19	1497635.93	5.5
Total cost (TC)	6445481.03	100	27200962.21	100
Revenue (₦)				
Quantity sold/Enterprise unit	6169.21		16714.88	
unit price per kg	1909.13		2822.60	
Total revenue	11777823.89		47179476.14	
Gross Margin (GM) = TR –TVC	6311579.93		21476149.86	
Net Income (NFI) = TR-TC	5332342.86		19978513.93	
Financial ratio				
Rate of return per naira investment (NI/TC)	0.83		0.73	
Rate of return on variable cost (TR-TFC/TVC)	0.84		0.93	
Profit margin = NI/TR	0.45		0.42	
Operating expense ratio = TVC/TR	0.46		0.54	

Source: Field survey (2024).

Confirmatory factor analysis for the measurement model

The results of confirmatory factor analysis as presented in Table 4 shows the values of the composite reliability (CR) and average variance extracted (AVE) for the latent variables. It shows that innovativeness has a CR of 0.88, competitive aggressiveness has a CR of 0.92, pro-activeness has a CR of 0.79, risk-taking has a CR of 0.89 and autonomy has a CR of 0.82. This means that convergent validity was achieved. The result indicates that the measurement model is internally consistent and reliable. The model's goodness of fit statistics for the final overall model assessment showed an acceptable fit of the measurement model to the data, that is: (CMIN/DF) = 2.105, Tucker and Lewis index (TLI > 90) = 0.924, Goodness of Fit Index (GFI> 90) = 0.906, Comparative fit index (CFI > 0.90) = 0.962 and root mean square error of approximation (RMSEA ≤ 0.08) =0.061. All these indices are within the recommended range as suggested by (Hair *et al.*, 2022) confirming that the model is appropriate.

Confirmatory factor analysis provides information on the measurement model and its fitness. The loading of indicators on the latent constructs is more than the threshold of 0.70 as suggested by Hair *et al.* (2022). However, in the initial analysis, some items having CR <0.7 and AVE< 0.5 were removed.

Table 4: Convergent validity and reliability of the measurement model

Latent construct	Items	SFL	CR	AVE
Innovativeness	IN5	0.63	0.88	0.78
	IN4	0.65		
Competitive	CA5	0.47		
aggressiveness			0.92	0.79
	CA6	0.54		
	CA4	0.47		
Pro-activeness	P2	0.69	0.79	0.58
	P1	0.63		
	P3	0.63		
Risk-taking	RT2	0.68	0.89	0.74

	RT1	0.52		
	RT3	0.45		
Autonomy	A2	0.57	0.82	0.79
	A1	0.68		

SFL = Standardized factor loading; AVE = Average variance extracted IN = Innovativeness, CA = Competitive aggressiveness, EH = Environmental hostility, ED = environmental dynamism, P = pro-activeness; RT = Risk-taking,

A= Autonomy

CR = Composite reliability

Source: Field survey (2024).

Influence of entrepreneurial orientation dimensions on the profitability of agribusinesses

The result in Table 5 shows the regression analysis of the influence of entrepreneurial orientation dimensions on the profitability of poultry and fisheries enterprises. The linear model was the lead equation. The coefficient of determination (R^2) shows that 54.3 percent of variability in the dependent variable was explained by the independent variables. From the result, autonomy (EA) was negative and significant at 10 percent level. Here, the null hypothesis is rejected. This implies that high profit (performance) can be earned when agribusiness owners exert adequate supervision on their workers. Workers are not allowed to enjoy independence and become self-directed. The result is in line with the study of Adibe *et al*. (2023) where entrepreneurial orientations (autonomy) had positive relationship with performance of SMEs in Southeast, Nigeria. Conversely, the coefficients for risk taking (ERT) was positive and significant at 1 percent level. Also, the null hypothesis is rejected. This implies that an increase in entrepreneurial risk taking will increase the entrepreneurs profit in the study area. Here managers have to exercise due diligence in defining risk, minimizing and managing it as much as possible.

Conclusion/ Recommendations

The study concluded that entrepreneurs in the study area were microbusiness owners and that poultry and fishery businesses in the study area were profitable despite the high operational cost. Also, the study concluded that autonomy and risk-taking were significantly related to profit. Generally, the study concluded that the high exit rate of businesses in Cross River State was as a result of lack of managerial ingenuity, in terms of poor handling of cost of production. The study recommended that agribusinesses should improve on their entrepreneurial behaviours and that agribusiness owners should imbibe good management practices to ensure cost minimization by employing the use of alternative feeds.

Table 5: Determinant of entrepreneurial profit of poultry and fisheries firms

Variables	+Linear Coefficient	t-Statistic	Double log Coefficient	t-Statistic	Semi-log Coefficient	t-Statistic	Exponential Coefficient	t-Statistic
C	2.694581	1.605505	-0.339853	-0.82868	-0.1311	-0.40634	2.861577	1.341375
ECA	0.315664	0.674931	0.193681	0.565207	0.040042	0.445372	1.290666	0.72407
EA	-0.53231	-1.82413*	-0.308899	-1.5716	-0.08435	-1.50365	-1.98456	-1.94105*
EIN	-0.06953	-0.17527	0.357654	1.281565	0.110981	1.455383	-0.35048	-0.24142
ERT	0.54081	17.804***	0.89208	4.38265***	0.004027	0.068969	0.259618	0.24519
EP	-0.15734	-0.41315	0.127583	0.475704	0.034076	0.465453	-0.47587	-0.3411
R-squared	0.54311		0.422973		0.422046		0.41534	
Adjusted R-squared	0.535395		0.413413		0.41357		0.405349	
S.E. of regression	2.799913		0.537978		0.538233		2.798452	
F-statistic	0.856636		1.387251		1.330021		0.919144	
Prob(F-statistic)	0.510687		0.228897		0.251333		0.468802	

***, **, and * Significance at 1 percent, 5 percent and 10 percent probability level, respectively, + indicates lead equation

Source: Field survey (2024).

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FACTORS INFLUENCING EFFICIENCY AND OUTPUT OF YAM PRODUCTION IN YALA LOCAL GOVERNMENT AREA, CROSS RIVER STATE, NIGERIA

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Abstract

A study on factors influencing efficiency and output of yam production in Yala Local Government Area, Cross River State, Nigeria was undertaken. A multi-stage sampling technique was adopted to select respondents for this study and multiple regression analysis and stochastic frontier production function (SFPF) were used to analyse the data. Result of regression analysis showed that farm size, fertilizer used, age of farmer and farming experience were factors that influenced output of yam as they are significant and correctly signed in line with economic theory. The coefficient of determination R^2 indicate that 63% of the variation in yam output was explained by the explanatory variables while 37% was due to random error. The result also showed that labour, fertilizer and seed yam had MVP ratio of 0.018, 0.078 and 0.002 respectively, indicating that yam farmers in the study area were overutilizing the use of these resources meaning that they were not efficiently utilized. Hence adjustment in resource use is required in order to improve farm output and profit at the percentage level of technology employed by yam farmers. Based on the findings of this study, the study recommends that government in collaboration with policy makers should develop policies to ease access to land by yam farmers

Key words: efficiency, output, yam production, regression analysis

1. Introduction

Yam (*Dioscorea spp*) is a clonally propagated economic crop, cultivated for it underground edible tubers. African, and more than 94% of the world's yams are produced in "West African yam belt" including countries like Nigeria, Ghana, Cote D'ivoire, Benin, and Togo. Nigeria ranks as the leading producer of yams, in the world, accounting for 66% (about 50.1 million tons) of Annual global production (Nweke 2020). Ogundari, (2022) noted that yam is an important source of dietary calories and contributed on average more than 200 kilocalories per person per day to over 300 million people between 2006 and 2010. Yam is a perennial crop grown principally for the tuberous root and leaves, a multifaceted crop with a lot of value chain, that has both food and industrial applications and processed into pounded yam, yam flour, yam chips, yam powder etc. For non-food application, the tuber crop can be used in the manufacture of industrial products like yam starch based biodegradable plastics, yam base animal feeds, yam based cosmetic; as well as used for biofuel. It contributes about 60-70 percent of the food requirements of rural household in the country (Ettah and Angba 2022).

Yam production remained the major driver of the sectors as it accounted for 91.99% of the overall normal growth of the sector in the second quarter of 2022 (National Bureau of statistics (NBS), 2022). In Nigeria, yam is grown in all the ecological zones and planted all year round depending on the availability of moisture. The crop however, did not gain importance in the country until the end of the nineteenth century, when processing techniques were introduced as many slaves returned home (Odoemenem and Otanwa, 2020). Comparing the output of various crop in Nigeria yam production ranks first with 27 million metrics tons, followed by sorghum at 7 million metrics tons, millet at 6 million metrics tons and rice at 5 million metrics tons Food of Agriculture Organization (FAO), 2021).

Expansion of yam production has been relatively steady since 1990 with an additional push between the years 1998 to 2002 and up to 2023 owing to release of improved varieties from International Institute for Tropical Agriculture (IITA). By zones, the north-central produced over 17 million metrics ton a year. South-South produces over 13 million metrics ton per year, the south- East about 10 million metrics ton per years, the south-west 8 million metrics ton per year, the North-west and north-east are small by comparison at 7.86 and 5.14 million metric ton respectively (IITA, 2021). On a per capita basis, north-central is the highest producing states at 0.92 per tons per person, followed by South-East 0.72 per ton per person, south-south 0.47 per ton per person, southwest 0.34 per ton per person, northwest 0.10 per ton per person and northeast 0 01 per ton per person (FOA 2021).

National per capita production shows that Benue state is the largest producers of yams in north-central, while cross river state, Akwa Ibom, Rivers and Delta States dominate yam production in South South Zones, while Enugu and Imo dominate yam production in south East. Kaduna alone in Northwest is comparable in output to many of the states in the southern region at almost 2 million metric tonnes a year, with very little currently produced in northeast. (International institute of tropical agriculture IITA, 2022). According to Agbachom, *et. al*. (2020), they confirmed that large proportions of yam crops are grown on marginal lands that are usually not competitive (not too good for other crops). The authors also averred that the crop production is constrained by the communal land tenure system practiced in Nigeria and other countries in Sub-Saharan Africa, which does not allow for large farm holding suitable for mechanization.

The majority of yam farmers cultivate small farm areas which are not conducive or economical for mechanization. Shioga (2023) argued that without mechanization, using improved inputs alone will not sufficiently boost yam production. Despite these challenges, yam is one of the fastest expanding staples or vital food crops in yam consuming countries and has continued to gain prominence among farmers while the industrial demand is also rising consistently (Wossen, 2019). Globally, yam undergoes consistent growth of well above 6% annually. Food of agriculture organization (FAO, 2021) posted that as of 2021, world yam production stood at about 298 million tonnes; Africa, total production was about 180 million tonnes (about 56% of world production). At the same period, Nigeria produced about 60 million tonnes and despite being the largest producer of the crop in the world, more than 90% of yam produced in Nigeria is consumed locally. National Bereau of statistics (NBS,2O22). This study is guided by the theory of production which is basically on activity of transforming input into output or a process of combining various input to produce an output for consumption and that of efficiency which is concerned with the relative performance of the process of transforming input into outputs.

2. Materials and Methods

Study Area

The study was conducted in Yala Local Government Area (LGA), located in the northern part of Cross River State, Nigeria. Yala LGA is one of the largest and most agriculturally productive areas in the state, with a high population engaged in farming activities. The LGA shares boundaries with Benue State to the north, Ebonyi State to the west, Ogoja LGA to the south, and Ikom LGA to the east. The headquarters of the local government is Okpoma, which serves as the administrative and commercial center. The area is located at approximately Latitude: 6.7500° N, Longitude: 8.5667° E. This geographic location places Yala LGA in the northern part of Cross River State, Nigeria, near the border with Benue and Ebonyi States.

Yala lies within the humid tropical rainforest and guinea savanna zone, which makes it suitable for agricultural activities, particularly yam production. Yala LGA covers an area of approximately 1,739 square kilometers and falls within the tropical rainforest and guinea savanna zone. The area experiences a humid tropical climate, characterized by two distinct seasons: rainy season typically lasts from April to October, with peak rainfall occurring between June and September and dry season which extends from November to March, with a significant reduction in rainfall. The average annual rainfall ranges from 1,500 mm to 2,000 mm, and temperatures range between 25°C and 32°C throughout the year. The fertile soil and favorable climatic conditions make the region suitable for agricultural activities, particularly yam cultivation, cassava, maize, rice, and other staple crops. Agriculture is the dominant occupation in Yala LGA, with most farmers practicing subsistence and small-scale commercial farming.

Yam production is a major economic activity due to the rich loamy soil, favorable climatic conditions, and traditional importance of yam in local diets and cultural practices. The area is known for producing high-quality yam tubers, which are sold in local markets and transported to other parts of Nigeria. Farmers in the region employ traditional and semi-modern farming techniques, with land preparation mostly done manually or with minimal mechanization. Yam farming is not only an economic activity but also a cultural practice in Yala LGA. The people of Yala are part of the Ejagham and Yala ethnic groups, and yam plays a crucial role in their festivals, such as the New Yam Festival, which signifies the beginning of the harvest season.

Sampling Procedure and Sample Size

A **multi-stage sampling technique** was adopted to select respondents for this study. This approach is chosen to ensure a fair representation of yam farmers across different communities in Yala Local Government Area (LGA). The sampling process was carried out in the following stages: In the first stage, Yala LGA was purposively selected as the study area because of its significant contribution to yam production in Cross River State. The Second Stage was the selection of major yam-producing communities, five major yam-producing communities were randomly selected within the area. The third stage involved selection of yam farmers from the selected communities, a random sampling technique was employed to select yam farmers for the study.

Data Collection Methods and analysis

Primary data were collected using structured questionnaires and interviews. resource use efficiency of yam farmers in the area. Multiple regression analysis was used to examine the factors influencing yam production in area the resource use efficiency of yam farmers achieved using the stochastic frontier production function (SFPF), which distinguishes random errors from inefficiency effects in production. The function is specified as:

Stochastic Frontier Analysis

$Y = f(X_1, X_2, X_3, X_4, X_5)\ e(V - U)$

Where:

Y = Yam output (kg)

X_1 = Farm size (ha)

X_2 = Labour input (man-days)

X_3 = Fertilizer input (kg)

X_4 = Seed yam (kg)

X_5 = Capital input (Naira)

V = Random error (accounts for statistical noise)

U = Inefficiency term (represents deviations from optimal efficiency)

The technical efficiency scores of farmers were derived from the model, indicating how efficiently farmers utilize available resources.

Regression Analysis

The model is specified as:

$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \ldots\ldots X_{10} + e$

Where:

Y = Yam output (kg)

X_1 = Farm size (hectares)

X_2 = Labor input (man-days)

X_3 = Fertilizer input (kg)

X_4 = Seed yam (kg)

X_5 = Capital input (Naira)

X_6 = age (No.)

X_7 = Sex (male 1, female 0)

X_8 = HHsize (ha)

X_9 = Educ. (no.)

X_{10} = Fexp. (No.)

β_0 = Intercept

β_1 - β_5 = Regression coefficients

e = Error term

The R-squared (R^2) value and significance of coefficients were used to assess the strength and reliability of the model in explaining the variations in yam output.

3. Result and Discussions

Analysis of factors influencing output of yam

Table 1 present result of factors that influence yam output in the study area. On the basis of the number of significant variables that are correctly sign in line with economic theory, the coefficient of multiple determination (R^2), the standard error of parameter estimates and the F-statistics, the exponential model was chosen as the lead equation. The lead equation has an adjusted R^2 and f-statistics values of 0.564 and 5.035 respectively. This implies that 56% of the variation in the dependent variable (yam output) was explained by the independent variables, while the remaining 44% was due to error term or uncontrollable factors in the model. The f-statistic was 5.035 and significant at 1% implies that the model has a good fit. The result revealed that farm size has a positive and significant effect on yam output. The coefficient of farm size was positive and significant at 1% level. This means that for every unit increase in farm size (1hectare), the output of yam increases by 1.3%.

The result further revealed that the quantity of fertilizer applied had a positive effect on yam output. Quantity of fertilizer applied was significant at 10% level. This implies that for every unit increase (1kg) in quantity of fertilizer applied the output of yam increases by 1.2%. This finding collaborates the findings of Theophilus & Chuks-Okonta (2021), Jibrin *et.al* (2023), Dansi *et.al* (2024), Ngongo and Bisimwa (2025).

The result equally showed that the age of the farmer had a negative influence on yam output and was significant at 5% level. This implies that as the age of the farmer increases by one unit (1year), the output of yam reduces by 0.6%. Moreso, the result showed that farming experience had a positive effect on yam output and was significant at 5% level. This implies that as the years spent in yam production increases by one unit (1year) yam output increases by 3.2%, this is probably due to the effect that the farmers might have acquired enough experience in yam cultivation and have known better and effective way of managing the farm.

Table 1 Regression result of factors influencing output yam in the Area

Variables	**linear**	**semi log**	**double log**	**exponential+**
Constant	3162.859	3814.900	7.359	8.070
	(771.099)***	(930.855)***	(.734)***	(.173)
X_1farmsz	43.157	156.142	.020	.013
	(83.618)	(302.027)	(.039)	(.019)*
X_2labor	39.602	-8.263	.010	.012
	(46.211)	(22.883)	(.011)	(.008)

X_3fert	-.957	76.252	.000	.042
	(1.901)	(172.666)	(.000)	(.011)***
X_4seed	-.715	23.326	-.012	.000
	(2.353)	(67.718)	(.077)	(.001)
X_5capital	.000	26.818	-.007	5.850E-8
	(.001)	(35.635)	(.046)	(.000)
X_6age	23.585	-5.031	.285	-.006
	(13.096)*	(21.565)	(.131)	(.003)**
X_7sex	-129.142	-151.030	.042	-.022
	(235.388)	(253.508)	(.047)	(.054)
X_8hhsz	11.543	-61.251	-.016	.001
	(30.944)	(186.790)	(.060)	(.007)
X_9edu.	15.549	36.405	76.252	.003
	(24.090)	(24.015)	(172.666)	(.006)
X_{10}fexp	-9.334	1.962	-.715	.032
	(18.391)	(15.967)	(2.353)	(.024)**
R^2	.101	.124	.119	.632
Adj.R^2	-.031	-.017	.019	.564
F-stat.	.764	.879	1.186	5.035
S.E	913.58873	916.33970	.20718	.20868

Source: computed from field survey data, 2025.

*** = 1% ** = 5%, * = 10% level of significant respectively.

3. Marginal productivity

When r = 1, there is efficient use of resource. While, r <1 there is over utilization of resource, r> 1indicates underutilization of resource. Table 9 shows that labor, fertilizer and seed yam had MVP ratio of 0.018, 0.078 and 0.002 respectively, indicating that yam farmers in the study area were overutilizing the use of these resources. This implies that yam farmers were inefficient in resource use. Therefore, to raise output, it would be necessary to use less of labor, fertilizer and seed yam. This findings collaborate the findings of Theophilus, and Chuks-okonta (2021), Omotoso *et. al.* (2021), Owoeye (2020).

Marginal productivity of inputs in yam production

Inputs	**MPP Kg**	**MVP (₦)**
Labour (X_2)	0.007	56.0
Fertilizer (X_3)	0.078	214.5
Seed yam (X_4)	0.002	4.7

Source: computed from field survey data, 2025

Efficiency of resource – use in yam production in Yala Local Government Area

Resource	**MVP (₦)**	**MFC (₦)**	**r = MVP/MFC**
Labour (X_2)	56.0	3000	0.018
Fertilizer (X_3)	214.5	2750	0.078
Seed yam (X_4)	4.7	2350	0.002

Source: computed from field survey data, 2025.

4. Conclusion

Result of regression analysis showed that farm size, fertilizer used, age of farmer and farming experience were factors that influenced output of yam as they are significant and correctly signed in line with economic theory. The coefficient of determination R^2 indicate that 63% of the variation in yam output was explained by the explanatory variables while 37% was due to random error. The result also showed that labor, fertilizer and seed yam had MVP ratio of 0.018, 0.078 and 0.002 respectively, indicating that yam farmers in the study area were overutilizing the use of these resources meaning that they were not efficiently utilized. Hence adjustment in resource use are required in order to improve farm output and profit at the percentage level of technology employed by yam farmers. Based on the findings of this study, the following recommendations were made:

Since farm size and fertilizer were significant and had direct relationship with output, government in collaboration with policy makers should bring policies that will make easy the access to land by yam farmers and farmers should be encouraged through extension training/workshop to increase the use of fertilizers to optimum levels.

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IMPACT ASSESSMENT OF AGRO-PROCESSING PRODUCTIVITY ENHANCEMENT AND LIVELIHOOD IMPROVEMENT SUPPORT (APPEALS, 2017-2023) on broiler production IN CALABAR METROPOLIS, CROSS RIVER STATE, NIGERIA.

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Abstract

This study examined the impact of the Agro-Processing Productivity Enhancement and Livelihood Improvement Support (APPEALS) program on broiler production in Calabar Metropolis, Cross River State, Nigeria, with a focus on estimating mean outputs, identifying production factors, comparing beneficiaries and non-beneficiaries, and assessing challenges faced by broiler farmers. Using a multi-stage sampling technique, two local government areas ie Calabar Municipality and Calabar South were randomly selected, and primary data were collected via structured questionnaires. A mixed-methods approach was employed, with descriptive statistics estimating mean outputs, a multiple regression model identifying factors influencing production, a Z-test comparing outputs, and a five-point Likert scale evaluating challenges. Findings revealed that APPEALS beneficiaries had a mean broiler output of 2,728 kg, compared to 582 kg for non-beneficiaries, with a substantial mean difference of 2,145.4 kg, demonstrating a significant positive effect of program participation. Regression analysis identified feed, stock size, labor, and cost of medications as key determinants of production, while the Likert assessment highlighted high feed costs, lack of modern technology, expensive transportation, and unreliable electricity as major constraints. Based on these findings, the study recommends expanding APPEALS to reach more farmers, particularly women, continuing targeted support and training, optimizing labor efficiency and feeding practices, and regularly monitoring and evaluating program impacts to enhance productivity, resource utilization, and livelihoods among broiler farmers in the metropolis.

1.1 Introduction

The Agro-Processing, Productivity Enhancement and Livelihood Improvement Support (APPEALS) project was a landmark initiative designed to enhance the productivity and livelihoods of small and medium-scale farmers in Nigeria. Launched in 2017 with $200 million in World Bank assistance, APPEALS targeted six states, including Cross River, where Calabar metropolis is located (Lagos State Ministry of Economic Planning and Budgeting, 2022), and was implemented from 2017 to 2023. During this period, the project created 12,350 jobs, empowered 17,469 farmers, and contributed to a 5–10% reduction in poverty likelihood.

The general objective of APPEALS was to improve agricultural productivity, enhance value addition, and promote livelihoods among small and medium-scale farmers, with a focus on priority value chains such as poultry, aquaculture, and rice production. This objective aligned with Nigeria's Agricultural Promotion Policy (2016–2020), which sought to strengthen agricultural development and improve rural livelihoods (Federal Ministry of Agriculture and Rural Development, 2020). The project addressed key challenges in Nigeria's agricultural sector, including low productivity, limited access to markets, and inadequate technology, by providing targeted support, training, and resources to farmers. In Cross River State, the initiative focused primarily on broiler production, a critical component of the state's agricultural economy.

APPEALS achieved its goals through several components, including capacity building, provision of inputs, and improved access to finance. In Cross River State, the project facilitated the establishment of broiler farms, offering both training and material resources while enabling farmers to access processors and consumer markets. The program's impact on poverty reduction was notable, with a reported 5–10% decrease in poverty likelihood (World Bank, n.d.), highlighting the potential of APPEALS to transform Nigeria's agricultural sector.

The project also aligned with the United Nations Sustainable Development Goals (SDGs), particularly Goal 1 (No Poverty), Goal 2 (Zero Hunger), Goal 8 (Decent Work and Economic Growth), and Goal 9 (Industry, Innovation, and Infrastructure). Its success depended on effective implementation, stakeholder engagement, and sustained support, with continuous monitoring and evaluation ensuring that objectives were met. APPEALS enhanced farmers' productivity through improved practices and technologies, increased income via market access, and improved livelihoods through financial support and training (Lagos State Ministry of Economic Planning and Budgeting, 2022).

Despite these successes, APPEALS faced challenges, including limited funding, infrastructure, and institutional capacity. Nevertheless, the project has strong potential for future expansion, particularly through increased funding, enhanced infrastructure, and capacity building to further support agricultural production and processing. In conclusion, APPEALS demonstrated significant potential to transform Nigeria's agricultural sector by improving productivity, increasing incomes, and reducing poverty, in line with national agricultural policies and broader sustainable development goals.

Methodology

Study Area

Calabar Metropolis, the capital of Cross River State, Nigeria, is situated in the southern part of the state. It encompasses Calabar Municipality and Calabar South Local Government Areas, lying between latitudes 4˚50'N and 5˚10'N and longitudes 8˚17'E and 8˚20'E. The area is bounded to the north by Odukpani Local Government Area and to the east by Akpabuyo Local Government Area, with the Great Kwa River to the east and the Calabar River to the west. The metropolis covers an estimated land area of approximately 274.593 km². Calabar falls within the tropical equatorial (Af) climate zone, characterized by high temperature, high relative humidity, and abundant annual rainfall of 2750 mm, with a mean annual temperature of 26.1˚C.

Geologically, the study area is underlain by sedimentary rocks, specifically the Coastal Plain Sands and the Benin Formation. The soil types in the area are predominantly: Sandy loam, Clay loam, -Alluvial soils along the riverbanks. These soil types support various agricultural activities, including crop farming and livestock rearing. The study area has witnessed significant population growth, from 10,000 in the pre-colonial era to 99,352 in 1993, 328,876 in 1991, and 371,022 in 2006.

Socio-economic activities of Calabar Metropolis is driven primarily by agriculture, with crop farming (cassava, yams, plantains), livestock rearing (poultry, cattle), and fishing being prominent. Commerce thrives in the area, with markets like Watt Market and Marian Market, shopping centers, and small-scale enterprises. Tourism also plays a vital role, with attractions such as the Calabar Carnival, Tinapa Business Resort, and historic sites like the Old Residency Museum. Education is well-represented, with institutions like the University of Calabar, Cross River University of Technology, and numerous primary and secondary schools. Healthcare services are provided by government and private hospitals/clinics, including the University of Calabar Teaching Hospital. Manufacturing activities include food processing, woodwork, and craft industries. Transportation networks, including roads and water transportation via the Calabar River, facilitate connectivity. The nearby Margaret Ekpo International Airport also supports air travel. Artisanal activities, such as tailoring, carpentry, blacksmithing, and traditional crafts, contribute to the area's economic diversity.

Sampling Procedure

This study employed a multi-stage sampling technique to investigate the impact of the Agro-Processing Productivity Enhancement and Livelihood Improvement Support (APPEALS) program on broiler production in Calabar Metropolis, Cross River State, Nigeria. In the first stage, two local government areas that is, Calabar Municipality and Calabar South—were randomly selected to represent the study area. The selection ensured coverage of the main urban centers within the metropolis, which are central to broiler production activities. Primary data were collected using structured questionnaires administered to 80 broiler farmers across the two local government areas. The sample included both APPEALS program beneficiaries and non-beneficiaries, allowing a comparative analysis of production outputs and the assessment of program impact.

Data analyses

The study utilized a mixed-methods approach to address the research objectives. Descriptive statistics were employed to estimate the mean broiler output of beneficiaries and non-beneficiaries. A Z-test was conducted to determine the significance of differences in mean outputs between the two groups. To identify factors affecting broiler production, a multiple regression model was applied (estimating four functional forms), examining variables such as feed quantity, stock size, labor, cost of medications, farmers' age, experience, and educational level. Additionally, a five-point Likert scale was used to assess the challenges faced by broiler farmers in the study area.

The regression model was specified as follows;

Yi=β0+β1Feedi+β2StockSizei+β3Labori+β4MedicationCosti+β5Agei +β6Experiencei+β7Educationi+ϵi

Where;

Yi = Broiler output (in kg)

Feed = Quantity of feed used (kg)

- Stock Size = Number of broilers stocked
- Labor = Labor employed (man-days)
- Medication Cost = Expenditure on veterinary care and medication (₦)
- Age = Age of the farmer (years)
- Experience = Years of broiler farming experience
- Education = Educational attainment of the farmer (years of schooling)
- β0 = Intercept term
- β1–β7 = Coefficients measuring the effect of each independent variable on broiler output
- ϵi\ = Error term capturing unobserved influences on output

The model was fitted as Linear, Semi-log, Double-log and exponential functions.

The model was estimated using ordinary least squares (OLS), with significance tested at 1%, 5%, and 10% levels. This specification allowed the study to identify which inputs and socioeconomic characteristics

Results and Discussion

Socio-Economic Characteristics of Respondents

Table 1 presents a summary of the socio-economic characteristics of broiler farmers in Calabar Municipality and Calabar South Local Government Areas.

Table 1: Socio-Economic Characteristics of Respondents

Variables	Frequency	Percentage (%)	Mean ($\bar{x}$)
Educational level			
No education	1	1.25	
Primary	17	21.25	
Secondary	26	32.50	
Tertiary	36	45	32.50
total	80	100	
Age			
1-20	3	3.8	
21-30	45	36	
31-40	30	37.5	
41-50	9	11.25	
51 and above	2	2.5	37.5
Total	80	100	
Stock size			
1-200	42	52.5	
201-400	18	22.5	
401-500	6	7.5	
501 above	14	17.5	52.2
Total	80	100	
Farming experience			
1-5	32	40	
5-10	35	43.75	
11-15	9	11.25	
16-20	4	5	43.75
Total	80	100	
Sex			
Male	61	76.25	
Female	19	23.75	76.25

Total	80	100
Marital status		
Married	36	45
Single	44	55
Total	80	100

Source: Computed from field survey, (2024).

The data collected from a sample of 80 farmers revealed a significant skew toward male participation, with 76.25% of respondents being male and 23.75% female. The mean age of the farmers was 37.5 years, indicating that most farmers are in their productive years. The marital status distribution was relatively balanced, with 55% single and 45% married, suggesting a stable demographic profile capable of sustaining farming activities over time.

The farmers reported an average of 4.38 years of experience in broiler production, with 40% of respondents being relatively new entrants (1–5 years), 43.73% having moderate experience (6–10 years), and 11.25% possessing extensive experience (11–15 years). This range of experience levels indicates a mix of novice and moderately experienced producers, contributing to both innovation and established production practices.

Educational attainment among broiler farmers was notably high, with an average of 12.5 years of schooling. About 45% held tertiary qualifications, 32.5% completed secondary education, 21.25% had primary education, and only 1.25% had no formal education, reflecting a well-educated farming community capable of adopting modern broiler production techniques.

Regarding production scale, the average stock size was 52.5 birds per farm. Most farmers (52.5%) operated small-scale farms with 1–200 birds, while 22.5% managed medium-scale farms with 201–400 birds, demonstrating that broiler farming in the study area is largely dominated by smallholders with limited stock capacity.

Determinants of broiler production

Table 3 presents the multiple regression results for the factors affecting broiler production in the study area. The semi-log functional form was selected as the lead equation based on the signs and magnitudes of the coefficients, as well as the number of significant variables and the explanatory power of the model. This model was deemed appropriate because most independent variables, including cost of medications and stock size, were significant and aligned with theoretical expectations. The lead equation produced an adjusted R^2 of 0.64, indicating that 64% of the variation in broiler output (kg) is explained by the included factors, while the remaining 36% is attributed to the error term or uncontrollable influences.

The results show that the cost of medications, measured at ₦532, had a positive coefficient, indicating that increased expenditure on medications was associated with improved output, consistent with the role of veterinary care in maintaining bird health and productivity. Stock size was also significant and positively correlated with broiler output, demonstrating that larger stock numbers directly contribute to higher production levels, a finding supported by Adesokan et al. (2018).

However, labor, measured in man-days, showed a negative coefficient of 0.008, which contradicts theoretical expectations, as increased labor is typically expected to enhance output. Similarly, feeding, although significant, exhibited a negative coefficient, suggesting that additional feed did not translate into higher output in this context, potentially due to inefficiencies in feeding practices or feed quality.

Other factors, including farmers' age, experience, and educational level, were significant and positively associated with output, highlighting the importance of human capital in broiler production. These results are consistent with studies by Olorunfemi et al. (2018) and Ajewole et al. (2019), which identified experience, age, and education as important determinants of poultry productivity. The unexpected negative effect of labor contrasts with findings by Oyewole et al. (2018), who reported a positive relationship between labor input and poultry output, indicating that labor may have been underutilized or misallocated in the study area.

Overall, the regression analysis confirms that cost of medications, stock size, feeding practices, labor, and farmer characteristics collectively influence broiler production, with stock size and human capital serving as the most consistent positive drivers of output. These findings provide insights for targeted interventions aimed at optimizing input use and improving overall productivity among broiler farmers in Calabar Metropolis.

Table 3: OLS Results of the determinants of broiler production

	Linear	Exponential	Double-log	Semi-log
Constant	2152.544 (1600.343)	5.716 (1.099)	6.551 (1.903)	3778.473 (2701.234)
X_1=Farmers' experience (years)	-119 (57.687)	-156 (040)	-062 (248)***	-078 (351.818)
X_2=Educational level (years of schooling)	-031 (58.059)	.122 (.040)***	-015 (.242)	-.012 343.716
X_3=Age(years)	-048 (25.076)	.090 (.017)	.059 (.574)	-.089 (814.981)
X_4=cost of medication (N)	-049 (367)***	-.075 (.000)	-.095 (.000)	-.049 (.355)***
X_5=Labour(man days)	-205 (52.868)	-280 (.036)***	-.307 (.305)***	-.199 (50.337)***
X_6=Feeding(kg)	-034 (266)*	.019 (.000)	-044 (.000)	-032 (255)*
X_7=Farm size (stock size)	884 (693)	.728 (000)	.712 (000)	875 (674)***
$R^{2.}$	.673	.683	.669	.674
Adjusted R^2	.640	.625	.669	.642
F-statistics	20.548	21.578	20.834	21.218
Standard Error	1041.14433	.71475	.72492	.23650

Source: computed from field survey, 2024. ***=1%.**=5%.*=10%

Conclusion and Recommendations

This study examined the impact of the Agro-Processing Productivity Enhancement and Livelihood Improvement Support (APPEALS) program on broiler production in Calabar Metropolis, Cross River State. Findings revealed that APPEALS beneficiaries achieved significantly higher broiler outputs (2,728 kg) compared to non-beneficiaries (582 kg), demonstrating the program’s positive effect on production. Regression analysis identified stock size, cost of medications, age, education, and farming experience as significant determinants of output, while labor and feeding practices were negatively associated with productivity, indicating inefficiencies in resource allocation. Socioeconomic analysis showed that most farmers were in their productive years, well-educated, and operated small-scale farms, while challenges such as high feed costs, limited access to modern technology, expensive transportation, and unreliable electricity constrained production. Based on these findings, the following recommendations are made:

1. Since stock size was positively correlated with broiler output, APPEALS should provide support for increasing farm stock through input grants, credit, or access to quality chicks, enabling farmers to scale up production effectively.
2. Given the positive impact of cost of medications on output, the program should continue to provide veterinary support and subsidized medications, while also training farmers on cost-effective health management practices to maximize productivity.
3. The negative relationship between labor and feeding with output suggests inefficiencies. APPEALS should provide training on proper labor allocation, modern feeding techniques, and nutrient optimization to ensure inputs translate into higher production.
4. Age and education positively influenced output, highlighting the importance of knowledge and experience. The program should expand training initiatives, workshops, and mentorship programs to improve management skills and adoption of best practices.
5. High feed costs, limited technology, transportation, and electricity constraints hinder productivity. APPEALS should facilitate access to affordable feed, modern equipment, reliable power, and efficient transport solutions to reduce these barriers.
6. Given the higher productivity among beneficiaries, APPEALS should extend its interventions to more farmers, particularly women, to promote gender inclusivity, equitable economic growth, and broader sectoral impact.

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MARKETING ANALYSIS OF GARRI IN CALABAR MUNICIPALITY, CROSS RIVER STATE, NIGERIA

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Abstract

The study focused on marketing of garri in Calabar municipality, Cross River State, Nigeria. The specific objectives of the study were to estimate the cost and returns of marketing garri in Calabar Municipality, estimate the relationship between gross margin and socio-economic characteristics. Data collected were analyzed using descriptive statistics and regression analysis.. Three (3) markets and eighty-one marketers were purposively selected and well-structured questionnaires and interviews were used to obtain information directly from the respondents. The result showed that total revenue (N139,200), total cost (N110,277), total variable cost (N108,950), fixed cost (N1,327), gross margin (N30,250) and net margin (N28.923) of 50kg of garri. The costs and returns analysis indicates that garri marketing is profitable in Calabar municipality. The study analyzed the four functional forms and exponential was chosen as the lead equation, due to the number of variables that were significant, the R^2 value and F-value. Regression coefficient value of (0.31) and F-test value 4.174 and its significant at 1% implies that the explanatory variables accounted for 31.7% and 4.174 of the variation of gross margin of garri marketers, given the value of gross margin as N30,250 and net return as N28,923. The study recommends that marketers should form cooperative society to benefit from economies of scale and that garri marketing is profitable in Calabar Municipality.

Keywords: marketing, gross margin, garri, regression analysis

Introduction

Cassava (Manihot spp) is a staple food crop and mostly cultivated in the southern in Akwa Ibom, Cross River, Rivers, Delta state while Benue and Kogi states dominate in the North Central states (IITA,2004).

cassava and other roots are the most cultivated species after cereals and legumes (Li *et al, 2023*). The two varieties mostly cultivated in West Africa are the sweet cassava (Manihot palmata) and the bitter cassava (Manihot utilisima). Nigeria is one of the largest producers of cassava and cassava product in Africa (AFDB, 2015). Cassava processing is simply the act of transforming freshly harvested cassava product into a finished product. It is processed before it can be consumed, and this is done for several reasons. These reasons include, removing toxic and harmful substances from the body of the fresh cassava, it also serves as a means of preserving it. Processing is done by fermenting, drying and cooking. Cassava can be processed into garri, fufu, flours tapioca, chips, animal feed, ethanol, starch, gum and glucose. In terms of its nutritive value, cassava roots form one of the major classes of food (carbohydrate) and contain 60% of water but low in protein content and can also be fed to animals or used in the manufacture of starch. The leaves are good sources of vitamins, minerals and are rich in calcium, magnesium, Iron, vitamin A, vitamin C etc. Among all the above-mentioned products of cassava, gari is the most common and forms the main meal of the day for majority of people in most of the West African countries, while Nigeria and Brazil taking the lead (Ozigbo, *et al*, 2020)

Nigeria is the largest producer of cassava and consumer of this cassava food product, which is the most popular in West Africa (Ndjouenkeu *et al*., 2021). Nigeria's economy has benefited greatly from the production of gari, and firms that process garri, account for a sizable share of small and medium-sized enterprises (SMEs) in the country (Lambull *et al*., 2018). Garri is obtained from processed roots and tubers crops commonly known as cassava, its saved

as food for man, raw materials for industrial manufacturing, and livestock feeds (Morris et al (2022)

Garri is produced from cassava by peeling, washing and grating of harvested root which is poured into a bag and subjected to pressure to drain out water and left to ferment for 2-4 days. The fermented and resulting mash is then removed, sieved and fried in a wide, shallow mental pan until it is well dried. A well dried garri can be stored for up to three months without spoilage. In Nigeria, garri is typically eaten with soups, stews, or sauces after being soaked in water to create a dough-like consistency. Also, it can be soaked in cold water and eaten with banana and groundnuts (Funke, et al., 2020). The growing popularity of gari as convenience food is mainly due to its affordability, easy storage and ease of preparation for consumption (Oluwafemi & Udeh, 2016)According to Kotler (2017), marketing theory is the application of marketing concepts and principles to the study of economic marketing. Food stuff(s) such as garri, rice, beans, palm oil, crayfish, fish are sold by traders in calabar municipality and the major markets where these food stuff(s) are traded are; Ika-Ika Oqua market (Marian market),Watt market, eight mile market and Ikot Ishe market.). Inadequate marketing system for garri retailers and other food commodities has been identified as a constraint to agricultural development in Nigeria, particularly in rural communities (AFDB, 2015) Garri marketing can be described as the set of activities that involves the buying, selling, distribution and promotion of garri, aimed at ensuring that the product moves from the producer to the final consumer (Ebewore and Eldore, 2015).

However, poor marketing infrastructure facilities further compound the problem. Rural roads especially those leading to production areas are in deplorable conditions making it very difficult for garri to be evacuated from such areas. This has adverse implication on the cost of transportation. In calabar, garri is a cherished commodity due to its relative importance in the preparation of other dishes. Studies have shown that efficient marketing system stimulates agricultural production (Awoyinka and Ikpi, 2015). However, there is also the problem the exploitative tendencies of the middlemen in the cassava product marketing chain. Therefore, since production is incomplete unless the product reaches the final consumers to meet their required satisfaction, it becomes necessary that an efficient marketing system be maintained. There is seemly few or no published work in Calabar Municipality, Cross River State, Nigeria in regard to the Marketing of cassava product (garri).

The study is guided by the following specific objectives

i. estimate costs and return
ii. analyze the relationship between gross margin and socio-economic characteristics of the garri marketers

Materials and Methods

The study area of this research is Calabar Municipality which is a Local Government Area located in Cross River State. Calabar Municipality lies between latitude 04^o 15' and 15^{o}N and longitude 8^{o}25'E. Calabar Municipality is bounded by Odukpani Local Government Area in the North, East by the Great Kwa River and South by Calabar South Local Government Area. It has an area of 331.551 square kilometers. Calabar Municipality is made up of two ethnic groups which form the indigenous population. These are the Qua's and the Efiks. The major markets are Ika-Ika Oqua (Marian market), Ikot Eneobong Market, Akim Market, Ikot Ishie Market and Timber Market, Akai Efa (Cross River Hub, 2017). Calabar Municipality area has a tropical mosoon type of climate. It experiences a moderately high temperature which ranges from 27^{o}C to 35^{o}C. The average annual rainfall is between 2000 to 3500mm and relative humidity of 80 to 100 percent throughout the year (NIMET, 2015). Calabar Municipality has a population of 245,500 people (National Population of Nigeria, National Bureau of Statistics, (2016). Majority of the inhabitants are farmers, traders and civil servants. The major crops cultivated are cassava and oil palm trees.

Sampling procedure and sample size

A two-stage sampling technique were employed in this study. First stage was a purposive sampling of three (3) markets in Calabar Municipality area based on the presence of large number of garri markets. The second stage was a random selection of Forty-Five (45) retailers of gari from Ika-Ika Oqua market (Marian Market), Twenty-Five (25) from Ikot Enebong Market and Eleven (11) from Akim Market making a total of Eighty-One (81) respondents for the study.

Method of data collection

The data collection was generated from primary sources. Primary data were collected through field survey from garri markets using a well-structured questionnaire as well as oral interview. The questionnaire was designed based on the study objectives

Model specification

A multiple regression model of four functional forms (linear, semi-log double-log and exponential,) was used to explain the marketing analysis of garri.

The regression equation is expressed as: $Y=F(X_{1,} X_{2,} X_{3,} X_{4.} \ldots\ldots X_n)\ldots..1$

The implicite form is expressed as: $Y= F(b_o + b_1 X_1 \ldots\ldots + b_6x_6 + b_7x_7, e)\ldots\ldots2$

Linear: $Y = b_o + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + e$

Semi log: $Y = \log b_o + b_1\log x_1 + b_2\log x_3 + b_4\log x_4 + b_5\log x_5 + b_6\log x_6 + b_7\log x_7 + e$

Double log: $\text{Log } Y = b_o + b_1\log x_1 + b_2\log x_3 + b_4\log x_4 + b_5\log x_5 + b_6\log x_6 + b_7\log x_7 + e$

Exponential: $\text{Log } Y = b_o + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + e$

Where;

$Y=$ Marketing of garri

X_1 = Transportation cost (N)

X_2 = Household size

X_3,= Age (years)

X_4 = Educational level(years)

X_5 = Experience (years)

X_6, = Marital status (married 1, others=0)

X_7 = Nature of Business (full time =1, part time=0)

X_8 Cooperative (du; yes=1, no= 0)

e = Error or stochastic term

Y = Gross margin = b_o (intercept) + b_1x_1 (transportation cost) + b_2x_2 (Household size) + b_3x_3 (age) + b_4x_4 (educational level) + b_5x_5 (experience) + b_6x_6 (marital status) + b_7x_7 (business nature) + b_8x_8 (coop) + stochastic term.

The regression analysis will be used to test for the level of relationship between gross margin (dependent variables) and socio-economic characteristics (independent variables).

GM = TR – TVC

TC = TFC + TVC

TR = TFC – Selling price per basin (kg)

TVC = Cost of garri + marketing activities

Where;

GM = Gross margin (dependent variables)

TC = Total cost

TR = Total revenue

TVC = Total variable cost

X_1-X_8 = Socio economic characteristics (independent variables)

Y = F (X_1,X_2, X_3, X_4, X_5, X_6, X_7, X_8 + e)

Y = Gross margin (N)

Results and Discussion

Marketing cost and returns of garri marketing per month

Table 1, explains the objective of analyzing the cost and returns of garri market in Calabar Municipality Cross River State. The marketing cost and returns/margins showed that on the average each garri marker in Calabar municipality makes a profit of N28,923.00. The result showed that Total Revenue (N139,200), Total Cost (N110,277), Total variable cost (N108,950), Fixed cost (N1,327), Gross margin (N30,250) and Net margin (N28.923). The findings contradict with the findings of Ebewore & Idoge (2015) on profit margin, also collaborates with the findings of Nduka & Udah (2015) on costs and returns of garri marketing, the gross margin was different from the Net returns because the marketers incurred a fixed cost of N1,327.

Table 1: Marketing costs and return incurred from Garri (50kg) marketing per month

Items	Amount (N)
Fixed cost	
Store rent	N1,327
Variable cost	
Garri (kg)	N103,176
Transport	N5,466
Dues	N308
Total cost	N110,277
Total variable cost	N108,950
Revenue	
Average quantity (kg)	12
Average price	N11,600
Total revenue	N139,200
Total cost	N110,277
Gross margin	N30.250
Net revenue	N28,923
Profit margin	N0.21

Source: Author's Compilation

Table 2: Multiple regression estimates of the relationship between the Gross margin and the socio-economic characteristics of the respondent

Variable	Linear	Exponential +	Semi Log	Double Log
Constant	0.502	1.408	13.425	7.617
	(0.617)	(.163)	(.000)	(.000)
Transportation	2.370	-2.277	2.398	-2.271
cost	(.020)	(.026)**	(.019)	(.026)
Household size	-1.618	-2.425	-1.182	-2.050
	(.110)	(.018)**	(.241)	(0.44)
Age	-.979	-1.563	-.284	-.921
	(.332)	(.122)	(.778)	(.360)
Educational	-.191	.186	.070	.237
level	(.849)	(.853)	(.944)	(.813)

Marketing experience	2.272 (.026)	3.603 (.001)*	2.047 (.044)	3.118 (.003)
Marital status	1.147 (.255)	1.160 (.250)	.588 (.592)	.614 (.541)
Business nature	-1.511 (.135)	-.1865 (0.66)***	-2.538 (.0.13)	-2.890 (.005)
Cooperative	.683 (.497)	.426 (.671)	1.017 (.312)	.800 (.426)
R^2	.227	.317	.244	.312
F-value	2.646	4.174**	2.898	4.090

Source: Field Survey, 2022.

*, **, *** variables statistically significant at 1%, 5% and 10% respectively.
Figures in parenthesis are t-ratio
+ = lead equation.

Table 2, presents the results of multiple regression analysis of the relationship between gross margin and the socio-economic characteristics of garri marketers in Calabar Municipality, Cross River State. The four functional forms showed that the lead equation was Exponential due to the number of significant variables, the value of R^2 and the F-value. The significant variables were; transportation cost, household size, marketing experience and business nature. The coefficient of determination (R^2) value is 0.317, implying that the explanatory variables accounted for about 31.7% of the variations in the gross margin of garri marketers in Calabar Municipality, Cross River State. Though the R^2 is low the F-statistics which also measures the overall explanatory power of the regression is significant at 1%. As with the coefficient of determination, R^2, the F-statistic relates to the relationship between the explained and unexplained variation in the dependent variable (Pappas and Brigham, 1978) thus, the regression has a good fit to explain the relationship between gross margin and socio-economic characteristics of garri marketers in the study area.

Conclusion/ Recommendation

The study focused on marketing of garri in Calabar municipality, cross river state, Nigeria. The findings showed that total revenue (N139,200), total cost (N110,277), total variable cost (N108,950), fixed cost (N1,327), gross margin (N30,250) and net margin (N28.923). This result indicates that garri marketing is profitable in Calabar municipality. The study analyzed the four functional forms and exponential was chosen as the lead equation, due to the number of variables that were significant, the R^2 value and F-value. Regression coefficient value of (0.31) and F-test value 4.174 and its significant at 1% implies that the explanatory variables accounted for 31.7% and 4.174 of the variation of gross margin of garri marketers, given the value of gross margin as N30,250 and net return as N28,923. The study recommends that marketers should form cooperative society to benefit from economies of scale and that garri marketing is profitable in Calabar Municipality.

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REVIEW AND DEVELOPMENT OF CROSS RIVER STATE COOPERATIVE SOCIETIES ADMINISTRATIVE PROCESSES, NIGERIA: A STEP TO AGRIC-BUSINESS INVESTMENT

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Sub Theme: Cooperatives, Finance and Risk Management in Agriculture

Abstract

Cross River State has competitive and comparative advantages across several agricultural value chains and the State Government is proactively driving investment into the agricultural sector, and therefore requires a contemporary, well-articulated and enforceable cooperative societies registration system. In view of the above, on the 16th November 2021, USAID, Feed-the-Future, Nigeria, commissioned a study which sought to review and develop the cooperative society's registration processes following a request made by the Cross-River State Ministry of Humanity and Social Welfare. A qualitative methodology, including Key Informant Interviews (KIIs), Focus Group Discussion (FGD), and stakeholders' meetings were employed for the review. From the review, we identified seven steps, different types of paper work and documents that needed to be manually submitted to complete a cooperative registration and issuance of certificate under what is called the Fiat Registration process, which begins and ends in the Department of Cooperative Directorate's (DCD) Office. Under this registration process, it takes 1 - 2 days to start and complete a process to be issued a Certificate of Registration. This process was found to be very cumbersome and full of paperwork. At the engagement and larger consultative stakeholders' meeting, the current registration procedures were reviewed and streamlined to a Three-Step Process in the interim, while a suggestion to float a digital system with time with support from USAID, Feed-the-Future, Nigeria was proffered. With a digital system,

the time to register a cooperative will be faster, easier, and reports will be submitted faster and more secured.

Keywords: Review, Development, Cooperative Societies, Cross River State.

1. Introduction

Agriculture is the leading revenue contributor to the State's economy and employs at about 70 percent of the State's labour force. Cross River State is the second highest producer of Cocoa in Nigeria. In addition, a source of high-quality oil palm, rubber, and cashews in commercial quantities. Other crops are cassava, yams, rice, plantain, banana, cocoyam, maize/corn, groundnut/peanuts, mangos, oranges, sugar canes, and pine apples.

The Cross-River State Ministry of Humanity & Social Welfare initiated the review of their administrative systems and procedures for the registration of cooperative societies and related transactions. Currently, there are an estimated 30,000 cooperative societies in the state, but these cooperatives are not categorized into specific sectors of the economy that they operate in (CRS – Cooperative Department, 2022). According to this Cooperative Department, about 80% of these cooperative societies are into agriculture, but many are not active. Cross River State has competitive and comparative advantages across several agricultural value chains and the State Government is proactively driving investment into the agricultural sector; specifically, cassava, oil palm, yam, maize, plantain, rice, aquaculture and banana.

Pursuant to the above, the State requires a contemporary, well-articulated and enforceable e-registration system that will create speedy channels for identification of cooperative societies and their sectorial spread across the state economic ecosystem. Such a system would help in efficient management of the large volume of data and performing necessary operations thus reducing the number of hours spent in compilation and other manual activities. The existing manual document filing and registration of cooperative societies is cumbersome, time consuming, insecure and not cost effective for cooperatives and the State.

In view of the above, on the 16th November 2021, USAID – Feed-the-Future, Nigeria commissioned a review and study of the cooperative registration process following a request for assistance by the Cross-River State Ministry of Humanitarian and Social Welfare.

2. Objectives of the study

The man objective of the study was to review and develop the Cross-River State cooperative societies administrative processes, Nigeria. The specific objectives were to:

1. review and evaluate the current coop registration administrative processes and guidelines;
2. recommend a suitable modern administrative guidelines and processes;
3. facilitate stakeholders' consultation (s);
4. develop and proffer recommendations and guidelines regarding the cooperative registration systems, based on stakeholders' meetings and validation workshops.

3. Methodology

The study was conducted in Cross River State (CRS), Nigeria. The state lies within longitude 40 50' and 90 28' east of the Greenwich Meridian and latitude 50 23' and 40 27' north of the equator. The National Population Census (2016) projected the population of the state at 3,862 634. Cross River State is made up of 18 Local Government Areas (LGAs). Under the Cross River State Agricultural Development Programme, the state is divided into three agro ecological zones which include the mangrove and the swamp forests which cover the Calabar Agricultural zone, tropical rainforest of Ikom Agricultural Zone and derived and guinea savannah belts of Ogoja Agricultural Zone

A Qualitative research methodology, including key informant interviews (KIIs), Focus Group Discussion (FGD), and stakeholders' meeting were employed for the review. KIIs were conducted with members of the Cross-River State Cooperative Federation, staff members of the Cooperative Department of the Ministry of Humanitarian and Social Welfare. A total of 10 KIIs were conducted between November 22, 2025 to February 02, 2022. A consultative group meeting of 33 participants also provided additional insights and concurrence on some of the earlier views obtained from the face-to-face interviews. Phone interviews were held with a few executives of some of Cooperative societies on the state's registration system and to identify any best practice for recommendation. Secondary data sources such as reports, publications and online sources were consulted to understand more the enabling framework for cooperatives in Nigeria and to seek best practice information.

4. Findings of the study

4.1. Evolution of cooperative registration in Cross River State

The review began with a historical assessment of the CRS cooperative registration system to understand how the current registration system evolved. In one of the focus group discussions held with members of the cooperative department, the state's Cooperative Director highlighted that in the past, the registration processes consisted of the below steps:

- Step i: Inaugural meeting with members who intended to form a cooperative;
- Step ii: A management committee is established;
- Step iii: Cooperative department staff will interact with the management committee to educate them on cooperative management and verification of the members;
- Step iv: The proposed cooperative society would submit a feasibility report on their proposed mode of operation to demonstrate their viability and sustainability;
- Step v: The cooperative department would study the report, if satisfied that all conditions for registration were met, the proposed cooperative society would be registered and a certificate of registration and a copy of the byelaws would be issued after payment of a prescribed fee.

During this era, the registration process took about 3-6 months and sometimes a year, depending on the response from the cooperative groups. Sadly, with the inception of military presidents in Nigeria, particularly during the Ibrahim Babangida regime (1989 -93), the wife, as the First Lady of Nigeria, in a bid to reach Nigerian women through her Better Life for Rural Women Programme, especially in Agriculture through cooperatives, all the Ministries that were saddled with the registration of cooperatives across the states of the federation were given specific instructions to relapse the existing cooperative registration process and begin a Fiat Registration.

Accordingly, the Cross-River State government mandated the ministry to adhere to the new directives. That was the advent of what is now called 'Fiat Cooperative Registration System (FCRS)' in the state; a prospective cooperative applicant works into the office of the DCD with their required documents and are registered and certificates are issued immediately. This system has been in place since the early 90's till date. The Fiat Registration process begins and ends in the DCD's Office in the Ministry of Humanity and Social welfare of the state. Though over the years, there have been little changes, but the Fiat Registration process had been maintained since the early 90's.

4.2 Current cooperative registration processes and procedures in cross river state

4.2.1. Conditions for the formation of cooperative societies

Given the Fiat Registration system in place, the conditions for formation of cooperative societies in the state are:

- All primary cooperative societies must be composed of a minimum of ten (10) members;
- All prospective members must be above sixteen (16) years;
- Every member must have a common need with other members of society; and
- Every member must be in an occupation relevant to the primary society.

Prospective applicants must present the below documents:

- Proposed name of the cooperative society;
- Proposed address of the cooperative society;
- Area of operation;
- The objective of the cooperative society;
- Number of shares and value of shares for thrift savings and share capital;

- Certified copy of the resolution passed at the first meeting of members with the cooperative officer;
- Official seal of the cooperative society.

4.2.2: Procedures for the registration of cooperative societies

An extract of the procedures for the registration of a cooperative society under Cooperative Societies Law CAP. C13 2004 (as amended by the laws) of Cross River State, show the following procedures and requirements:

- An application for registration is made to the Director of Cooperatives at the Ministry of Humanity and Social Welfare requesting to be registered as a cooperative society;
- Preliminary meetings are held with members at the headquarters for further interactions and education;
- An application form is issued to the members to fill in their details, attached required documents and returned to the office of the head of cooperatives;
- The minimum required members, depending on the category of the cooperative society must duly sign the application form;
- Upon meeting all conditions, the applicant pays the prescribed registration fees;
- All documents are submitted for verification and approval by the director of cooperatives;
- After verification, if the Director of Cooperatives is satisfied, a certificate of registration with a duly signed certified copy of the by-laws governing the cooperative will be issued to the cooperative.

In the current fiat registration process, issuance of registration certificates is within one working day. According to the Cooperative Director, from inception of the Fiat system, 30, 000 cooperative societies have been registered, but only about 50 cooperative societies are active and out of the 50 cooperative societies, only about 10 that are reliable. Majority of these cooperative societies are engaged in agriculture.

4.2.3 Challenges with the current registration system

The stakeholders identified the following challenges inherent in the current registration system:

- Excess paper work involved with the process;
- Data gathering, storage and retrieval are very cumbersome;
- Certificates are issued to cooperatives for life; there is no recertification of registered cooperatives;
- Emergency (political) cooperative registrations are very common;
- The registration process is not computerized;
- All documents must be physically submitted for verification and approval by the director of cooperatives, which cost time and money for transportation;
- Registered cooperatives are not categorized into specific sectors of the economy that they operate; hence some registered cooperatives operate beyond the boundaries of their objectives;
- Many of the cooperatives are not working;
- No monitoring and evaluation process in place for registered cooperatives, especially in rural areas because almost all the area offices are no longer functional as a result of gross shortage of staff and funding;
- No adequate education of members of cooperative groups before registration as a result most members have little or no knowledge on the workings of cooperative societies; and
- Uniform bye- laws are issued to all categories of cooperative societies.

4.3: Recommended procedures for cooperative societies administrative processes and guidelines

- At the one-on-one engagement and at the larger consultative stakeholder meeting, participants reviewed the current registration procedures and the procedures were streamlined to a

Three-Step Process:

- **Step 1**. Submit application letters for registration to the Director of Cooperatives and issuance of application forms to prospective societies to complete and return to the office of the Director of Cooperatives. The requirements for registration of cooperative societies as contained in the registration form were streamlined to:

i. Proposed name of the cooperative society;
ii. Address of the cooperative society;
iii. Area of operations;
iv. Objectives of the cooperative society;
v. Minimum number of shares and value of shares for thrift savings and share capital;
vi. Type of cooperative society; and
vii. Names of interim Management Committee

- **Step 2**: Make registration payment as stipulated by the Ministry of Humanity and Social Welfare
- **Step 3**: Issuance of certificate to approved Cooperative Societies by the Director of Cooperatives.

From the above steps, the recommended New CRS Cooperative Societies Registration Process Chart flow -

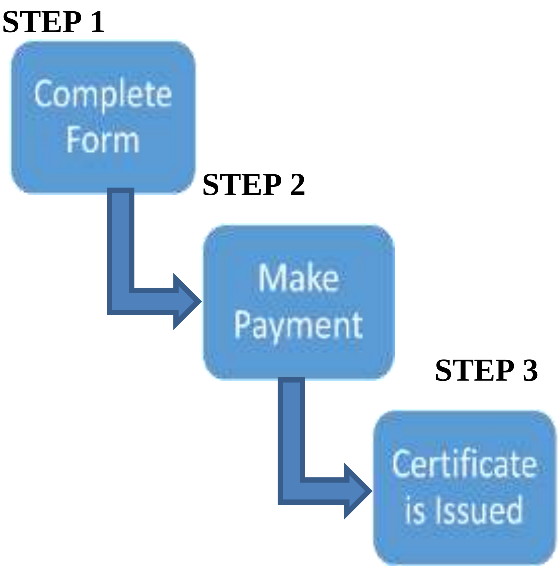

Fig. 2: Chart flow showing stakeholders proposed Cooperative Societies Registration process

4.3.1: Recommended policy changes to support the new registration system

The stakeholders recommended the following policy changes to support the new registration process in the state's Cooperative Department.

- All cooperative societies should be registered by the Director of Cooperatives in the Department of Humanity and Social welfare.
- Periodic revalidation exercises are needed to remove the chaff from the wheat. Revalidation should be followed by recertification. This was highly recommended to separate the active from the inactive coops. The Ministry should plan to do this revalidation periodically as resources and time will permit.
- Since many members have little or no knowledge of the workings of cooperative societies, awareness campaigns and continuous education at the rural level were highly recommended.
- Cooperative societies should be registered according to their categories such as agricultural, credits and savings and multipurpose cooperative society, etc. When this is done, it will be difficult for consuming cooperatives to have the same bye-laws with producing cooperatives.
- For the improvement of the current registration procedures, the cooperative department should authenticate the integrity of the information that is provided on the filled forms before certificates are issued. Minimum time for verifications of information and education should be one week, while registration and issuance of certificates should take 24 hours.
- The Cross-River State legislature in conjunction with the cooperative department of the Ministry should develop new cooperative laws that are not only relevant to the current needs but those that help guide administrative activities around cooperative societies.
- The memorandum of association for coops (or objectives) should be left for the cooperative societies to determine and present to the DCD.

- There should be periodic monitoring and evaluation of cooperative societies to ensure operations are in line with operational objectives.
- All emergency cooperative societies registrations should be discouraged. If such cooperative societies must be registered, it should be indicated in the registration forms for ease of tracking.
- Only valid identification cards (like National Identity Card, Driver's License, Voters Card, and International Passport) should be accepted for registration for ease of tracking of cooperative members. Furthermore, BVN and duly registered phone numbers of cooperative members should be included in the list of means of identification.
- Ministry should ensure that all registered cooperatives turn in their annual returns/reports regularly. This is one of the ways to keep tract of active and inactive cooperatives and a criterion for revalidation.
- The Department of Cooperatives on their part should reach out to cooperative Societies through phones, emails to remind them of their annual reports and other reports.
- **Digital system**: Due to the many challenges in the current registration procedures, stakeholders welcomed the idea of digitalization of the registration system and incorporation of a loan portal and e-wallet into the cooperatives operational system.

4.4 Conditions to kick–start any digitalization process

Stakeholders were of the opinion that the right foundation needs to be established and put in place for a successful transition to a modern, digital system. They enumerated the following conditions as necessary before digitalization can begin:

1. Review the existing cooperative law of the state, to be in line with the current trend and allow for virtual registration. The current law stipulates that a prospective applicant must visit the Office of the Coop Department to commence the registration process. This needs to be amended to accommodate virtual, online registration.
2. Develop a new cooperative policy for the state. The current coop policy is outdated.

3. Provide sensitization and awareness of the benefits of digital system to get support from all stakeholders. These benefits when properly spelt out may help active and inactive cooperatives to wake up and realign their activities.
4. Draw-up a monitoring and evaluation programme to ensure that registered cooperative societies meet the terms and conditions of the Ministry;
5. Development of a programme for continuous education of cooperative members; and
6. All inactive cooperatives should be deregistered.

4.4.1 Requirements for sustainability of proposed digital system

- There must be digital infrastructures on ground.
- Adequate staff must be recruited in the headquarters and in all area offices.
- Adequate capacity building of all staff is of necessity

After mounting the digital system, mapping of existing cooperative societies to be captured into the system is required. This can be achieved through revalidation process of all registered cooperative societies in the state by the ministry. Reference should be made to the list of agricultural cooperative societies created from FADAMA III as baseline for mapping.

4.4.2 Benefits of improved registration system for cooperatives

- With the improved system, fewer documents will be required
- Allows for a shorter registration process
- Can complete the improved registration process in less than a day
- Allows for a simplified Three- Step- Process registration
- The improved system is time saving

4.5 Conclusion and recommendations

4.5.1 Conclusion

Agriculture being the leading revenue contributor to the CRS economy and employs at about 70 percent of the State's labour force, the Ministry is supporting the government's effort to improve the agricultural sector of the state, by reviewing the current coop registration process and procedure in a bid to make it better. We have completed the review of the registration process and procedures and have provided what the stakeholders considers as vital next steps going forward towards a modern and improved system (page 8).

4.5.2 Recommendations

As requested by all stakeholders, a revalidation and recertification program should be considered as the next step to properly identify active agricultural cooperative societies and properly situate them to support the state's economic transformation agenda. Also, the other five conditions listed on page 9, as necessary foundation before a digital system is put in place should be considered for immediate action.

References

Cooperative Societies Law (2004), CAP. C13 laws of Cross River State, Vol.2

STRESSORS AND COPING STRATEGIES OF ARABLE CROP FARMERS IN CROSS RIVER STATE, NIGERIA

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Abstract

Despite possessing uncommon potential for food security, poverty alleviation and economic growth, arable crop farming is prone to shocks and stresses with implications for increasing farmer vulnerability. This study identified prevalent shocks in arable crop farming and ascertained coping strategies adopted by farmers across the three agricultural zones of Cross River State, Nigeria. The multi-stage sampling technique was used in the selection of respondents, the study utilized primary data, collected by use of structured questionnaire. Data were analyzed using descriptive statistics like means, frequencies and percentages. Specifically, a five-point likert scale was used to identify the stressors and coping strategies of arable farmers in the study area. The findings showed that soil infertility (Mean = 4.0, Rank = 1), increasing input prices (Mean = 4.0, Rank = 2), and lack of access to input/land and resources (Mean = 3.9) were the core stressors of arable crop farmers, and the coping strategies of these farmers were in the decreasing order of change diet to more affordable meal(mean =3.4, Rank = 1) engagement in small off farm businesses(mean = 3.4,Rank = 2) and diversification of crops(mean = 3.3, Rank=3). The study therefore, recommends promotion of sustainable agricultural practices through subsidies and farmer training, support for rural entrepreneurship, off-farm employment and skill acquisition programmes to reduce economic vulnerability, engagement of farmers in policy formulation and adequate monitoring at implementation to enhance access to input.

Key words: stress, shocks, arable crops, vulnerability.

Introduction

Food is core to human and economic development, playing significant roles in the areas of poverty alleviation, food security and employment generation. Food crop production (especially arable crops) is a major component of all production activities in the agricultural sector and a basic prerequisite for maintaining a robust food system. The typical rural arable crop farmer responds to three distinct demands per time; those from urban dwellers (accounting for over 50% of regional total populace) who obtain nearly all their foods from rural markets, demands occasioned by the curb of unhealthy growth pattern in food importation and the food needs of the immediate environment of the farm family. But in reality, the arable farming (Cassava, Maize, Rice, Yam, Cowpea, Okra, etc) enterprise in Nigeria is identified with slow growth. Dominated by small scale farmers who cultivate between 0.1 – 5.99 hectares with heavy reliance on crude materials and methods accompanied by inadequate finance, price volatility and other farm specific factors, the prevailing circumstances that characterize the typical production system in most localities where arable crop production happens dampen efforts to commit to increased production, delineate production frontiers and bring low output (Maurice *et al*., 2013; Chiaka *et al.*, 2022; Oladoyin,2022).

Increasing farm efficiency has always meant subscribing concertedly to agricultural technologies, at the expense of the environment. This argument however is not far-fetched, Agriculture happens within the environment and as such, influences and is impacted by the environment. The implication is that attempts at further expanding the capacity of natural capital create many economic and social irregularities with attendant effects on area available for arable crops production, yield, output and revenue (Sajjad and Nasren, 2016; Candan,2022). Existing literature upholds a pattern of arable crop production in Cross River State that reinforces inefficiency in rural food availability and contributes significantly to the depletion of the natural resource base which constitute the backbone of rural livelihood through a range of primary activities. The production pattern supports the destruction of soil organic matter, trees and vegetation around streams, transforms erstwhile perennial streams to seasonal ones and is plagued by eutrophication traceable to increased use of agrochemical due to reduced organic matter content of the soil. Worse still, arable crop production is entirely weather dependent, orchestrating an observable decline in agricultural productivity (Eko, 2013; Ashagwu *et al*.,2013; Edet *et al*., 2021).

As a result, arable crop farmers are prone to stresses and a range of seasonal, resource or economic shocks, emanating from a myriad of issues with great implications for the expansion of the farm enterprise and future decisions in its entirety. Specifically, the seasonal nature of arable crop production, wide margins between expected and actual yields, resource use inefficiency, market price volatility, environmental hazards, climate change effects (intense temperature, irregular rainfall, excessive flooding, severe droughts and tropical storms that erode soil quality/moisture, lessen crop resilience, dampen crop yields and grain quality and may lead to crop failure), desertification, land fragmentation, and insecurity especially as farmer/ herder clashes, constitute risks with social and economic implication that define the arable crop farmers' reality. This is because, shocks, trends and seasonality leave arable crop farmers more vulnerable as a result of the accompanying deterioration of the asset base. Vulnerable farmers either apply short-term measures known as coping strategies or adaptation strategies which are relatively of long-term nature. (Nelson *et al.,* 2009; Ogalley *et al*.,2012; Dadabhau and Kisan, 2013; Orebiyi *et al*., 2014; Mba *et al.,* 2018; Yang *et al*., 2021; Vihi *et al*., 2021; Ansah *et al*., 2022; Ogunbode *et al*., 2023; Chete *et al.,* 2025).

Whichever options notwithstanding, managing these risks require foremost, the ability to identify and apply the appropriate coping strategies to stresses and shocks, as they do affect not only the farming households in particular, but the entire economy. Stresses are the external and internal factors, events, circumstances, or conditions that create a harmful and overwhelming response in farmers when the demands of their agricultural operations exceed their capacity to manage them while shocks are sudden, unexpected, and severe disruptions such as droughts, floods, pest outbreaks, or sharp price drops that negatively impact agricultural production, income, and food security (Salimonu and Falusi, 2009; Berchoux *et al*., 2019; Aminu *et al*.,2023). This study therefore seeks to identify the nature of shocks and stresses that arable crop farmers are prone to as well as their adopted coping strategies. The relevance of this study is established on several fronts. Firstly, the insights will provide the needed understanding of the actual shocks and seasonality of arable farmers in Cross River state. That will in turn, enable the policy environment demonstrate a clear understanding as evidenced in the policies and interventions to assist people's coping and adaptive strategies. In similar vein, it will assist the targeting of interventions, providing answers readily to the how, where and when of such interventions. The insights finally, will guide researches targeted at proffering alternate coping strategies that are promising to long lasting recovery from shocks and stresses.

Methodology

The study was conducted in all the agricultural zones of Cross River state, Nigeria, namely Ikom, Calabar, and Ogoja. The multi stage sampling technique was employed in the random selection of 384 arable crop farming household from the list of registered arable crop farmers in Cross River state. The process involved purposive selection of three local government areas from each agricultural zone followed by the selection of three communities per local government making a total of 27 communities. Thereafter, the population lists of arable crop farming households for the various communities from which the samples were drawn were obtained from the community heads and used for the selection of 384 arable crop farming households. The basic considerations for selection were the prevalence of factors that threaten ecological balance, especially indiscriminate felling of trees, nature and extent of use of agrochemicals, bush burning, communal/ farmer-herder clashes and the social and economic status of farmer households. The selected LGAs had been identified as arable crop producing LGAs by the Cross River State Ministry of Agriculture.

The data for this study were collected entirely from the primary source using structured questionnaire made available to the arable crop farming household heads. The arable crops considered were Yam, Rice, Vegetable, Cassava, Potatoes, Plantain/Banana, and Beans. The questionnaire items covered household, ecological, economic, and social profiles at the farm level. The farmers were also interviewed, and discussions were held. Data were analyzed using descriptive statistics such as frequencies and percentages. Respondents reacted to items related to nature of shocks and coping strategies on a five-point likert scale calibrated as extremely severe (5), very severe (4), severe (3), mild (2), very mild (1), and very frequently (5), frequently (4), occasionally

(3), rarely (2), never (1) respectively. Thereafter, the frequencies of response were obtained and the respective means calculated and ranked.

Results/ Discussion

Nature of stresses and shocks experienced by arable crop farmers in the state

The examination of Table 1 indicates that soil infertility (Mean = 4.0, Rank = 1) and increasing input prices (Mean = 4.0, Rank = 2) represent the most significant stressors of arable crop farmers in the State. the tie between the means of soil infertility and input prices signals a cyclical relationship where high input prices cause a decline in fertilizer use, leading to reduced soil fertility, which in turn reduces the effectiveness of future inputs(Food and Agricultural Organization,1994). This result is consistent with that reported by Bationo *et al*. (2018), which recognized soil fertility depletion as a major obstacle to agricultural productivity in sub-Saharan Africa. Farmers who lack access to adaptive resources such as improved seeds, irrigation, and extension services are particularly at risk from poor soil fertility, as these limitations greatly impact yield stability, leaving them with little defense against food insecurity. Rising input prices, ranked second and, corresponds with the findings of Olayemi *et al*. (2019), who reported that fluctuations in input costs significantly affect the profitability of smallholder farmers in Nigeria. The high costs associated with fertilizers, seeds, and pesticides hinder farmers' ability to implement advanced agricultural technologies, consequently restricting productivity growth. This economic vulnerability intensifies for smallholder farmers working with minimal profit margins, as price shocks may result in decreased investments in farming, affecting long-term productivity and income stability.

The third-ranked issue, lack of access to input/land and resources (Mean = 3.9), supports the conclusions drawn by Bitzer *et al*. (2024), who identified limited resource access as barriers to agricultural advancement. Farmers confronting land tenure insecurity are more vulnerable to environmental risks, as they are less likely to obtain credit or invest in enhancements to their land. Crop pests, diseases, and fire outbreaks (Mean = 3.7, Rank = 4) were also identified as major stresses. This finding corresponds with research by Nwilene *et al*. (2013), which documented the severe impacts of pest outbreaks, like the African rice gall midge and army worms, on crop yields in West Africa. Social factors, including low education levels and restricted access to agricultural knowledge, contribute to this vulnerability, as households are less likely to adopt resilient farming practices, making them more susceptible to the impacts of pests and diseases. Drought (Mean = 3.5, Rank = 5) is another significant concern, particularly in light of climate change. Similarly, Oguntunde et al. (2017) emphasized that drought occurrences in Nigeria's Sahel region have resulted in considerable yield declines and increased food insecurity. Farmers who lack access to irrigation or drought-resistant crop varieties are especially at risk from these climatic challenges. At the lower end, unstable market prices for produce (Mean = 2.0, Rank = 11) were considered the least severe issue. However, research by Uduji *et al*., (2021) contends that price volatility remains a significant risk for smallholder farmers, potentially resulting in income instability, the likely implication of this contrast is that the stressor was not perceived as severe in the study area during the survey period.

Table 1: Distribution of Respondents according to Nature of Shocks/ Stresses experienced by Arable crop farmers

Shock / Stress	Extremely Severe Freq (%)	Very Severe Freq (%)	Severe Freq (%)	Mild Freq (%)	Very Mild Freq (%)	Mean	Rank
Government Policy Change	67(19.4)	109(31.5)	44(12.7)	27(7.8)	99(28.6)	3.1	8
Poor soil fertility	87(25.1)	208(60.1)	31(9.0)	10(2.9)	10(2.9)	4.0	1
Flooding	51(14.7)	78(22.5)	89(25.7)	82(23.7)	46(13.3)	3.0	9
Lack of technical know how	44(12.7)	154(44.5)	79(22.8)	35(10.1)	34(9.8)	3.4	6
Crop pest / diseases/ fire outbreak	53(15.3)	165(47.7)	95(27.5)	22(6.4)	11(3.2)	3.7	4

Illness/ epidemic	23(6.6)	78(22.5)	90(26.0)	90(26.0)	65(18.8)	2.7	10
Rising input prices	98(28.3)	164(47.4)	65(18.8)	13(3.8)	6(1.7)	4.0	2
Low volume of sales	44(12.7)	101(29.2)	117(33.8)	66(19.1)	18(5.2)	3.3	7
Unstable market prices of produce	29(8.4)	36(10.4)	32(9.2)	64(18.5)	185(53.5)	2.0	11
Drought	85(24.6)	132(38.2)	35(10.1)	75(21.7)	19(5.5)	3.5	5
Lack of input/ access to land and resources	147(42.5)	96(27.7)	44(12.7)	35(10.1)	24(6.9)	3.9	3

Source: Field survey data (2024)

Coping Strategies of Arable crop farmers

The distribution of arable crop farmers in Cross River State according to the coping strategies against stresses and shock is as shown in Table 2. Findings showed that, the three (3) core coping strategies were; change of diet to more affordable meal, engagement in small off farm businesses and diversification of crops. Hinging consumption chiefly on affordability is worrisome as the chances of compromising adequate nutrition are high, leading to a threatened human asset base especially when the attendant lifestyle diseases begin to present. Human resources hold the key to breaking the stagnation in agricultural growth and productivity (Hatai and Sen, 2008) only when people are healthy. The adoption of ecofriendly practices occupies the seventh (7^{th}) place in the options of arable crop farmers in dealing with shocks and stresses signaling the need to create more awareness in light of the enormous benefits that are resident in this approach, not just for building immediate resilience but for sustainable agricultural development. The finding is in tandem with Azumah *et a*l., (2023) that farmers are highly involved in non-agricultural businesslike handicrafts, household as well as non-household small-scale manufacturing, construction, mining, quarrying, repair, transport, community service etc., to survive and cater to needs. While Coulibaly *et al*. (2015) upheld engagement in a non-farm livelihood diversification and off farm labour as coping strategies, Mehar *et al*. (2016) supported consumption related decisions and Babatolu & Akinnubi (2014) buttressed the adoption of eco-friendly practices as a means of responding to crop failure.

Table 2: Distribution of Respondents according to coping strategies of Arable crop farmers

Strategy	Very Frequently Freq (%)	Frequently Freq (%)	Occasionally Freq (%)	Rarely Freq (%)	Never Freq (%)	Mean	Rank
Sale of household assets like livestock	38(11)	91(26.3)	153(44.2)	31(9.0)	33(9.5)	3.2	4
Change diet to more affordable meals	33(9.5)	140(40.5)	120(34.7)	47(13.6)	6(1.7)	3.4	1
Ecofriendly practices	20(5.8)	69(20)	140(40.5)	52(15.0)	65(18.8)	2.8	7
Off farm labour	36(10.4)	82(23.7)	157(45.4)	58(16.8)	13(3.8)	3.2	4
Diversification of crops	35(10.1)	108(31.2)	127(36.7)	58(16.8)	16(4.6)	3.3	3
Small business	41(11.8)	115(33.2)	136(39.3)	41(11.8)	13(3.8)	3.4	2
Irrigation	23(6.6)	53(15.3)	157(45.4)	53(15.3)	60(17.3)	2.8	8
Sale of forest products, firewood, charcoal etc	12(3.5)	41(11.8)	135(39.0)	97(28.0)	61(17.6)	2.6	9
Loans from							

formal credit institutions	13(3.8)	19(5.5)	25(7.2)	64(18.5)	225(65.0)	1.6	11
Borrowing from friends, neighbours and cooperatives	24(6.9)	107(30.9)	115(33.2)	62(17.9)	38(10.9)	3.0	6
Food aid from government and local community	21(6.1)	27(7.8)	43(12.4)	66(19.1)	189(54.6)	1.9	10

Source: Field Survey data, (2024)

Conclusion

Harnessing the untapped potentials in Arable crop production in Cross River state is a sustainable solution to food crop supply deficit. However, achieving such feat would require considering in strong terms, the myriads of issues that undermine the genuine efforts of arable farmers and proffering lasting solutions, especially through the policy formulation and institutional pathway. Currently, soil infertility, rising input prices and limited access to resources, amongst others, are the realities to which most farmers respond by changing diets, diversifying production and engaging in small businesses. Reducing farmer vulnerability requires promotion of sustainable agricultural practices through subsidies and farmer training, support for rural entrepreneurship, off- farm employment and skill acquisition programmes to reduce economic vulnerability, engagement of farmers in policy formulation and adequate monitoring at implementation to enhance access to input.

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THE PROBLEMS AND PROSPECTS OF MICROFINANCE INSTITUTIONS IN FINANCING AGRIBUSINESS ENTERPRISES.

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Abstract

This paper examines the problems and prospects of microfinance institutions (MFIs) in financing agribusiness enterprises in Nigeria. Agriculture remains a major contributor to employment and national income, yet smallholder farmers continue to face limited access to formal financial services. The study reviews the role of MFIs in providing credit, savings, insurance, and other financial services to agribusinesses, while also highlighting the benefits of financial inclusion, poverty reduction, and productivity enhancement. However, several constraints limit the effectiveness of MFIs, including lack of acceptable collateral, high interest rates, seasonality of agricultural production, and high covariant risks associated with weather variability and pest outbreaks. Drawing from existing literature, the paper argues that although MFIs have significant potential to bridge the financing gap in agriculture, institutional, structural, and policy challenges must be addressed to improve their performance. The study provides insights for policymakers, practitioners, and researchers seeking to promote financial inclusion and agricultural business development in Nigeria.

Keywords: Microfinance Institutions (MFIs); Agribusiness Financing; Smallholder Farmers; Access to Finance.

Introduction

Agriculture as the backbone of West Africa economy is further revealed by the fact that it contributes an average of about 75 percent of various countries exports. Agriculture remains a vital sector in Nigeria, contributing approximately 25% to the nation's Gross Domestic Product (GDP) and employing about 70% of its labour force (Central Bank of Nigeria, 2020; Food and Agriculture Organization, 2017). Despite its importance, the agricultural sector in Nigeria faces several challenges, particularly limited access to finance for smallholder farmers who constitute the majority of agricultural producers. Many farmers are unable to obtain loans from conventional financial institutions due to lack of collateral, unstable income patterns, and absence of formal credit histories, while inadequate infrastructure and limited market opportunities further constrain agricultural productivity (Food and Agriculture Organization, 2017). In response to these financing gaps, Microfinance Institutions (MFIs) have emerged as important financial intermediaries that provide financial services such as savings, loans, insurance, payment services, and money transfers to low-income individuals who lack access to traditional banking services (Conroy, 2003; Azevedo, 2007; Nilsson, 2010). Over the past few decades, microfinance has grown rapidly and has become a key development tool for promoting financial inclusion and supporting small-scale entrepreneurs, including farmers (IPA, 2009). However, MFIs still face several challenges such as high operational costs, limited outreach in rural areas, and low financial literacy among farmers, which restrict their ability to effectively finance agricultural activities (World Bank, 2019; IFAD, 2019). In addition, high transaction costs and weak risk management systems often limit the effectiveness of microfinance models in supporting agribusiness development (Ajibefun & Ajala, 2015).

Specifically, the study seeks to:

v. Identify the benefits that microfinance institutions provide to agribusinesses.

vi. Identify the problems, challenges and limitations faced by MFIs in effectively financing smallholder farmers.

Literature Review

The literature illustrates the transformative impact of microfinance institutions on smallholder farmers and agribusinesses. According to Olomola (2017), MFIs have the potential to empower smallholder farmers through various financial services that facilitate agricultural investments. Research by Ajibefun and Ajala (2015) corroborates this by demonstrating the positive relationship between access to microfinance and increased agricultural productivity. However, challenges persist. Studies have pointed out that high-interest rates and inadequate outreach limit the effectiveness of MFIs in truly transforming the agricultural landscape (International Fund for Agricultural Development, 2019). According to Adebayo (2016), insufficient attention to the specific needs of farmers can lead to suboptimal loan utilization, underscoring the need for tailored financial products.

Moreover, challenges relating to financial literacy among farmers prevent them from maximizing the benefits of microfinance services. As noted by Zeller (2001), many farmers lack the knowledge to effectively manage loans, resulting in high default rates. Hence, despite the valuable role MFIs play, further research is necessary to address these systemic issues (Hassan & Wajahat, 2021).

Role of Microfinance Institutions in Agribusiness Financing

Microfinance institutions play an important role in financing agribusiness enterprises by providing credit and other financial services to farmers and rural entrepreneurs. Access to microcredit allows farmers to purchase farm inputs such as fertilizers, seeds, pesticides, and farm equipment. It also enables agribusiness operators to invest in processing, storage, and marketing activities that improve the value of agricultural products (Adebayo, 2016).

In addition to providing credit, MFIs also encourage savings among rural households and provide financial education that helps farmers improve their financial management skills. According to the World Bank (2019), access to microfinance services can significantly improve rural livelihoods by increasing income levels and reducing poverty.

Here are some key roles of MFIs in financing smallholder farmers:

1. Access to Credit: MFIs provide agribusiness enterprise with access to credit, enabling them to invest in their farm operations, purchase inputs, and improve productivity (Adebayo, 2016; Olomola, 2017).
2. Savings Opportunities: MFIs offer savings accounts, helping smallholder farmers build financial reserves for emergencies or future investments (Central Bank of Nigeria, 2020).
3. Insurance Coverage: Some MFIs offer insurance products that protect smallholder farmers against crop failures, natural

disasters, or other risks, reducing their vulnerability (International Fund for Agricultural Development, 2019).
4. Financial Literacy: MFIs often provide financial literacy training to smallholder farmers, enabling them to manage their finances effectively and make informed decisions (Food and Agriculture Organization, 2017).
5. Risk Management: MFIs help smallholder farmers manage risks associated with agricultural production, such as crop failure or price fluctuations (Adebayo, 2016).
6. Increased Productivity: By providing access to finance and other services, MFIs can help smallholder farmers increase their productivity and improve their livelihoods (Olomola, 2017).
7. Improved Food Security: By supporting smallholder farmers, MFIs can contribute to improved food security and reduced poverty in rural areas (Food and Agriculture Organization, 2017).
8. Empowerment: MFIs can empower smallholder farmers, particularly women, to take control of their financial lives and make informed decisions about their agricultural activities (International Fund for Agricultural Development, 2019).

Overall, microfinance institutions play a critical role in supporting smallholder farmers and promoting agricultural development in rural areas.

Problems of Microfinance Institutions in Funding Agribusiness

Agriculture in Nigeria has remained largely underdeveloped for several decades despite numerous government interventions. Many farmers still face limited access to capital needed for farm expansion and mechanization, which keeps them trapped in a persistent cycle of poverty. Some of the challenges MFIs face in financing agribusinesses are:

i. Lack of Acceptable Collateral/Security: many rural farmers do not possess assets that formal financial institutions consider suitable collateral for obtaining credit. Rural women face even greater constraints in this regard. Land titles to farmland are often difficult to formalize, transfer, or use as security. As a result, the land tenure system remains a major barrier to financing agricultural activities in rural areas, where farmland is typically the only tangible asset available to those seeking credit.

ii. High interest rates: high interest rates were identified by credit users as a major constraint, as they limit farmers' ability to obtain larger loan amounts. This supports the position of the Central Bank of Nigeria, which has noted that elevated lending rates discourage farmers from accessing credit, leading to reduced investment and lower agricultural productivity. Nevertheless, MFIs maintain that such rates are applied to agricultural loans because of the considerable risks involved in the sector. The government control also translates into quotas, with banks mandated to lend a minimum of 16 percent of their total advances to agriculture. It also leads to artificially low interest rates (currently 9 percent per annum, or about 200 basis points above lending rates to AAA corporations), without any consideration of cost of funds, operating costs and risk. MFIs cannot sustain themselves at these rates.

iii. Seasonality: seasonality is another important reason for MFIs not giving crop loans. Since the farmers all need money at nearly the same time for sowing the crop, it places peak demand on MFIs which they are not able to mobilize.

iv. High co-variant risk due to weather and pest attacks is another reason. A failure in rainfall, unseasonal rains, cyclones, hailstorms, high temperature spells, and likewise, pest attacks, affect crops adversely and impact all the farmers in a region. Since MFIs work in geographically compact areas, they can be severely affected by the high co-variant risk that crop loan borrowers face.

Benefits of Microfinance Institutions

Microfinance institutions offer several significant benefits to agribusiness enterprises and smallholder farmers such as:

i. Access to Financial Services: MFIs provide essential loans that enable farmers to purchase inputs and invest in improved farming techniques. As noted by Olomola (2017), this access can lead to increased productivity and enhanced income for farmers.

ii. Financial Inclusion: By targeting underserved populations, MFIs promote financial inclusion and empower smallholder farmers with crucial financial resources (Adebayo, 2016). This empowerment can ultimately help lift communities out of poverty, as highlighted by the World Bank (2019).

iii. Poverty Alleviation: The financial services provided by MFIs can help improve the livelihoods of farmers, thereby contributing to poverty reduction in rural areas (Ajibefun & Ajala, 2015). This aligns with findings from the International Fund for Agricultural Development (2019), which emphasizes the importance of financial inclusion in alleviating poverty.

iv. Risk Management: MFIs often offer insurance products that allow farmers to manage risks associated with crop failures and natural disasters (Hassan & Wajahat, 2021), fostering a more resilient agricultural sector.

v. Innovation Promotion: As noted by the Food and Agriculture Organization (2017), MFIs can facilitate funding for innovative agricultural practices, contributing to technological advancements and increased efficiency in farming operations.

Conclusion

In conclusion, microfinance institutions remain essential instruments for expanding access to finance among smallholder farmers and agribusiness enterprises in Nigeria. Their capacity to provide tailored financial services can significantly enhance agricultural productivity, promote financial inclusion, and alleviate poverty in rural communities. However, their effectiveness in agricultural financing continues to be constrained by structural challenges such as high interest rates, limited outreach, inadequate collateral systems, seasonal loan demand, high lending risks, and institutional sustainability concerns.

Addressing these constraints is crucial for maximizing the impact of MFIs on agricultural development. Policymakers, financial institutions, and development partners must therefore collaborate to refine microfinance models, strengthen risk-management mechanisms, and enhance financial literacy among farmers. Creating a more enabling environment for agricultural microfinance will help unlock the full potential of agribusiness enterprises, foster a more resilient agricultural sector, and contribute meaningfully to national economic growth and development.

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TREND, GROWTH RATE, INSTABILITY, AND DECOMPOSITION ANALYSIS OF YAM (DIOSCOREA SPP.) PRODUCTION IN NIGERIA

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Abstract

This study examined the trend, growth rate, instability, and decomposition of yam (Dioscorea spp.) output, harvested area, and yield in Nigeria. Secondary data were obtained from the Food and Agriculture Organization (FAO) for the period 1961 to 2024. The results show that yam output, harvested area, and yield followed fluctuating long-term trends across the study periods. The estimated compound growth rates were 4.64% for output, 4.46% for harvested area, and 0.17% for yield. The Cuddy-Della Valle instability index (CDI) and Coppock instability index (COI) were 30.88 and 89.85 for output, 38.63 and 85.36 for harvested area, and 20.28 and 45.89 for yield, respectively. These values indicate considerable variability over time, especially in output and harvested area. The decomposition results further show that area effect accounted for 94.84% of the total change in output, while yield effect and interaction effect contributed 0.31% and 4.85%, respectively. The findings suggest that long-run yam production growth in Nigeria has been driven mainly by expansion in harvested area rather than sustained improvement in yield. The study therefore recommends stronger investment in productivity-enhancing interventions, including improved seed yam systems, agronomic improvement, extension support, and other yield-oriented technologies to increase output on a more sustainable basis.

Keywords: growth rate, instability index, yam, trend analysis, Nigeria

Sub-theme: Production Economics and Farm Management

Introduction

Yam belongs to the genus Dioscorea and the family Dioscoreaceae. It is an important tuber crop cultivated widely in Nigeria and across West Africa. Research indicates that more than 600 yam species exist globally, although only a limited number are widely cultivated in Nigeria (IITA, 2024; NRCRI, 2024). The major species commonly reported in the country include white yam (Dioscorea rotundata), yellow yam (Dioscorea cayenensis), water yam (Dioscorea alata), trifoliate yam (Dioscorea dumetorum), aerial yam (Dioscorea bulbifera), and Chinese yam (Dioscorea esculenta) (Olubukola and Bolarin, 2006; Zaknayiba and Tanko, 2013). Among these, white yam remains the most widely cultivated and is notable for its social, cultural, and economic importance (Bamire and Amujoyegbe, 2005; Obidiegwu and Akpabio, 2017). Proximate analyses also show that yam is rich in carbohydrates, vitamins, minerals, and other nutrients that make it an important staple food (Olatoye and Arueya, 2019; Nwafor et al., 2020; Adegboyega et al., 2020; Godfrey et al., 2023). In addition to its food value, yam contributes to household income, employment, livestock feed, and the supply of industrial starch.

Nigeria is one of the leading global producers of yam and contributes more than half of world output (NRCRI, 2023; FAO, 2024). According to FAO data, Nigeria produced about 61.17 million tonnes of yam from about 7.48 million hectares in 2022. Despite this production volume, domestic demand remains strong and, in many areas, still outpaces efficient supply and market distribution (NRCRI, 2009; Amusa et al., 2018). In response, governments at different levels have introduced interventions such as input support, credit schemes, processing initiatives, and market development efforts. Even so, yield growth has remained modest. FAO figures indicate that average yield increased only slightly from about 7.97 tonnes per hectare in 2021 to 8.18 tonnes per hectare in 2022 (FAO, 2024). This modest progress raises concern for food security and for the broader goal of achieving zero hunger under the Sustainable Development Goals (Akpan et al., 2024).

More than 90% of crop production in Nigeria is rain-fed, and this makes agricultural performance highly sensitive to weather variability and climate change (Elijah et al., 2018; Kemi et al., 2021). At the same time, widespread poverty, weak access to improved inputs, and the slow adoption of innovation continue to limit the ability of many farmers to raise productivity (Akpan et al., 2019; Edet et al., 2024a; Edet et al., 2024b; Edet et al., 2024c). Dependence on traditional production practices, resource constraints, insecurity, disease pressure, land tenure limitations, and macroeconomic instability can all contribute to fluctuations in output, harvested area, and yield. Such instability matters because it can reduce farm income, discourage investment, and widen rural vulnerability.

Previous studies have shown that different arable crops in Nigeria exhibit varying growth paths and instability patterns over time (Abu and Adakole, 2017; Ikuemonisan et al., 2020; Antia-Obong et al., 2024). However, there is still value in providing a long-run assessment of yam production that jointly examines trend, compound growth, instability, and the relative contribution of harvested area and yield to output change. This study addresses that need by analysing the trends, growth rates, and instability indices of yam production, harvested area, and yield in Nigeria, and by decomposing output change into area, yield, and interaction effects.

Materials and Methods

Study Area

The study was conducted in Nigeria, which has diverse agro-ecological zones and provides suitable conditions for yam cultivation. Yam is produced in many parts of the country under varying environmental, socio-economic, and institutional conditions, making Nigeria an appropriate setting for a long-run analysis of production trends and instability.

Data source

The study employed secondary time-series data obtained from the Food and Agriculture Organization (FAO). The dataset covered annual observations on yam output, harvested area, and yield in Nigeria from 1961 to 2024.

Model Specification
Analytical Techniques

The study applied descriptive trend analysis, compound growth rate estimation, instability measures, and output decomposition. These techniques were selected because they permit an assessment of long-run movement in output, harvested area, and yield, as well as the relative contribution of land expansion and productivity change to total output.

(a) Measuring a compound growth rate of variables

To estimate compound growth rates for yam output, harvested area, and yield, the following semi-log model was specified in line with Akpan et al. (2024):

ln(Yt) = b0 + b1t + et (1)

$$log_e(Y_o, Y_a, Y_y) = \delta_0 + \delta_1 t + U_t \dots\dots\dots\dots.\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (2)$$

Where Yt represents the variable of interest in year t, namely yam output (tons), harvested area (hectares), or yield (tons per hectare). The parameter b0 is the intercept, b1 is the estimated time trend coefficient, and et is the stochastic error term. Given the compound growth relationship:

Yt = Y0(1 + r)^t (3)

By comparing equation (2) with equation (3), the compound growth rate was obtained as:

r = (antilog b1 - 1) × 100 (4)

Where r is the compound growth rate expressed in percentage terms.
The model parameters were estimated using the Ordinary Least Squares (OLS) method.

Measuring series instability index

Instability in yam output, harvested area, and yield was examined using the Coefficient of Variation (COV), the Cuddy-Della Valle Index (CDI), and the Coppock Instability Index (COI). Together, these measures provide complementary evidence on the degree of variability in the series.

(a) Coefficient of Variability (COV)

The Coefficient of Variation (COV) measures relative dispersion around the mean. Although it is useful as a simple variability measure, it can overstate instability when a strong time trend is present in the data. Higher COV values indicate greater variation, while lower values indicate more stability.

$$COV = \frac{standard\ deviation}{mean} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. (5)$$

(b) Cuddy-Della Valle index (CDI)

The Cuddy-Della Valle Index (CDI) adjusts the coefficient of variation for the presence of trend and is widely used in agricultural instability studies (Cuddy and Della Valle, 1978). It is expressed as:

CDI = CV × √(1 - R^2) (6)

$$CDI = CV\sqrt{1 - R^2} \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

Where CV is the coefficient of variation in percent and R^2 is the coefficient of determination from the time-trend regression. Instability was interpreted as low when CDI was 0-15, moderate when greater than 15 but less than 30, and high when above 30.

(c) Coppock Instability Index (COI)

The Coppock Instability Index (COI) measures instability based on logarithmic first differences of the series (Coppock, 1962). A higher COI implies greater instability, while a lower value indicates a more stable series. The index is expressed as:

$$Coppock\ Instability\ Index\ (COI) = Antilog\left(\sqrt{logV} - 1\right)x\ 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (8)$$

COI = [Antilog(√Vlog) - 1] × 100 (9)

Vlog = [Σ(log Xt+1 - log Xt - M)^2 / (N - 1)] (10)

$$M = \frac{1}{N-1}\sum(logX_{t+1} - logX_t) \ldots \ldots \quad (11)$$

Where Xt is the value of the variable in period t, M is the mean of the logarithmic first differences, and N is the number of observations.

X_t is the time series variable under consideration (output/area/yield) in period t.

M = mean value of the first differences of logarithm

(d) Yam Output Decomposition

Growth and instability measures do not by themselves show how much output change is attributable to harvested area, yield, or their interaction. A decomposition analysis was therefore carried out to separate the contribution of these components to total output change. The identity used is:

ΔP = A0ΔY + Y0ΔA + ΔAΔY (12)

$$P = \frac{A_0\Delta Y * 100}{\Delta P} + \frac{Y_0\Delta A * 100}{\Delta P} + \frac{\Delta Y\Delta A * 100}{\Delta P} \ldots \ldots \quad (13)$$

Where A0 is harvested area in the base year, ΔA is the change in harvested area, Y0 is yield in the base year, ΔY is the change in yield, and ΔP is the change in output. The three terms on the right-hand side represent yield effect, area effect, and interaction effect, respectively.

A_0 = Area in the base year
ΔA = Current harvested area minus the base area
Y_0 = Yield in the base year
ΔY= Current yield minus the base yield
ΔP = Current production minus base production

All analyses were conducted for the following periods: 1961-1970, 1971-1980, 1981-1990, 1991-2000, 2001-2010, 2011-2022, and the pooled period 1961-2022.

Results and Discussion

Trend Analyses of output, harvested area and yield of yam in Nigeria

Figures 1 to 3 present the trends in yam output, harvested area, and yield in Nigeria from 1961 to 2022. Overall, yam output shows a fluctuating but strongly rising long-run pattern. The upward movement in production becomes particularly pronounced from the early 1990s onward, which is broadly consistent with expansion in harvested area.

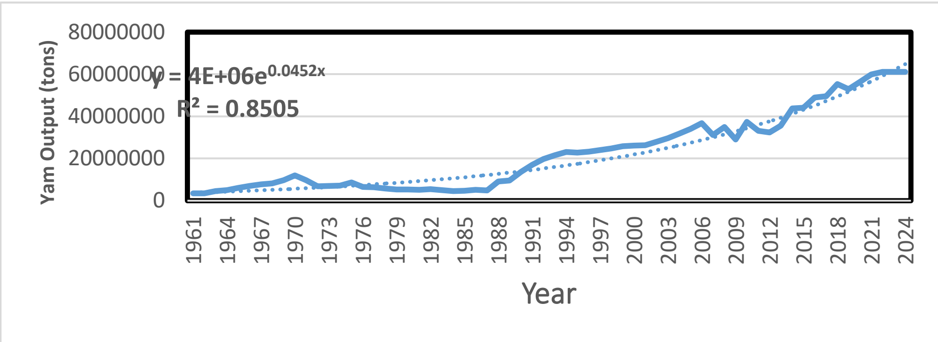

Figure 1: Yam production (tons) in Nigeria, 1961-2022

The harvested area under yam followed a pattern that closely tracked changes in output. This suggests that much of the increase in production was associated with expansion in cultivated land rather than major improvement in average productivity. While policy support and changing market incentives may have encouraged area expansion, the descriptive trend alone does not establish direct causality.

The yield series shows a more modest and less consistent pattern than output and harvested area. Between 1961 and 1980, yield moved irregularly, followed by stronger improvement in the 1980s. Thereafter, the series exhibited periods of both gain and decline, indicating that productivity improvement has been less stable than the expansion of cultivated area.

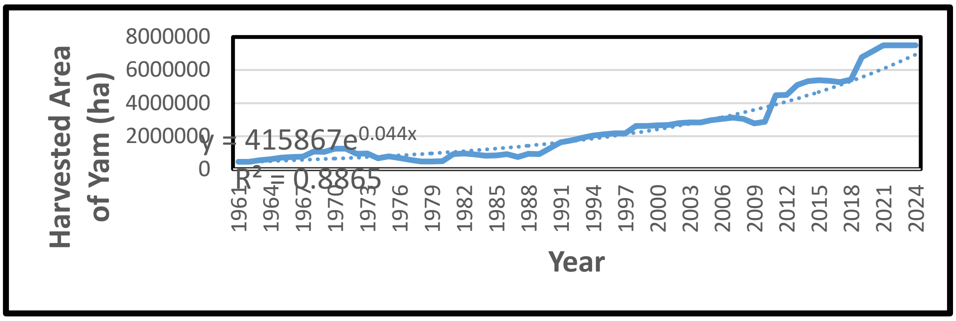

Figure 2: Trend in harvested area of yam (ha) in Nigeria, 1961-2022

The historical evolution of yield may reflect a mix of agronomic change, seed quality, input use, weather conditions, and institutional support. For example, collaboration involving NRCRI and IITA contributed to improved yam technologies, including seed yam multiplication approaches. However, the trend evidence in this study should be interpreted as descriptive rather than as proof of the isolated effect of any single programme.

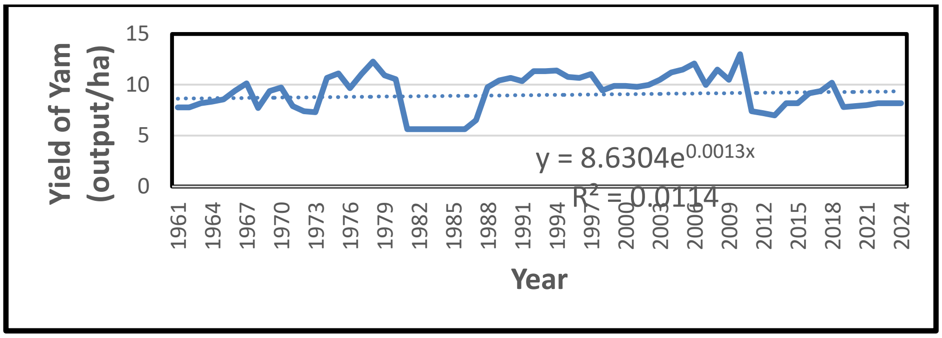

Figure 3: Trend in yield of yam (tons/ha) in Nigeria, 1961-2022

Seed yam multiplication initiatives such as minisett technology were designed to address the problem of inadequate high-quality planting material by increasing the multiplication rate of white yam (IITA, 1985). Such innovations are relevant because they can improve the availability of quality seed and support yield improvement over time, although the evidence presented here remains descriptive.

Compound growth rate and instability indices of output, area, and yield of yam in Nigeria

Tables 1 to 3 report the coefficient of variation (COV), compound growth rate (CGR), Cuddy-Della Valle index (CDI), and Coppock instability index (COI) for yam output, harvested area, and yield across the selected periods. Together, these indicators show that growth was not uniform over time and that instability differed across production dimensions.

Growth rates and Instability Indices in yam (tons) in Nigeria

For yam output, the period 1961-1970 recorded a COV of 41.50% and a CGR of 14.83%, indicating substantial variation alongside strong growth. Output growth turned negative in 1971-1980, but became positive again in later periods. The pooled estimates for 1961-2022 show a COV of 79.02% and a CGR of 4.64%, suggesting that output increased over the long run, but with considerable variability.

Table 1: Growth rates and Instability Indices in yam production (tons) in Nigeria

	1961-1970	1971 – 1980	1981-1990	1991-2000	2001-2010	2011-2022	1961-2022
Mean	6.73e+06	6.86e+06	6.74e+06	2.28e+07	3.19e+07	4.78e+07	2.14e+07
Std. dev.	2.79e+06	1.43e+06	3.04e+06	2.81e+06	3.77e+06	1.01e+07	1.68e+07
COV (%)	41.5018	20.7907	45.0388	12.3135	11.8347	21.1199	79.0201
CGR (%)	14.8321	-5.3241	10.1766	4.0771	2.6433	6.1815	4.6373
	Instability indices						
CDI	8.7842	12.4106	28.7683	4.1283	8.9019	4.4704	30.8782
COI	56.0809	44.8745	53.8451	41.9598	41.4347	46.0522	89.8546

Note: COV = Coefficient of Variation; CGR = Compound Growth Rate; CDI = Cuddy-Della Valle Instability Index; COI = Coppock Instability Index.

Between 1971 and 1980, yam output recorded a negative compound growth rate of -5.32%, which points to contraction during that period. In contrast, the periods 2001-2010 and 2011-2022 recorded positive growth rates of 2.64% and 6.18%, respectively. The CDI and COI values also indicate that instability remained substantial, especially in the pooled series. High instability in this context should be interpreted as marked variability over time rather than as evidence of positive activity.

The output indicators therefore suggest that Nigeria experienced long-run expansion in yam production, but that this expansion was accompanied by sizeable fluctuations across decades.

The pooled evidence for output confirms a positive long-run trend, but one that was not smooth. This has important policy implications because unstable production performance can weaken income planning, market coordination, and food security outcomes.

(a) Growth rates and Instability Indices in harvested area (ha) of yam in Nigeria

The harvested area indicators broadly mirror the pattern observed for output. This supports the view that changes in yam production in Nigeria have been strongly associated with expansion or contraction in cultivated area. The harvested area CGR was negative only during 1971-1980 and positive in the remaining periods, with a pooled growth rate of 4.46% for 1961-2024.

Table 2: Growth rates and instability indices in harvested area of yam (ha) in Nigeria

	1961-1970	**1971 -1980**	**1981-1990**	**1991-2000**	**2001-2010**	**2011-2022**	**1961-2022**
Mean	7.61e+05	7.23e+05	9.23e+05	2.17e+06	2.89e+06	5.81e+06	2.33e+06
Std. dev.	2.73e+05	2.49e+05	1.39e+05	3.63e+05	1.41e+05	1.10e+06	1.96e+06
COV (%)	35.8061	34.2784	15.1024	16.7615	4.8637	19.0106	84.2582
CGR (%)	12.2817	-9.7328	1.6674	5.5883	0.7678	4.9573	4.4616
	Instability indices						
CDI	8.9659	13.0124	13.8510	3.9629	4.2871	6.8598	38.6303
COI	52.5143	51.0023	42.2729	43.5604	38.6190	44.2797	85.3581

Note: COV = Coefficient of Variation; CGR = Compound Growth Rate; CDI = Cuddy-Della Valle Instability Index; COI = Coppock Instability Index.

The pooled harvested-area values show a COV of 84.26%, a CDI of 38.63, and a COI of 85.36. These results indicate that land devoted to yam expanded substantially over time but also fluctuated considerably. Such fluctuations may reflect changing incentives, weather conditions, resource constraints, land access, and broader structural conditions in the agricultural sector.

Growth rates and Instability Indices in the Yields (ton/ha) of yam in Nigeria

The yield indicators differ from those of output and harvested area. The coefficients of variation for yield remained below 30% in most periods, except for 1981-1990, indicating that yield was generally less volatile than output and area. The pooled growth rate of yield for 1961-2022 was only 0.17%, which points to very weak long-run productivity growth.

Table 3: Growth rates and instability indices in yield of yam (tons/ha) in Nigeria

	1961-1970	**1971 - 1980**	**1981-1990**	**1991-2000**	**2001-2010**	**2011-2022**	**1961-2022**
Mean	8.7001	9.8843	7.1188	10.6180	11.0050	8.2168	9.2236
Std. dev.	0.8923	1.7459	2.2176	0.6990	1.0453	0.9382	1.8883
COV (%)	10.2563	17.6634	31.1513	6.5827	9.4983	11.4183	20.4729
CGR (%)	2.2714	4.8841	8.3696	-1.4312	1.8613	1.1664	0.1682
	Instability indices						
CDI	7.6049	11.3581	16.5718	4.9859	7.5909	10.6858	20.2847
COI	40.7232	44.3654	48.9286	39.3318	40.3861	41.0975	45.8996

Note: COV = Coefficient of Variation; CGR = Compound Growth Rate; CDI = Cuddy-Della Valle Instability Index; COI = Coppock Instability Index.

The CGR values of 2.27%, 4.88%, and 8.37% for the early sub-periods indicate episodes of rising yield, but the rate turned negative in 1991-2000 before becoming positive again afterward. Overall, the evidence suggests that improvements in yield were modest and less sustained than expansion in cultivated area. This result strengthens the argument that output growth in Nigeria's yam subsector has been driven primarily by area expansion rather than by major productivity gains.

Decomposition of yam output in Nigeria

Table 4 presents the decomposition of yam output change into area effect, yield effect, and interaction effect. The results show that the contribution of harvested area dominated the decomposition in most periods. In the pooled estimates, area effect accounted for 94.83% of total output change, while yield effect and interaction effect accounted for 0.31% and 4.85%, respectively.

Table 4: Percentage decomposition of yam production change in Nigeria

Components	1961-1970	1971 -1980	1981-1990	1991-2000	2001-2010	2011-2022	1961-2022
Area effect	71.74	129.07	23.42	112.80	16.95	79.39	94.83
Yield effect	10.28	-72.14	55.58	-7.93	77.49	12.33	0.31
Interaction effect	17.98	43.07	21.00	-4.87	5.56	8.28	4.85
Total effect	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Source: compiled by authors, data from FAO.

The dominance of the area component in both the sub-period and pooled results reinforces the conclusion that output growth came mainly from land expansion. Yield contributed more strongly in a few periods, notably 1981-1990 and 2001-2010, but this pattern was not sustained over the full study horizon. From a policy perspective, this suggests that future gains in yam production will be more sustainable if they come from productivity-enhancing interventions rather than continued dependence on area expansion alone.

Summary and Recommendations

This study examined the trends, growth rates, instability indices, and output decomposition of yam production, harvested area, and yield in Nigeria using FAO data for 1961-2022. The results show that yam output increased over time, but that the increase was accompanied by substantial fluctuations. Harvested area recorded strong long-run growth, whereas yield growth remained weak.

The pooled coefficients of variation for output, harvested area, and yield were 79.02%, 84.26%, and 20.47%, respectively. This indicates that output and harvested area were far more variable over time than yield. The pooled compound growth rates were 4.64% for output, 4.46% for harvested area, and only 0.17% for yield. These results show that long-run growth in yam production was driven mainly by expansion in cultivated area, not by strong productivity improvement.

The decomposition analysis supports this conclusion. In the pooled results, area effect contributed 94.83% of total output change, while yield effect contributed only 0.31% and interaction effect contributed 4.85%. Although yield played a stronger role in a few sub-periods, its overall contribution to long-run output growth was limited.

Based on these findings, the study recommends increased investment in improved seed yam systems, farmer access to better planting materials, agronomic training, extension delivery, storage and post-harvest support, and other productivity-enhancing technologies. Policies should focus not only on increasing land under cultivation, but also on improving yield per hectare in order to achieve more stable and sustainable growth in yam production.

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UNDERSTANDING RICE PRODUCTION OF SMALLHOLDER FARMERS IN INI LOCAL GOVERNMENT AREA, AKWA IBOM STATE, NIGERIA

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Abstract

Rice production remains central to global food security, particularly in developing economies where smallholder farmers dominate the production landscape. In Nigeria, despite being one of Africa's leading rice producers, domestic output continues to lag behind national demand, resulting in substantial import bills and foreign exchange This study assessed the factors influencing rice production among smallholder farmers in Ini Local Government Area of Akwa Ibom State, Nigeria. A multistage sampling technique was adopted to select 383 registered rice farmers from a population of 8,897 across five production clusters, with 376 valid responses used for analysis. Descriptive statistics were employed to examine the socioeconomic characteristics of respondents, while a Cobb–Douglas multiple regression model was used to estimate determinants of rice output. Findings revealed that rice farmers in the study area were predominantly in their productive age (mean age = 46 years), mostly married, experienced in farming (average 24 years), and had at least secondary education. The majority operated small-scale farms averaging 1.5 hectares, cultivated improved rice varieties, and practiced transplanted lowland rice production. However, access to credit remained limited. Regression results indicated that seed quantity, fertilizer, pesticide use, farm size, age, education level, and household size positively and significantly influenced rice output. Conversely, family labour and farming experience showed significant negative effects, suggesting inefficiencies and possible diminishing returns to certain inputs. The model explained approximately 73% of the variation in rice output (R^2 = 0.729), confirming a good fit. The study concludes that enhancing access to productive resources particularly quality seeds, fertilizer, farmland, and education would significantly improve rice production among smallholder farmers in Ini LGA. Policies aimed at strengthening input subsidy programs, improving credit accessibility, and promoting efficient resource utilization are recommended to bridge Nigeria's rice demand–supply gap and enhance food security.

Keywords: Rice Production, Small-holder, Finance, Credit, Akwa Ibom State

Introduction

Rice production stands as a cornerstone of global agriculture, feeding over half the world's population with its versatile, nutrient-rich grains, and is a mainstay in terms of food security (Luo et al., 2018). Global rice cultivation is dominated by Asia with China and India together accounting for more than half of the roughly 535-562 million metric tons produced annually in recent records (USDA, 2021). Yields have climbed through hybrid varieties and better management, pushing production to all-time highs like the forecasted 561.6 million tonnes (milled basis) for 2025/26, but this mask stagnating productivity in parts of Africa and South America amid erratic rains and soil degradation (FAO, 2026).

Sub-Saharan Africa (SSA) has recorded a rise in consumption of rice as a widespread staple cereals food, with more household's preference for it keep increasing on daily basis. Rice contributes about 27 percent and 20 percent energy and protein requirements respectively, in less developed nations (USDA, 2011). Consumption of rice has risen above many roots' crops and tubers foods. As such, consumption figure is estimated to rise up to 36 million tonnes in 2026, from 27-28 million tonnes now (Nigatu, et al. 2017). Among rice producing nations in continent of Africa, Nigeria stands tall as a major producer, where in 2021/2022 over 5 million tonnes were produced (USDA, 2021). In West Africa Sub-region, Nigeria is well known as the most significant rice cultivator as-well-as consumers.

In Nigeria, smallholder farmers are the primary rice producers. However, their yields, averaging 1.9–2.3 t/ha from 2020 to 2025, are substantially lower than the global average of 4 t/ha and the 8–10 t/ha potential

According to the United States Department of Agriculture and Foreign Agricultural Service (USDA/FAS, 2021), Nigeria imported 9.6 million metric tonnes of rice between 2017 and 2022. During the same period, domestic production totalled 23.93 million tonnes, while national consumption reached 34.33 million tonnes. This created a demand-supply gap of approximately 2 million metric tonnes, as consumption of nearly 7.0 million tonnes exceeded domestic production of 5.0 million tonnes per year. The Food and Agriculture Organization (FAO, 2021) estimated that the rice import bill for 2017–2020 was about N467.96 billion, projected to rise to N901.93 billion by 2029.

Study Methodology

This study was conducted in Ini Local Government Area (LGA) of Akwa Ibom State, Nigeria, located in the northern part of the state within the tropical rainforest belt. The LGA covers an estimated land area of 406.9 square kilometres and falls under the Ikot Ekpene Agricultural Zone. It is bounded to the northeast and northwest by Abia State and to the south by Obot Akara, Ikono, and Ibiono Ibom LGAs. Ini LGA comprises five clans: Itu Mbonuso, Ikpe, Nkari, Iwere, and Odoro Ikono.

The study population consisted primarily of smallholder rice farmers. For sampling purposes, the area was grouped into five rice production clusters, each comprising ten villages. A multistage sampling method was employed: first, the five rice clusters were purposively selected; second, registered rice farmers in each cluster were enumerated, totalling 8,897 individuals; and third, the Taro Yamane (1967) formula was applied to determine the sample size, assuming a 5% margin of error and 95% confidence level. The sample calculation is presented in Equation 1.

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

where n =sample size, N = finite population (total number of registered rice farmers), e=level of significance (0.05), and 1 = unit or constant value. The sample were drawn as follows:

$$n = \frac{8897}{1+8897(0.05)^2}\ , n = \frac{8897}{1+8897\ (0.0025)}\ , n = \frac{8897}{1+22.2425}\ ,$$

$$n = \frac{8897}{23.2425}\ , =\ \ 382.79.\ n \simeq 383$$

The three hundred and eighty-three (383) respondents were selected using simply random sampling technique.

Table 1. Sampling procedures

Stage I Purposive Selection of 5 Rice Clusters	Stage II No. of Registered Rice Farmers Per Cluster	Stage III Sample Size of Rice Farmers Per Cluster
Itu Mbonuso	2,568	111
Ikpe	2,675	115
Nkari	2,102	90
Iwere	1,214	52
Odoro Ikono	338	15
Total	8897	383

Source: The researcher's field data (2026).

A total of 383 questionnaires were distributed in the field, of which 376 were retrieved, representing a 98% response rate.

Descriptive statistics, including frequency counts, means ($\bar{X}$), and percentages (%), were used to analyze the socioeconomic characteristics of the smallholder rice farmers. To identify the factors influencing rice production among smallholder farmers, the study employed a Cobb–Douglas production function. This functional approach relates rice output to various inputs and farmers' socioeconomic characteristics. The implicit form of the model is expressed as shown in Equation 2:

$$Y\ = b_o\, X_1^{b_1}\, X_2^{b_2}\ \ldots\ X_{13}^{b_{13}}\ e^u \qquad (2)$$

The model is explicitly described as shown in Equation 3;

$$\text{LnY} = b_o + b_1 lnX_1 + b_2 lnX_2 + \cdots + b_{13}\, lnX_{13} + u1 \quad (3)$$

where, Y = Output/quantity of paddy rice produced in (kg),
X_1 = Seeds/planting material in (kg),
X_2= Fertilizer in (kg),
X_3=Pesticides in (litres),
X_4= Family Labour in (Mandays),
X_5= Hired labour in (Mandays),
X_6 = Rice variety (dummy I = improve variety, O = otherwise),
X_7= Farm size in hectares (ha),
X_8= Age of farmer (years),
X_9= Farming experience (years),
X_{10}= Educational level (Years spent in school),
X_{11} = Household size (count) No. of persons,
X_{12} = planting method (dummy 1 yes, O= otherwise),
X_{13} =Extension access (No. of contact),
L_n=Natural logarithm,
b_o = Constant term, $b_{1-}b_{13}$ = Coefficients of the variables to be estimated or slopes of independent variables, u_i= Error term

Results and Discussion

The socioeconomic profile of the rice farmers is summarized in Table 2. The mean age of respondents was 46 years, with the majority (64.9%) aged between 41 and 50 years, indicating that farmers in the study area are in their prime productive years. This aligns with findings by Idowu, Lawal, and Gabriel (2025), who reported that rice farmers in Ekiti State were predominantly middle-aged and actively engaged in fieldwork. Males represented 52.1% of the respondents, while females accounted for 47.9%. The higher proportion of male farmers in swamp rice cultivation may be due to the physically demanding nature of the work and cultural norms that favor male-headed households in accessing land and production resources, as observed in studies across Nigerian farming communities (Idowu et al., 2025; Oseni & Oduaro, 2022).

Marital status revealed that 53.7% of farmers were married, 19.4% were single, 22.6% were widowed, and 4.3% were divorced. Most farmers had considerable experience in rice cultivation, averaging 24 years. Specifically, 25.3% had 20 years of experience, while 12.5% had more than 40 years, indicating that respondents possess substantial practical knowledge of rice farming. The positive contribution of farming experience to productive knowledge and decision-making has been supported by research showing that long-term engagement in crop farming increases agricultural skills and adaptive capacity (Idowu et al., 2025).

Table 2. Socioeconomic characteristics of the Respondents (N=376)

Characteristics	Frequency	Percentage	Mean
AGE			
21 – 30 years	43	11.4	
31 – 40 years	51	13.6	
41 – 50 years	244	64.9	46
> 50 years	38	10.1	
SEX			
Male	196	52.1	
Female	180	47.9	
MARITAL STATUS			
Single	73	19.4	
Married	202	53.7	
Widowed	85	22.6	
Divorced	16	4.3	
FARMING EXPERIENCE (YEARS)			
≤ 12	25	6.6	
18	50	13.3	
20	95	25.3	24
21	71	18.9	
25	16	4.3	
35	72	19.1	
≥ 40	47	12.5	
LEVELS OF EDUCATION			
Primary	174	46.3	
Secondary	193	51.3	
Tertiary	9	2.4	

HOUSEHOLD SIZE			
1 – 4	45	12.0	
5 – 8	231	61.4	6
Above 8	100	26.6	
EXTENSION ACCESS			
Had Contact	249	66.2	
Had no Contact	127	33.8	
CREDIT ACCESS			
Had Access	130	34.6	
Had no Access	246	65.4	
FARM SIZE			
< 1(ha)	124	33.0	
1 – 2 (ha)	245	65.1	1.5
> 2 (ha)	7	1.9	
MEMBERSHIP OF CO-OPERATIVE			
Belong to Co-operative	331	88.0	
Not belong to any Co-operative	45	12.0	
RICE VARIETY			
Improved	329	87.5	
Local	47	12.5	
OTHER OCCUPATIONS			
Trading	148	32.15	
Civil Service	7	1.9	
Other Artisans	50	13.3	
None other than farming	170	52.65	
RICE PRODUCTION SYSTEM			
Transplanted rice (TPR) production system (lowland)	376	100.0	
Direct seeded rice (DSR) Production System (upland)	-	-	
PLANTING METHOD			
Broadcasting	301	80.1	
Line Planting	75	19.9	

Source: The researcher’s field data (2026).

Education levels showed that 51.3% of respondents had completed secondary education, 46.3% had primary education, and 2.4% had tertiary education. This suggests that farmers are capable of understanding new production techniques and adopting improved practices. Similar findings were reported by Luka, Alabuja, and Ebukiba (2022), who noted that education enhances farmers' ability to adopt technologies and make better production decisions.

Household size averaged six members, with 61.4% having 5–8 members. Larger household sizes have been shown to provide additional labor for farm operations, which can enhance productivity, as reported in studies of rural farming systems in Nigeria (Idowu et al., 2025; Oseni & Oduaro, 2022).

Access to extension services was reported by 66.2% of respondents, suggesting that a majority of farmers receive timely information on improved rice production practices. This supports findings by Idowu et al. (2025) that extension contact plays a key role in improving farmers' technical knowledge and production strategies. However, only 34.6% had access to agricultural credit, indicating limited financial support may constrain farm operations and productivity—an issue documented in Nigeria's smallholder farming research (Luka et al., 2022).

Farm size was predominantly small, with 65.1% cultivating 1–2 hectares (mean = 1.5 ha), 33.0% cultivating less than 1 hectare, and only 1.9% cultivating more than 2 hectares. This confirms that most rice farmers in the study area are smallholders with limited land holdings, consistent with land structure patterns observed in other Nigerian states (Oseni & Oduaro, 2022).

Membership in cooperatives was high, with 88% of respondents belonging to such associations, which can provide access to inputs, technical advice, and markets. Improved rice varieties were cultivated by 87.5% of respondents, while 12.5% planted local varieties. The widespread adoption of improved rice varieties such as NERICA and other high-yielding strains has been documented in studies of smallholder systems in Nigeria, where improved seeds were linked to higher productivity and resilience (Bala et al., 2025).

Regarding other occupations, 52.65% of respondents were full-time farmers, while 47.35% engaged in off-farm activities, including trading (32.15%), artisanal work (13.3%), and civil service (1.9%). Off-farm engagements provide supplementary income that can support household needs and farm investment, a phenomenon widely observed in rural farming economies (Luka et al., 2022).

All respondents (100%) used the transplanted lowland rice production system, reflecting the suitability of the swampy terrain for this method. In terms of planting methods, 80.1% used broadcasting, while 19.9% employed line planting. The lower adoption of row planting is attributed to its labor and time requirements, consistent with observations in Nigerian rice farming studies (Oseni & Oduaro, 2022).

Determinants of Rice Production in the study area

Table 3 presents the results of the regression analysis using the Cobb–Douglas production function to estimate factors influencing rice output among smallholder farmers. The Cobb–Douglas functional form is widely applied in empirical agricultural studies because it allows measurement of the marginal productivity of each input and captures the contribution of multiple factors to total output (Miller, 2008; Adetunji, Akinbode, & Onyenweaku, 2012; Chisasa et al., 2013; Ahmad et al., 2015).

The model's R-squared value of 0.729 indicates that approximately 73% of the variability in paddy rice output is explained by the independent variables included, with the remaining 27% captured by the error term. The F-value was significant at $p < 0.01$, confirming the goodness of fit of the model.

The regression analysis revealed that seed quantity had a positive and significant effect on rice output, with a coefficient of 1.77275 at the 5% significance level. This implies that a 1% increase in seed usage results in a 1.77% increase in rice production, consistent with Onyenweaku et al. (2010), who found a positive relationship between seed quality and rice productivity in southeastern Nigeria. Similarly, fertilizer use, with a coefficient of 0.03931 and significance at the 1% level, was positively associated with output, indicating that increased fertilizer application improves yields, corroborating the findings of Osanyinlusi et al. (2016)

in smallholder rice systems. Pesticide use also had a positive and highly significant effect (1.01026, $p < 0.01$), suggesting that effective pest management enhances productivity, a result supported by Luka et al. (2021) in Abuja.

In contrast, family labor exhibited a negative coefficient (-0.55351) and was statistically significant, contrary to a priori expectations. This suggests overutilization or inefficient allocation of household labor, possibly due to off-farm activities that reduce effective labor on the farm. Similar negative impacts of family labor have been reported in studies of rice and sugarcane production in Ogun and Kwara States (Akinbode et al., 2011; Aina et al., 2015).

Farm size was positively associated with output (0.12484) and significant at the 1% level, indicating that larger holdings enable higher production, consistent with findings from Nwaobiala et al. (2013), Ebido et al. (2020), and Luka et al. (2021). Farmer age also positively influenced output (0.01299, $p < 0.01$), reflecting that more mature farmers manage resources efficiently, a pattern observed by Ebido et al. (2020) in Anambra State. Educational attainment had a strong positive effect (0.40510, $p < 0.01$), suggesting that more educated farmers adopt improved practices and maintain records, which enhances productivity, aligning with Onyenweaku et al. (2010).

Conversely, farming experience showed a significant negative effect (-1.27822), indicating diminishing returns, likely because older farmers allocate fewer hours to active fieldwork. While some studies report positive correlations between experience and output (e.g., Nwaobiala et al., 2013), others, including Osanyinlusi et al. (2016) and Olanrewaju et al. (2022), have documented negative effects in cassava and rice production in other Nigerian states. Household size was positively associated with output (0.41070, $p < 0.01$), reflecting the contribution of household labor to farm activities, consistent with Ebido et al. (2020).

Other variables, including planting method (3.03598), hired labor (-0.06926), rice variety (-0.16075), and extension contact (-0.09770), exhibited coefficients consistent with theoretical expectations, but these effects were not statistically significant.

Table 3. Multiple regression result (Cobb Douglas) showing estimates factors influencing rice production

Variables	Coefficients	Std. Error	t-ratio	p-value
(Constant)	7635.26***	7.12494e-011	1.072e+014	<0.0001
Seed	1.77275**	0.752740	2.355	0.0210
Fertilizer	0.0393117***	0.0112454	3.496	0.0008
Pesticide	1.01026***	0.207425	4.870	<0.0001
Family labour	-0.553510***	0.151088	-3.663	0.0004
Hired labour	-0.0692622	0.0683104	-1.014	0.3137
Rice variety	-0.160755	0.195532	-0.8221	0.4135
Farm size	0.124842**	0.0483144	2.584	0.0116
Age	0.0129894***	0.00462982	2.806	0.0063
Farming experience	-1.27822***	7.09573e-012	-1.801e+014	<0.0001
Education	0.405101***	0.0853984	4.744	<0.0001
Household size	0.410701***	0.117352	3.500	0.0008
Planting method	3.03598e-012	3.03321e-012	1.001	0.3175
Extension contact	-0.0976996	0.0805017	-1.214	0.2285
R2	0.728958			
$\bar{R}^2$	0.691064			
S.E	0.805934			
F – value	8.62e-38			

*** significant at 1 percent** Significant at 5%, * Significant at 10 percent.
Source: The researcher's field data (2026).

Conclusion and Recommendations

This study examined rice production among smallholder farmers in Ini Local Government Area, Akwa Ibom State, focusing on their socioeconomic characteristics and the factors influencing rice output. The findings indicate that the majority of farmers (64.9%) are aged between 41 and 50 years, with a mean age of 46 years, placing them in their most productive years. Most respondents (53.7%) are married, and 25.3% have more than 20 years of farming experience, with an average of 24 years. Regarding education, 51.3% of farmers have attained secondary education, which equips them with the knowledge to adopt improved practices and manage resources efficiently. Household size averaged six members, with 61.4% of respondents having 5–8 members, providing labor support for farm operations.

Approximately 66.2% of farmers had contact with agricultural extension officers, while 65.4% lacked access to formal credit facilities, which may constrain investment in production inputs. Farm holdings were predominantly small, with 65.1% cultivating 1–2 hectares (mean = 1.5 ha). Most farmers (88%) were members of cooperative associations, and 87.3% cultivated improved rice varieties. Full-time farming was reported by 52.65% of respondents, with the remainder engaged in off-farm activities. Men comprised 52.1% of farmers. All respondents (100%) practiced transplanted lowland rice cultivation, and the majority (80.1%) used broadcasting as their planting method.

Regression analysis revealed that seed, fertilizer, pesticide use, farm size, age, education, and household size significantly and positively influenced rice output. In contrast, family labor, farming experience, rice variety, and extension contact had negative coefficients, indicating an inverse relationship with total paddy rice output. These results underscore the importance of both physical inputs and human capital in determining productivity, while also highlighting potential inefficiencies in labor allocation and resource utilization.

Based on these findings, the study recommends the following:

1. Government institutions and private organizations should support smallholder rice farmers by providing quality seeds, fertilizers, pesticides, and farmland at subsidized rates to enhance production.
2. Farmers with underutilized inputs, such as seeds, fertilizer, and land, should increase them, while overused resources, including family labor, hired labor, and pesticides, should be managed efficiently.

3. Agricultural extension outreach should be strengthened by the relevant agencies to ensure farmers receive timely information on improved practices, modern technologies, and efficient labor management.
4. **Government and other stakeholders in should encourage** continuous farmer education and training programs to improve knowledge, management skills, and adoption of best practices in rice production.
5. Farmers should be encouraged to form and belong to cooperatives and farmer organizations, which can provide technical assistance, input support, and market access.
6. **Government and financial institutions must d**evelop programs to increase smallholder farmers' access to credit facilities, enabling investment in farm inputs and productivity-enhancing technologies.

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IMPACT EVALUATION OF THE AGRO-PROCESSING, PRODUCTIVITY ENHANCEMENT AND LIVELIHOOD IMPROVEMENT SUPPORT (APPEALS) PROGRAMME (2017-2023) ON CATFISH PRODUCTION IN CALABAR METROPOLIS, CROSS RIVER STATE, NIGERIA.

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Abstract

This study evaluated the impact of the Agro Processing, Productivity Enhancement, and Livelihood Improvement Support (APPEALS) program on catfish production in Calabar Metropolis, Cross River State. Data were collected from 40 purposively selected catfish farms using structured questionnaires, with a multistage sampling technique. The study aimed to determine the level of catfish output by beneficiaries and non-beneficiaries, compare their output levels, identify factors affecting production, and examine production constraints. Descriptive statistics were used to analyze the output levels of beneficiaries (25,951kg) and non-beneficiaries (9,550kg), while a Z-test compared the mean outputs, and multiple regression identified factors influencing production. A five-point Likert scale assessed key challenges faced by farmers. Results showed equal participation by males and females (50% each), with beneficiaries achieving a significantly higher mean output (25,951 kg) than non-beneficiaries (9,550 kg), confirmed by a Z-test with a difference of (16,401kg) which was statistically significant between the two gr. Regression analysis revealed that medication costs positively influenced output, while labor and feeding showed negative impacts, contrary to expectations. Stock size, however, had a positive correlation with output. Major constraints included high feed costs, inadequate technology, high transportation expenses, and unreliable electricity. The study recommends continued targeted support from APPEALS, improved labor and feeding efficiency, and enhanced access to microfinance and low-interest loans to boost production and scale.

Regular monitoring and evaluation of the program are also suggested to ensure sustained improvements in catfish farming.

Keywords: Processing, APPEALS, catfish production, beneficiaries, non-beneficiaries, Livelihood support

1.1 Introduction

Agro-processing refers to the transformation of raw agricultural products into value-added goods. In the context of catfish production, it could involve activities such as fish processing, packaging, and preservation. The goal of agro-processing is to increase the shelf life of products, improve their quality, and create additional revenue streams for farmers. Productivity enhancement is another critical aspect of the project. It entails implementing strategies and technologies to improve the efficiency and output of catfish farming operations. This could involve adopting better feed management practices, optimizing water quality, implementing disease control measures, and utilizing advanced farming techniques. Livelihood improvement support refers to initiatives aimed at enhancing the socio-economic well-being of catfish farmers and their communities. This could include providing training and capacity building programs, facilitating access to credit and financial services, promoting market linkages, and supporting the establishment of cooperative societies or farmer associations. The project's focused on Calabar Metropolis, Cross River State, Nigeria, suggests that it sought to evaluate the specific impacts and outcomes of these interventions in that particular geographical area, by conducting a comprehensive evaluation, the project aimed to assess the effectiveness of the interventions in terms of their impact on catfish production, productivity, and the livelihoods of catfish farmers, Damilola and Obijubutu. (2021) Capacity building and food safety awareness. The evaluation process involved collecting and analyzing data on various indicators, such as fish yield, income levels, employment generation, market access, and the adoption of improved practices. This research will help evaluate the overall effectiveness of the interventions and identify any gaps or areas for improvement. The findings of this project could have significant implications for policymakers, researchers, and practitioners in the field of agriculture and rural development. The results may inform policy decisions that would guide future interventions, and contribute to the body of knowledge on sustainable catfish production and rural livelihood improvement. Overall, this project aimed to contribute to the understanding of how agro-processing, productivity enhancement, and livelihood improvement support can positively impact catfish production in Calabar Metropolis, Cross River State, Nigeria. By evaluating the outcomes of these interventions, it strives to provide valuable insights and recommendations for the development of the catfish farming sector and the improvement of farmers' livelihood, (Federal Ministry of Agriculture and Rural Development (FMARD) (2018).

Nigeria's catfish farming industry has the potentials for addressing food security, creating employment opportunities, and driving economic growth. In enhancing catfish production, various agro-processing, productivity enhancement, and livelihood support programs have been implemented. This section provides a detailed background on the impact of these programs on catfish production in Nigeria. Agro-processing programs are designed to add value to catfish products and improve market access for farmers. These programs often involve the establishment of fish processing units, cold storage facilities, and the introduction of modern processing techniques. The Nigerian Institute for Oceanography and Marine Research (NIOMR), 2020) has implemented the "Fish Processing and Preservation" program, which provides technical support and training to catfish farmers across Nigeria (NIOMR, 2020). This program aims to reduce post-harvest losses, enhance product quality, and increase market competitiveness. Productivity enhancement programs focus on improving the efficiency and productivity of catfish farming operations. These programs often include the adoption of improved production techniques, access to quality inputs, and the provision of technical assistance and training to farmers. The Federal Ministry of Agriculture and Rural Development (FMARD) has implemented the Youth Empowerment in Agriculture Program (YEAP), which aims to enhance the productivity of young catfish farmers in Nigeria through capacity building, access to finance, and the provision of modern farming equipment (FMARD, 2018). Livelihood support programs aim to uplift the socio-economic conditions of catfish farmers by providing them with access to credit facilities, market linkages, and entrepreneurial training. These programs often target marginalized and vulnerable groups, such as women and youth, to promote inclusivity and empowerment. The National Directorate of Employment (NDE), in collaboration with microfinance institutions, has implemented the "Catfish Farming Support Scheme" to provide financial assistance, business development services, and market linkages to small-scale catfish farmers in Nigeria (NDE, 2020).

The implementation of agro-processing, productivity enhancement, and livelihood support programs had a significant impact on catfish production in Nigeria. These programs have resulted in increased production volumes, improved product quality, reduced post-harvest losses, and enhanced market competitiveness. A study conducted by Oluwole and Adekunle (2019) examined the impact of productivity enhancement programs on catfish production in selected farms in Nigeria. The study found that the adoption of improved production techniques led to a 35% increase in catfish production. Furthermore, the introduction of agro-processing programs has enabled farmers to add value to their products, thereby increasing their profitability. The establishment of fish processing units and the utilization of modern processing techniques have improved the quality of catfish products, making them more attractive to consumers and expanding market opportunities. Livelihood support programs have played a crucial role in improving the socio-economic conditions of catfish farmers. By providing access to credit facilities, these programs have enabled farmers to invest in their operations, purchase quality inputs, and expand their production capacity. Additionally, the provision of business development services and market linkages has enhanced the entrepreneurial skills of farmers and facilitated their integration into formal markets. The implementation of agro-processing, productivity enhancement, and livelihood support programs in Nigeria has positively influenced catfish production. These programs have led to increased productivity, improved product quality, and enhanced market access for catfish farmers. The success of these programs highlights the importance of continuous monitoring, evaluation, and capacity building initiatives to sustain and expand their impact. Collaboration among policymakers, development agencies, and stakeholders is crucial to strengthen these initiatives and ensure the long-term growth and sustainability of the catfish farming sector in Nigeria.

Methodology

1.2 Study Area

Calabar Municipality and Calabar South Local Government Areas of Cross River State. Calabar Municipality and Calabar South Local Government Area and lies between latitude $4^{o}50'$N and $5^{o}10'$N longitude $8^{o}17'$E and 8’20E. Population; 685,000 as at 2024. Area; 406 square kilometers.

Calabar Metropolis is an administrative urban area located in Cross River State, Nigeria. It serves as the capital of the state and is known for its rich history, cultural heritage, and natural beauty. The study area of Calabar Metropolis encompasses various aspects, including its geography, demographics, economy, infrastructure, and social dynamics.

Geographically, Calabar Metropolis is situated at the southeastern part of Nigeria, bordered by the Cross River to the south. It covers an area that includes Calabar South and Calabar Municipality local government areas.

In terms of demographics, Calabar Metropolis is home to a diverse population comprising different ethnic groups, including Efik, Ejagham, and Bekwarra, among others. The Efik people, who are the indigenous inhabitants, have played a significant role in shaping the city's cultural identity.

The economy of Calabar Metropolis is multifaceted, with sectors such as trade, tourism, manufacturing, and services driving its growth. The city's strategic location and well-developed infrastructure have made it a hub for international trade, attracting investments and fostering economic activities. Calabar Free Trade Zone, located within the metropolis, has further facilitated trade and industrial development.

Calabar Metropolis is also known for its thriving tourism industry. The city boasts numerous attractions, including historical landmarks like the Calabar Slave Museum, Mary Slessor Tomb, and Duke Town Church. The annual Calabar Carnival, which is Africa's largest street party, attracts tourists from far and wide, contributing to the local economy.

Infrastructure-wise, the metropolis has witnessed significant improvements in recent years. It has a well-maintained road network, modern healthcare facilities, educational institutions, and recreational centers. The Calabar International Convention Centre, known for hosting major events and conferences, has further enhanced the city's reputation as a destination for business and tourism.

1.3 Sampling Technique

A multistage sampling was used for the study. The first stage involved purposive selection of Calabar South and the Calabar Municipal which are under Calabar metropolis. The second stage involved purposive selection of one community each of which the fish farms are located. Final stage involved purposive selection of forty (40) fish farms in the study area.

Socio-Economic Characteristics of Respondents

Table 1 showed the summary of the results on the socio-economic characteristics of broiler farmers in Calabar municipality and Calabar South local government area. The result showed that the data collected from sampling of 80 farmers made up of 76.25% male and 23.75% female, this showed a significant skew towards male participation in broiler farming. The result revealed that the mean age of brother farmers in the study area was 37.5%, the result equally showed that 55% were singles, 45% this implies that the majority of broiler farmers in the study area are in their productive years, with a relatively balanced marital status distribution, suggesting that the age and marital status distribution may contribute to a stable and experienced broiler farmers. On average, broiler farmers had 43.75% years of experience. experience levels varied, with 40% being relatively new (1-5 years), 43.73% having moderate experience (6-10 years), and 11.25% having extensive experience (11-15 years).

The study further revealed that, the Broiler farmers in the study area demonstrated a high educational standard, averaging 32.5 years of education. This group is characterized by a predominantly well-educated community, with 45% holding tertiary qualifications, and smaller proportionsof 21.25% having primary, 32.50% having secondary education and 1.25% with no education. The average stock size of broiler farmers was 52.5. The distribution showed that a majority (52.5%) of respondents had small-scale operations with 1-200 birds, while 22.5% had medium-scale operations with 201-400 birds.

Socio-Economic Characteristics of Respondents

Variables	**Frequency**	**Percentage (%)**	**Mean (x̄)**
Educational level			
No education	1	1.25	
Primary	17	21.25	
Secondary	26	32.50	
Tertiary	36	45	32.50
total	80	100	
Age			
1-20	3	3.8	
21-30	45	36	
31-40	30	37.5	
41-50	9	11.25	
51 and above	2	2.5	37.5
Total	80	100	
Stock size			
1-200	42	52.5	
201-400	18	22.5	
401-500	6	7.5	
501 above	14	17.5	52.2
Total	80	100	
Farming experience			
1-5	32	40	
5-10	35	43.75	
11-15	9	11.25	
16-20	4	5	43.75
Total	80	100	
Sex			
Male	61	76.25	
Female	19	23.75	76.25
Total	80	100	

Marital status		
Married	36	45
Single	44	55
Total	80	100

Source: Computed from field survey, (2024).

Results and Discussion
Socio-Economic Characteristics of Correspondents
Table 1 below shows the summary of results on the socio-economic characteristics of catfish farmers in Calabar metropolis. The result shows that the data collected from sampling of forty (40) catfish farmers

Age of respondents
The result in Table 4.1 revealed that 37.5% of the respondents were between 21-30 years, 30% were 31-40 years, 20% were 41-50 years, 7.5% were above 51 while, 5% were between 10-20 years. The approximated mean age of the respondents was 36 years. This implies that the fish farmers were in their young and active age.

Sex of the respondents
The result in Table 4.1 revealed that half of the respondents (50%) were female while the other half were male (50%). This implies that both male and female actively participates in catfish farming.

Marital status of the respondent
The result in Table 4.1 revealed that majority of the respondents were married (62.5%), 35% were single while 2.5% were divorced. This implies that the study area was dominated by married individuals and they were relatively responsible as marriage indicate some level of responsibility, commitment and stability.

Educational level
The result showing the educational level of respondent reveals that majority of the respondents attained primary education (42.5%), 30% had tertiary education, 22.5% had secondary education while, 5% had no formal education. This indicates high literacy in the study area.

Farmer's experience
The result showing farmer's experience indicates that 85% of the respondents had 1-5years farming experience, while 15% had 6-10 years farming experience. The approximated mean farming experience was 3 years. This revealed that the respondents has little experience in catfish farming.

Household size
The result showing household size revealed that 82.5% had 1-5 persons while 17.5% had 6-10 persons. The mean household size was 3 persons. The study showed that the respondents had small household size. The low number of persons per household may indicate the unavailability of family labour to carry out production activities.

Table 4.1: Socio-economic characteristics of correspondents

Variables	Frequency	Percentage (%)	Mean ($\overline{X}$)
Age			
10-20	2	5.0	36
21-30	15	37.5	
31-40	12	30.0	
41-50	8	20.0	
51 and above	3	7.5	
Total	**40**	**100**	**36**
Gender			
Male	20	50.0	
Female	20	50.0	
Total	**40**	**100**	
Marital status			
Single	14	35.0	
Married	25	62.5	
Divorced/widowed	1	2.5	
Total	**40**	**100**	
Educational level			
No formal education	2	5	

Primary	17	42.5	
Secondary	9	22.5	
Tetiary	12	30.0	
Total	**40**	**100**	
Farmer's experience			
1-5	34	85.0	
6-10	6	15.0	
Total	**40**	**100**	**3**
House hold size			
1-5	33	82.5	
6-10	7	17.5	
Total	**40**	**100**	**3.0**
Extension contact			
No contact	**33**		
1-5	**5**		
6-10	**1**		
11-15	**1**		
Access to credit			
Beneficiaries	20	50	
Non-beneficiaries	20	50	
Total	**40**	**100**	
Income			
50,000-200,000	17	**42.5**	
201,000-350,000	6	**15**	
351,000-500,000	15	**37.5**	
501,000-650,000	1	**2.5**	
651,000-800,000	-	**-**	
801,000-950,000	-	**-**	
951,000-1,000,000	-	**-**	
1,101,000-1,250,000	-	**-**	
1,251,000-1,400,000	-	**-**	
1,401,000-1,550,000	1	**2.5**	
Total	**40**		

Determinant of the Level of Output of Beneficiaries and Non-Beneficiaries

The analysis demonstrates a statistically significant difference in mean output between beneficiaries and non-beneficiaries of the APPEALS grant. The mean output of beneficiaries stands at an impressive 25,951kg surpassing the significantly lower output of non-beneficiaries which registers at 9,550kg. The analysis clearly shows a statistically significant difference in the mean outputs between beneficiaries and non-beneficiaries of the APPEALS grants. Beneficiaries have an impressive average output of 25,951 kg, which is substantially higher than the 9,550 kg produced by non-beneficiaries. This notable difference highlights the strong positive impact of participation in the APPEALS program on catfish production. The significant gap in mean outputs indicates that beneficiaries have seen remarkable improvements in productivity, efficiency, and overall farming practices. These findings affirm the success of the APPEALS program in enhancing the capacity of catfish farmers to produce and supply poultry products.

The program's targeted support has addressed specific challenges faced by catfish farmers, delivering measurable results. Additionally, the study emphasizes the importance of initiatives like APPEALS in promoting sustainable agricultural development and improving livelihoods for catfish farmers. By providing access to resources, knowledge, and expertise, programs like APPEALS contribute significantly to driving economic growth, reducing poverty, and strengthening food security. The positive outcomes of the APPEALS program suggest its potential for replication and scaling to benefit even more farmers and communities.

Table 4.2: Mean output of beneficiaries and non-beneficiaries in kg

CLASS	MEAN	DIFFERENCE
Beneficiaries	25951	16401
Non-Beneficiaries	9550	
Number of respondents	**Non-beneficiaries**	**Beneficiaries**
1	45.7	102.9
2	73.2	187.4
3	21.9	75.2
4	98.5	245.1
5	12.8	130.8
6	65.1	210.9
7	50.3	148.2
8	89.4	182.6
9	7.2	90.5
10	124.9	278.4
11	34.5	119.8
12	59.7	201.7
13	82.1	166.3
14	19.8	81.9
15	46.2	239.2
16	108.3	145.6
17	29.1	192.8
18	61.9	113.4
19	39.6	261.9
20	253.8	977.5
Total	**9550**	**25951**

Source: Computed from field survey, 2024

Comparing of the Output of Both Beneficiary and Non Beneficiary of Catfish Appeals Grant

As shown in table 4 below, the first section, displays the results most relevant independent samples or test. In this study, there are 40 catfish farmers, 20 beneficiaries of APPEALS grants and 20 non-beneficiaries. The mean output of beneficiaries in kg is 46,100.0000 while the mean output of non-beneficiaries of APPEALS grant is 9,550.0000 kg. There are two parts that provide useful information:

(A) Levene's test for equality or variance
(B) t-test for equality or means.

A. Levene's test for equality or variance: This test results for Levene's test from left to right. F is the test statistics of Levene's test. ey is the E-value corresponding to this test statistics. The objective of this analysis is to compare the mean output between 20 beneficiaries and 20 non-beneficiaries of a program using an independent samples t-test.

Group Statistics
Beneficiaries
Mean = 46,100.0000 kg
Standard Deviation = 36,107.87930 kg
Standard Error = 8,073.96726 kg
Non-beneficiaries
Mean = 9,550.0000 kg
Standard Deviation = 6,082.54621 kg
Standard Error = 1,360.09868 kg

The beneficiaries have a much higher mean output (46,100 kg) compared to non-beneficiaries (9,550 kg). The large standard deviation for beneficiaries (36,107.88 kg) suggests considerable variation in their output, while non-beneficiaries show much less variation (6,082.55 kg).
Levene’s Test for Equality of Variances

F = 20.208, Sig. = 0.000:

Levene's test examines whether the variances of the two groups are equal. With a p-value of 0.000 (less than 0.05), we reject the null hypothesis of equal variances. This means that the variances between beneficiaries and non-beneficiaries are significantly different, so we will use the row labeled "Equal variances not assumed" for the t-test results.
Independent Samples T-Test for Equality of Means
Equal variances not assumed
t = 4.464
df = 20.077
Sig. (2-tailed) = 0.000:

The p-value is less than 0.05, meaning the difference in mean outputs between beneficiaries and non-beneficiaries is statistically significant. The results indicate strong evidence that the mean output for beneficiaries is significantly higher than that of non-beneficiaries.

Mean Difference = 36,550.00000 kg:

On average, beneficiaries produce 36,550 kg more than non-beneficiaries.
The t-test results show a significant difference in the mean output between beneficiaries and non-beneficiaries, with beneficiaries producing an average of 36,550 kg more than non-beneficiaries. The high statistical significance (p = 0.000) confirms that the participation in the program has a positive and substantial impact on production output. The confidence interval also provides strong evidence that this effect is real and not due to random variation.

Group Statistics

	Category	N	Mean	Std. Deviation	Std. Error Mean
output	beneficiaries	20	46100.0000	36107.87930	8073.96726
	nonbeneficiaries	20	9550.0000	6082.54621	1360.09868

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
output	Equal variances assumed	20.208	.000	4.464	38	.000	36550.00000	8187.72348	19974.82037	53125.17963
	Equal variances not assumed			4.464	20.077	.000	36550.00000	8187.72348	19474.93130	53625.06870

Determinant of the Factors Affecting Catfish Production of Beneficiaries and Non-Beneficiaries

On the basis of the R^2 and Adj R^2 values, the number of significant variables that are correctly signed, the F statistics value, and the SE, the exponential model was chosen as the lead equation.

The result shows an adjusted R^2 value of .510 (51%). This implies that 51% of the variability in output of catfish among beneficiaries and non-beneficiaries of APPEAL grant is explained by the model. Also, most of the variables were significant and agrees with economic theory.

The result further reveals that income (#) and feeding (kg) were positive and significant at 1% respectively which means that as income increases, output of catfish also increases, as feeding increases, output of catfish also increases. Labor and pond size were positive and significant at 5% indicating that increase in labor and pond size results to increase in output of catfish. Credit/grants increase by 10% resulting to the increase in output of catfish.

Conclusion and Recommendation

The study concluded that the APPEALS program has had a positive effect on catfish production in Calabar Metropolis, with beneficiaries achieving higher average outputs than non-beneficiaries. Key factors such as feeding, interest rate, and electricity were found to significantly influence production. Despite the program's positive contributions, challenges remain, including restrictive government policies and limited access to credit, which impede sustainable growth. Overall, APPEALS has played a role in reducing poverty among catfish farmers, but further efforts are needed to address the ongoing challenges.

Based on the findings of this study, the following recommendations were made;

i. Government should encourage a platform where beneficiaries can share knowledge, practices, and experiences with non-beneficiaries.
ii. The government should strengthen the supply chain for quality fingerlings and cost-effective feed to reduce production costs for

catfish farmers by infrastructure development, financial support, market development.

iii. The government should facilitate farmers' access to microfinance and low-interest loans, specifically tailored for aquaculture investments to increase the scale of production.

iv. In aquaculture, government should provide technologies such as solar power system, automated feeding machines which can significantly enhance yields and reduce labor costs.

v. Partnerships with research institutions and agricultural extension services should be strengthened.

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UTILIZATION OF CLIMATE-SMART AGRICULTURAL PRACTICES AMONG CASSAVA FARMERS IN AKPABUYO LOCAL GOVERNMENT AREA, CROSS RIVER STATE, NIGERIA.

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Abstract

This study was carried out to determine the utilization of climate-smart agricultural practices among cassava farmers in Akpabuyo Local Government Area, Cross River State. Specifically, the study identified the types of climate-smart agricultural practices utilized by cassava farmers, ascertain the extent of utilization of the practices and assessed the constraints to the utilization of the practices. A multi-stage sampling procedure was adopted in selecting a sample size of 178 respondents. Data were collected using questionnaire and analyzed using descriptive statistics. Result of the types of climate-smart practices showed that; crop diversification (92.7%), crop rotation (84.3%), use of improved varieties (78.7%), mulching (73.6%) and timely planting (59.6%) were significant. Results of extent of utilization showed that use of improved cassava varieties ranked 1st and lack of access to credit ranked 1st as a constraints to utilization of climate smart practices. The study therefore recommended that farmers should be supplied with farm inputs at subsidized rate by extension.

Key words: Utilization, climate-smart, agricultural practices, cassava production.

1. Introduction

Agriculture remains the backbone of many developing economies including Nigeria, where a large proportion of the population depends on crops production for their livelihood (Olaniyi *et al.,* 2023). Nnaji *et* *al.* (2023) opined that cassava is crucial for food security of millions of people in Sub-Saharan Africa and has great potential to contribute to African development. In addition, it increases the income earning potential for small-scale farmers and related value chains on the continent. According to Anyanwu *et al.* (2018), cassava is very important, not just as a food crop but as a major source of income to over 800 million people in the world.

Despite the gross importance of cassava crop, its production in Nigeria, particularly in Cross River State is increasingly vulnerable to climate variability and change which poses serious threats to global agriculture thus necessitating the utilization of climate-smart agricultural practices.

Globally, the utilization of climate smart agricultural practices has been identified as a promising strategy to mitigate the impacts of climate change while enhancing agricultural productivity (Mpinda, *et al.* 2025). According to the Food and Agriculture Organization-FAO (2018), climate-smart agricultural practices aim to achieve three main objectives which are; improving productivity and income, enhancing resilience, and reducing greenhouse gas emissions.

A variety of climate smart agricultural practices such as; crop rotation, use of fertilziers, use of improved seeds, agroforestry, rain water harvesting, minimum tillage, and cassava-legume intercropping have been identified to improve productivity, food security and livelihood. FAO, (2020) and Nnaji *et al.,* (2023) added that climate-smart agricultural practices facilitate a transition to agriculture and food systems that are more sustainable, productive and climate friendly. Also, efforts to address climate related stress in agriculture recognize climate-smart agricultural approaches and in cassava production, some of the approaches include, use of improved cassava varieties, use of fertilizer and manure, use of irrigation and drainage etc., and Ali *at al.* (2022) noted that the utilization of climate smart practices such as drought tolerant varieties, minimum tillage, mulching, agroforestry and water harvesting techniques can significantly enhance farmers' adaptive capacity to climate change.

According to Eze *et al.* (2023), climate-smart agricultural practices include the creation of new technologies that facilitates farmers shift to more climate aware practices and provide for the ‘cessation’ or reduction of operations that raise greenhouse gas emissions. It also makes it possible to use skills and knowledge effectively, access and disseminate information about climate change, improve the efficiency of pro-environmental technologies, which may strengthen relationships and help farmers bargain for higher market prices (Okoro *et al.,* 2021).

Several studies have been carried out on cassava production and climate change in Nigeria and sub-Saharan Africa at large. For instance, ogbonna (2014) carried out a study on Analysis of constraints to cassava production among smallholder farmers in South-Eastern Nigeria, also ogwidele *et al* (2022) assessed the factors influencing the adoption of climate-Smart Practices Among Smallholder farmers in Nigeria. In spite of these researches, little has been done on the utilization of climate-smart agricultural practices in Akpabuyo Local Government Area, hence the need to explore the use of climate-smart agricultural practices among cassava farmers in Akpabuyo Local Government Area of Cross River state. Understanding the utilization of climate-smart agricultural practices in Akpabuyo Local Government Area, types and constraints to their utilization is critical for enhancing agricultural productivity, improving livelihoods, and ensuring sustainable development in the region.

It is against the foregoing that this study is designed to determine the utilization of climate-smart agricultural practices among cassava farmers in Akpabuyo local govt Area Cross River State. The objectives of the study were to:

1. Identify the types of climate smart agricultural practices utilized by cassava farmers in Akpabuyo Local Government Area.
2. Ascertain the extent of utilization of climate smart agricultural practices in the study area and
3. Assess the constraint to the utilization of climate smart agricultural practices by cassava farmers in the study area.

Methodology

This study was carried out in Akpabuyo Local Government Area in Cross River State. Akpabuyo Local Government Area lies between latitude 4^{o} 5’ and 5^{o} 4’ and longitude 8^{o} 25’ and 8^{o} 32’ East of the

Greenwich meridian. It has a total land mass of approximately 1, 241, square kilometers and a population of 271,395 (National Population Census data, 2006). There are 12 council wards in the local government area and it is one of the local government area that make up the 18 local government areas in Cross River State.

A multi-stage sampling procedure was used to sample cassava 178 cassava farmers for the study. In the first stage, simple random sampling was adopted in selecting 5 cells out of the 10 cells that make up the area. The selected cells were; Ikot Eneyo, Ikot Edem Uda, Eneyo, Ikang South and Idundun/Anyananse. The second stage involved the simple random selection of 20% of the registered cassava farmers in each of the selected cells giving a sample size of 178.

Types of climate-smart agricultural practices utilized were measured by asking the farmers to indicate Yes (1) or No (0) to the climate-smart agricultural practices presented to them.

The extent of utilization of the climate-smart agricultural practices was measured using a three point likert type scale of often used (3), rarely used (2) and never used (1). A mean value of 2 was achieved by adding 3+2+1 and dividing by 3 giving a mean of 2. Any climate-smart agricultural practice with mean of 2 and above was perceived as highly utilized and any climate-smart agricultural practice with a mean score of less than 2 was perceived to have a low utilization.

Constraints to the utilization of climate-smart agricultural practices was measured using a 3 point likert type scale of very serious constraints (vsc)(3), serious constraints (sc)(2) and not a constraints (nac)(1). Variables with mean score of 2.0 and above were perceived as major constraints, while items with mean scores of less than 2.0 were perceived as minor constraints.

Results and Discussion

Types of climate-smart agricultural practices

The results in Table 1 reveals that t majority (92.7%) of cassava farmers utilized crops diversification, 78.7% utilized improved cassava varieties, 84.3% utilized crops rotation while 59.6% utilized timely planting and proper spacing. The implication of these results is that, cassava farmers paid more attention to their cropping patterns since they had the improved cassava varieties at their disposal. This result is consistent with the study of Omodora *et al.* (2023) who observed that cassava farmers utilized improved cassava varieties, crops diversification, crops rotation etc in cassava production. On the other hand, irrigation and drainage (11.8%), use of organic manure (33.1%), and agroforestry (38.2%) were not adequately utilized possibly due to certain constraints experienced by the farmers.

Table 1: Types of climate-smart agricultural practices utilized in cassava production

Climate-smart agricultural practices	Frequency (n=178)	Percentage
Use of improved cassava varieties	140	78.7
Crop rotation	150	84.3
Intercropping	89	50
Mulching	131	73.6
Crop diversification	165	92.7
Use of organic manure	59	33.1
Fertilizer application	62	34.9
Irrigation/drainage	21	11.8
Agroforestry	68	38.2
Timely planting and proper spacing	106	59.6

Source: Field Survey, 2026

Extent of utilization of climate-smart agricultural practices

Result on Table 2 shows the extent of utilization of climate-smart agricultural practices among cassava farmers in the study area. Results show that crops diversification, crops rotation and the use of improved cassava variety ranked 1st, 2nd and 3rd with mean values of 2.60, 2.48 and 2.46 respectively. Mulching recorded a mean value of 2.29 and ranked 4th. The results show that cassava farmers highly utilized the practices that were crop based because a variety of crops were being cultivated in the study area. This study is similar with the findings of Iheme (2025) which showed that in cassava production, farmers mostly utilized crop rotation, crop diversification, use of improved cassava varieties and mulching.

Results also show that a variety of other climate-smart agricultural practices which included; fertilizer application, irrigation/drainage and a lot others were not adequately utilized in the study area.

Table 2: Extent of utilization of climate-smart agricultural practices

S/N	Climate-smart agricultural practices	Often used (3)	Rarely used (2)	Never used (1)	Total	Mean	Ranking
1.	Use of improved cassava varieties	120 (360)	20 (40)	38 (38)	438	2.46	3rd
2.	Crop rotation	115 (345)	35 (70)	28 (28)	443	2.48	2nd
3.	Intercropping	51 (153)	38 (76)	89 (89)	318	1.78	5th
4.	Mulching	99 (297)	32 (64)	47 (47)	408	2.29	4th
5.	Crop diversification	121 (362)	44 (88)	13 (13)	463	2.60	1st
6.	Use of organic manure	37 (111)	22 (44)	119 (119)	274	1.53	7th
7.	Fertilizer application	21 (63)	41 (82)	116 (116)	261	1.46	9th
8.	Irrigation/drainage	15 (45)	6 (12)	157 (157)	214	1.20	10th
9.	Agroforestry	17 (51)	51 (102)	110 (110)	263	1.47	8th
10.	Timely planting and proper spacing	30 (90)	76 (152)	72 (72)	314	1.76	6th

Source: Field Survey, 2026

Constraints to utilization of climate-smart agricultural practices

Results in Table 3 show the distribution of respondents based on constraints to the utilization of climate-smart agricultural practices.

Results show that among the variables considered, only three were not considered as serious constraints implying that cassava farmers in the study area encountered several set backs in utilizing climate-smart agricultural practices. Lack of access to credit with a mean value of 3.51 ranked 1st, followed by high cost of farm inputs (2.59) which ranked 2nd. Shortage of labour, weak government support and insufficient timely information with mean values of 2.51, 2.43 and 2.42 ranking 3rd, 4th and 5th ,respectively. These results imply that cassava farmers in the study area were confronted with lots of constraints ranging from financial to lack of information. The views of this study is upheld by Autio *et al.,* (2021) who observed that small-holder farmers in south-east Kenya encountered a variety of constraints to the utilization of climate-smart agricultural practices such as lack of resources, lack of capital and a lot others.

Table 3: Constraints to the utilization of climate-smart agricultural practices

Constraints	VSC (3)	SC (2)	NAC (1)	Total	Mean	Rank
High cost of farm inputs	131 (393)	40 (80)	7 (7)	480	2.69	2nd
Lack of access to credit	152 (456)	17 (34)	9 (9)	625	3.51	1st
Poor access to improved varieties	8 (24)	19 (38)	151 (151)	213	1.19	8th
Inadequate extension services	78 (234)	93 (186)	7 (7)	427	2.39	6th
Shortage of labour	97 (291)	76 (152)	5 (5)	448	2.51	3rd
Insufficient timely	82 (246)	89 (178)	7 (7)	431	2.42	5th

information						
Lack of awareness of climate-smart practices	64 (192)	59 (118)	55 (55)	365	2.05	7th
Poor infrastructure	6 (18)	9 (18)	163 (163)	1`99	1.11	9th
Cultural belief	9 (27)	7 (14)	162 (162)	203	1.14	10th
Weak government support	83 (249)	89 (178)	6 (6)	433	2.43	4th

Source: Field Survey, 2026

Conclusion and Recommendations

Cassava production is influenced by climate change and for enhanced production, farmers utilized climate-smart agricultural practices. Cassava farmers in Akpabuyo Local Government Area were constraints by factors like high cost of farm inputs, lack of access to credits, shortage of labour and in their utilization of the practices a variety of other constraints. Based on the findings of the study, the following recommendations were made;

1. There should be awareness of climate-smart agricultural practices by extension through workshops, trainings and other awareness programmes.
2. Small-holder farmers should be supplied with farm inputs such as fertilizers and agro chemical at subsidized rate to enable their purchase and utilization.
3. Low interest loans should be made available to farmers to enable them assess and use for cassava production.

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