

**FARM LEVEL EFFICIENCY OF SMALLHOLDER LOWLAND AND UPLAND
CASSAVA PRODUCTION IN OGBIA LOCAL GOVERNMENT AREA, BAYELSA
STATE, NIGERIA**

BY

Nyaluaziba Samuel ITESI

PG/AGR0400945

**DEPARTMENT OF AGRICULTURAL ECONOMICS AND RESOURCE
MANAGEMENT
FACULTY OF AGRICULTURE
UNIVERSITY OF BENIN
BENIN CITY**

MAY, 2025

**FARM LEVEL EFFICIENCY OF SMALLHOLDER LOWLAND AND UPLAND
CASSAVA PRODUCTION IN OGBIA LOCAL GOVERNMENT AREA, BAYELSA
STATE, NIGERIA**

BY

Nyaluaziba Samuel ITESI

PG/AGR0400945

**A THESIS SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES IN
PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE
DEGREE OF MASTER OF SCIENCE (M.Sc) IN AGRICULTURAL ECONOMICS IN
THE DEPARTMENT OF AGRICULTURAL ECONOMICS AND RESOURCE
MANAGEMENT, FACULTY OF AGRICULTURE, UNIVERSITY OF BENIN, BENIN
CITY, NIGERIA**

MAY, 2025

CERTIFICATION

We certify that this work was carried out by **Nyaluaziba Samuel ITESI (PG/AGR0400945)**, Department of Agricultural Economics and Natural Resource Management, Faculty of Agriculture, University of Benin, Benin City, Nigeria.

.....
Prof. C.O EMOKARO
SUPERVISOR

.....
DATE

.....
Dr. J. EGBODION
Head of Department

.....
DATE

CERTIFICATION OF THESIS/DISSERTIFICATION ON PLAGIARISM

We the undersigned attest and declare that the thesis of **Nyaluaziba Samuel ITESI**

Titled: **FARM LEVEL EFFICIENCY OF SMALLHOLDER LOWLAND AND UPLAND CASSAVA PRODUCTION IN OGBIA LOCAL GOVERNMENT AREA, BAYELSA STATE, NIGERIA**, has successfully passed the anti-plagiarism test and does not violate any copyright regulations.

.....
Prof. C.O EMOKARO
SUPERVISOR

.....
DATE

.....
Dr. J. Egbodion
Head of Department

.....
DATE

UNIVERSITY OF BENIN, BENIN CITY

RELEASE FORM

NAME OF AUTHOR: Nyaluaziba Samuel ITESI

TITLE OF THESIS: FARM LEVEL EFFICIENCY OF SMALLHOLDER
LOWLAND AND UPLAND CASSAVA PRODUCTION
IN OGBIA LOCAL GOVERNMENT AREA,
BAYELSA STATE, NIGERIA

DEGREE FOR WHICH THESIS IS PRESENTED: M.Sc.

YEAR THESIS DEGREE WAS GRANTED:

PERMISSION IS HEREBY GRANTED THE UNIVERSITY OF BENIN LIBRARY
TO REPRODUCE SINGLE COPIES OF THE THESIS AND TO LEND AND SELL
SUCH COPIES FOR SCHOLARLY OR SCIENTIFIC RESEARCH ONLY.

THE AUTHOR RESERVES OTHER PUBLICATION RIGHTS AND NEITHER
THE THESIS NOR EXTENSIVE EXTRACTS FROM IT MAY BE PRINTED OR
OTHER WISE REPRODUCED WITHOUT THE AUTHOR'S WRITTEN
PERMISSION

AUTHOR'S SIGNATURE.....

DATE.....

PERMANENT ADDRESS: NO 4, ACTOR ADDO STREET, OFF EAGLE
FURNITURE ROAD, OFF UWASOTA ROAD, UGBOWO, BENIN CITY

DEDICATION

I dedicate this thesis to my beloved children, Iwinosa and Osawese. May you always follow your dreams with courage and determination

ACKNOWLEDGEMENTS

My gratitude goes to God almighty for grace and wisdom throughout this period of my academic pursuit.

I would like to express my profound gratitude to my supervisor, Prof. C.O Emokaro, for his timely feedback, and dedication throughout this journey. Your accessibility and commitment to guiding me have been invaluable, and I deeply appreciate your insightful supervision

I wish to sincerely appreciate the Head of Department of Agricultural Economics and Resource Management, Dr J. Egbodion and the entire staff, Head of Department of Extension Services and Rural Development, Prof Koyenekan and the entire staff. I am grateful to Dr Osabhuohein, your willingness to address our concerns as the postgraduate coordinator made a significant impact and Dr Ojogho for your constructive criticism on my work.

Special appreciation goes to Prof Okoedo-Okojie and Prof E.R Orhue for your mentorship for the past 15years. I am grateful for all your counsel.

I am deeply grateful to my husband, Mr Henry Osarumwense Agbonavbare , and my children, Iwinosa Azibaola Henry and Osawese Azibaobebh Henry, for your love, support and encouragement throughout this academic journey. Your sacrifices made this achievement possible.

I also want to thank Prof Abiodun E. Adelegan, Mr Emmanuel Otu, Mr Raphael Atim and Dr Oyintonyo Michael-Olomu for your love and encouragements. Finally, thank you to my parents and siblings for your care and concern towards me throughout my studies.

Table of Content

Cover Page.....	ii
Certification.....	iii
Certification of Thesis on plagiarism.....	iv
Release form.....	v
Dedication.....	vi
Acknowledgements.....	vii
Abstract.....	xiii
Table of content	ix
CHAPTER ONE.....	1
1.0 INTRODUCTION.....	1
1.1 Background to the study.....	1
1.2 Problem Statement.....	3
1.3 Objectives of the Study.....	5
1.4 Justification of Study.....	6
CHAPTER TWO.....	7
2.0 LITERATURE REVIEW.....	7
2.0.1 Overview of Cassava Production in Nigeria.....	9
2.1 Conceptual and Theoretical Framework.....	9
2.1.1 Technical Efficiency.....	9
2.1.2 Economic Efficiency.....	11
2.2 Stochastic Frontier Analysis (SFA).....	12
2.3 Translog Production Function.....	13
2.4 Empirical Literature.....	14
CHAPTER THREE.....	28
3.0 METHODOLOGY.....	28
3.1 Area of Study.....	28
3.2 Sampling Procedure.....	30
3.3 Method of Data Collection.....	32

3.4	Data Analysis	32
3.4.1	Profiling of the Socioeconomic Characteristics	33
3.4.2	Estimation of Technical and Cost Efficiency	33
3.4.3	Specification of the Translog Production Function	33
3.4.4	Determinants of Technical Inefficiency	35
3.5.5	Estimation of the Translog Cost Function	36
3.4.6	Constraints Faced by both Uplands and Lowland Cassava Farmers	38
CHAPTER FOUR		38
4.0	RESULT PRESENTATION AND DISCUSSION	38
4.1.	Socioeconomic Characteristics of the Farmers	38
4.1.1	Sex Categorization	40
4.1.2	Marital Status	40
4.1.3	Nature of Farming	41
4.1.4	Farming Experience	41
4.1.5	Age Distribution of Farmers	42
4.1.6	Household Size	42
4.1.7	Variety Planted	43
4.1.8	Farm Size	43
4.1.9	Harvest Duration	43
4.1.10	Years of Schooling	44
4.2.	Estimation of the Production Function of Cassava Farmers	45
4.3.1	Maximum Likelihood Estimates of the Stochastic Frontier Translog Production Function of Lowland and Upland production systems.	45
4.4	Technical Inefficiency Sources in the Stochastic Frontier Production Function	49
4.5	Estimation of the Cost Function of Smallholder Cassava Farmers (Lowland and Upland)	53
4.7	Efficiency Parameters of the Stochastic Frontier Translog Cost Function	57
4.8	Distribution of Cost Efficiency of Lowland and Upland Cassava Farmers	57
4.9	Comparison of Technical and Cost Efficiency of Lowland and Upland Farmers	59
4.10	Production Constraints for Upland and Lowland Smallholder Cassava Farmers	60
4.10.1	Insufficient Funds	60

4.10.2	Insufficient Land.....	61
4.10.2	Absence of mechanized farming tools.....	61
4.10.3	Farm Insecurity.....	62
4.11.4	High Transportation cost.....	62
4.10.5	Farm Theft.....	62
4.10.6	High Labour Cost.....	63
4.10.7	Flooding.....	63
CHAPTER FIVE.....		64
5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS.....		64
5.1	Summary.....	64
5.2	Conclusion.....	65
5.3	Recommendations.....	62
5.4	Contribution to knowledge.....	63
REFERENCES.....		68
APPENDIX.....		76

List of Tables

Table 1.0.	Cassava production, area harvested in Nigeria (2019-2023) Error! Bookmark not defined.	
Table 3.1	Total number of farmers per community and number sampled.....	31
Table 4.1:	Socioeconomic characteristics of upland and lowland.....	39
Table 4.2:	Maximum likelihood estimates of the stochastic frontier translog production function for upland and lowland smallholder cassava farmers.	46
Table 4.5:	maximum likelihood estimates of translog frontier cost function for upland and smallholder cassava farmers.....	54
Table 4.6:	Cost efficiency scores distribution for upland and lowland smallholder farmers.....	57
Table 4.7:	T test for equality of means for technical and cost efficiencies of upland and lowland farmers.....	59

Table 4.8: Production constraints of upland and lowland cassava farmers 60

ABSTRACT

Despite interventions by the government and other institutions to boost cassava production in Bayelsa State, maximum yield for consumption in the State is yet to be achieved. Hence, need to ascertain if the inability of the State to attain cassava sufficiency is linked to farmer-level efficiency. The main objective of the study was farm-level efficiency of smallholder lowland and upland cassava production in Ogbia Local Government Area (LGA) of Bayelsa State. The specific objectives of the study were to; identify the socioeconomic characteristics of smallholder lowland and upland cassava farmers in the study area, estimate the technical and cost efficiencies of lowland and upland smallholder cassava farmers in the study area, compare the technical and cost efficiencies of the lowland and upland cassava farmers, and identify the constraints faced by smallholder cassava farmers in the study area.

A multi-stage sampling procedure was used to select 325 cassava farmers (176upland, 149 lowland) from 12 communities in Ogbia LGA. Cross sectional data were collected for the 2023/2024 cassava farming season using questionnaire. Descriptive statistics were employed to profile the socioeconomic characteristics of the farmers, a translog stochastic production and cost frontier model using maximum likelihood were used to estimate the level of technical and cost efficiency and also identify inefficiency sources in cassava production, T test was used to compare the mean technical and cost efficiencies scores of the upland and lowland smallholder farmers and a four (4) point Likert scale was used to identify the severity of the constraints faced by the farmers.

Findings showed that the mean farming experience (years), age, and farm size were 20.55, 47.58, and 0.34ha for upland farmers and 17.40, 43.58 , and 0.26ha for lowland farmers respectively. Empirical results showed that mean technical efficiency of upland and lowland cassava farmers was 0.83 (83%) and 0.45 (45%) respectively. The mean cost efficiency was 0.97 (97%) for upland farmers and 0.98 (98%) for lowland farmers implying that the farmers are cost efficient. The study also found that there is a significant difference between the mean technical and cost efficiency scores of upland and lowland smallholder farmers. Constraints faced by both upland and lowland farmers include high labour costs, insufficient finance, high transportation cost and inadequate mechanized farming tools. Flooding was identified as a very serious constraint for lowland farmers only. It was therefore concluded that the smallholder upland cassava farmers in the study area technically efficient while the smallholder lowland cassava farmers are not technically efficient. The study recommends amongst others that youths should be encouraged and trained to participate in cassava cultivation. Also, fast-maturing (six-month) varieties should be provided and timely planting after flood should be encouraged especially for lowland farmers. Overall, improving cassava production efficiency, especially in lowland areas can significantly enhance cassava sufficiency in Ogbia LGA and Bayelsa State as a whole.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the study

Cassava is one of the most significant crops grown for staple foods and an essential priority food crop needed in Nigeria for increased food security and the eradication of poverty. It is less expensive to produce and does well in soil that is present in most of the country's ecological zones, cassava is the favored staple crop grown. More than any other important staple crops, the cassava plant can withstand poor soil, bad weather, pests, and diseases (Ajayi & Olumitese, 2017). In 2017, Africa contributed approximately 60% of the world's total two hundred and ninety one million tonnes of cassava production. Nigeria produced 59 million tonnes in 2017, making it the top producer in the world (20% of global production). Additionally, between 1970 and 2017, cassava production expanded at a pace of as much as 10.6% per year, continuing to grow at a high rate. However, expanded harvesting has been a major factor in making this growth possible. While cassava production increased, the harvested area also grew by 10.9% (Ikuemonisan et al., 2020).

According to Food and Agriculture Organisation (FAO, 2018), 88% of Nigeria's farmers are grouped as smallholder with an average farm size of 0.5 hectares. Only 16% of them have access to motorized equipment and 6% benefit from agricultural extension services. 72% of the smallholder farmers live below the poverty line of USD 1.9 a day. Furthermore, only 26% of their agricultural produce is sold on the average.

In the upland regions of Bayelsa state, farming predominates among rural communities. Farmers raise a variety of crops, with cassava and plantain standing out (both are included in subprojects of Fadama III in Bayelsa State). Cassava-growing areas are thus at danger as urbanization spreads into peri-urban farming areas. Though growing for subsistence is very common since huge agro-investors are unable to gain significant tracts of land due to land tenure issues (Ikuemonisan et al., 2020). Similarly, mechanized land preparation services and linkage to agro dealers do not exist in the State. The State has abundance of small scale farms scattered in remote locations on upland and lowland areas. Although the figure of cassava producers in Bayelsa State is low compared to the other Niger Delta States, the crop is cultivated in all the LGA's in the State having a total area of cultivation of about 374.35 hectares with female involvement of about 68.34% (Market Development in the Niger Delta [MADE], 2019). According to MADE (2019), Growing cassava in the Niger Delta region of Nigeria under traditional agriculture (zero or no improved technology) produces a yield per hectare of 10 tonnes on the average and 25-40 tonnes/ha in cases where there is total adoption of improved technologies.

Cassava farming begins with land preparation before the cassava stems are planted followed by tending to the plants till maturity, which takes less than or about a year. Cassava roots are

gathered at harvest time and used to make food such as garri, starch or fufu (a traditional food in Bayelsa State), and *kpokpo garri* (a snack). Inputs for the cassava production include labour (manual), cassava stems, herbicides, and pesticides (Hamadina and Hamadina, 2015).

The concept of efficiency entails the performances and processes involved and used in the conversion or transformation of inputs into output. Farm level efficiency of a farm is measured in relation to the other farms in the sample individually. Detailed information about the farm such as inputs (land, labour, technology, planting materials etc) used in the production process are used in the estimation of the farm level efficiency. Types of efficiency include technical, allocative and economic and can be estimated using data envelopment approach (DEA) and the stochastic frontier approach (SFA). To ascertain the farm level efficiency of cassava production, inputs such as cassava stems, land, labour, pesticides and other production inputs are utilized (Hansson,2008).

1.2 Problem Statement

The majority of Nigeria's smallholder farmers who cultivate for a living furnish the country with its food (Chiaka et al., 2022). With a small area of Nigeria's most fertile land suitable for the production of root and tuber crops like cassava, yam, sweet potato, cocoyam, and many other crops, Bayelsa State is endowed with great potentials for high-productivity and profitable agricultural practices. Additionally, the presence of water bodies makes aquaculture, such as fish farming feasible (Okonkwo et al., 2015). Even though there have been numerous interventions from the government and other institutions to boost cassava production in the upland areas (areas that are not flooded during the raining season) and in the lowland areas (riverbanks, flood prone,

easily waterlogged), maximum output for consumption within the State is yet to be attained. The State's Agricultural Development Program (Wauton et al., 2022), the Fadama III program (Ovharhe, 2019), and the Anchor Borrowers Program are a few of the initiatives (Ajuwa, 2020; Egbo, 2021). The living conditions of smallholder farmers are not better because 75% of the food produced from crops consumed in Bayelsa State is still imported from neighboring States (Wauton et al., 2022). A greater percentage of cassava derivatives produced within the State by smallholder farmers is often times for the farmers 'household consumption and not for commercial purposes.

According to Chepng'etich et al. (2014), farmland and other production resources are scarce, thus it is necessary to boost agricultural productivity by making efficient use of the few resources that are available. This highlights the value of efficiency and how it relates to agriculture. There has not been much empirical research on farm level efficiency of cassava cultivated in the lowland and upland areas of Bayelsa State to the knowledge of the researcher. Hence, there is need to ascertain if the inability (or otherwise) of the State to attain cassava sufficiency is linked to efficiency (technical and cost). It is important because to improve the productivity of smallholder farmers, the current level of technical and cost efficiency has to be known as it will guide farmers and policy makers in decision making. This study aims to investigate the farm level efficiency of cassava production by smallholders on the lowland and upland farming areas of Bayelsa State, using Ogbia LGA of the State as the study area. In light of this, the study looked for responses to the following research questions;

1. what are the socioeconomic characteristics of smallholder lowland and upland cassava farmers in the study area?

2. how technical efficient were the lowland and upland smallholder cassava farmers in the study area?
3. what is the cost efficiency of lowland and upland smallholder cassava farmers in the study area?
4. How do the technical and cost efficiencies of lowland cassava farmers compare to those of upland cassava farmers in the study area?
5. what are the constraints facing both lowland and upland cassava farmers in the study area?

1.3 Objectives of the Study

The main objective of the study was to assess the farm level efficiency of smallholder lowland and upland cassava production in ogbia LGA.

The specific objectives of the study were to;

1. profile the socio-economic characteristics of lowland and upland cassava farmers in the study area.
2. estimate the technical efficiency of lowland and upland smallholder cassava farmers in the study area
3. estimate the cost efficiency of lowland and upland smallholder cassava farmers in the study area.
4. compare the technical and cost efficiencies of lowland and upland cassava farmers in the study area.
5. identify the constraints encountered by both upland and lowland cassava farmers in the study area.

1.4 Justification of Study

Studies into the technical and economical (cost) efficiencies of cassava production have been carried out by several researchers in Nigeria. Some of the findings have shown that cassava farmers were technical and economic inefficient due to several factors. Examples of such studies include Ogundari and Ojo (2006); Awerije and Rahman (2014); Itam et al. (2015); Adedeji et al. (2019) ; Esiobu (2019) and Esheya (2022) which focused on only upland cassava farms. Also, the above studies were neither carried out in this research study area (Ogbia LGA) nor in Bayelsa State.

In spite of continued efforts to improve cassava productivity in Bayelsa State, there is very little information on the efficiency of small holder cassava farmers in Bayelsa State. While there are many empirical works done on efficiency with respect to cassava farming on upland areas in Nigeria, there is scarcity of literature on research done on efficiency of cassava production in lowland areas as well as studies that compared lowland and upland cassava production. The results of this study will fill this knowledge gap in literature and contribute to the efficiency discuss especially with regards to the lowland farmers. The government, non-governmental groups and academic institutions will all greatly benefit from our work. It will help the government and policy makers to make policies that will aid cassava farmers to increase efficiency. The study offers a good beginning point, but it will also set the stage for researchers to do extensive investigations on growing cassava in lowland areas and other parts of Bayelsa State and Nigeria as a whole.

1.5 Scope of Study

This study investigates the farm level efficiency of lowland and upland smallholder cassava production in Ogbia LGA, Bayelsa State. The research covers cross sectional data collected over the 2023/2024 cassava planting season in Ogbia LGA. It examines specifically the socio economic characteristics, the technical and cost efficiencies of smallholder upland and lowland cassava farmers and the constraints faced by the farmers.

CHAPTER TWO

2.0 LITERATURE REVIEW

This chapter presents the conceptual and theoretical framework of the study and the empirical literature review.

2.0.1 Overview of Cassava Production in Nigeria

Nigeria has continued to remain the highest producer of cassava in the world and also with the largest harvested area from 2019 through 2023 (Food and Agriculture Organisation [FAO], 2024) as shown in figure 1 below. Also, in comparison with other crops (rice and maize) grown in Nigeria as shown in Table 1, cassava has the highest production in tonnes. Cassava has a very high demand in Nigeria for domestic consumption (household staple food) and for industrial use (production of ethanol, animal feed etc). According to Hand in Hand [HIH] (2024), investments in cassava value chain add up to 382million USD. Cassava has been attributed to be a crop with

the potential to improve food security and the income level of households in rural communities. This projection is yet to be achieved because of the inefficiencies in the production systems of cassava across the country. Other challenges that have bedeviled cassava potentials include; limited access to agricultural technologies, minimal or absence of mechanization (Omoluabi and Ibitoye,2024).

According to Onubuogu and Esiobu (2019) factors that have an impact on cassava output are education, cooperative membership, extension contact, farming experience, farm size, household size, labour, and fertilizer use. While Inadequate capital, low productivity, low inorganic fertilizer use, high transaction costs, problems with land tenure and cassava farm fragmentation, lack of mechanization along its value chain, inadequate use of yield-increasing and labour-saving technologies in cassava production and processing, limited access to credit for cassava farmers, inconsistent policy, and small-scale cassava farming are some of the identified constraints to cassava production (Otekunrin & Sawicka, 2019).

Figure 1: Cassava production in the world 2018-2023

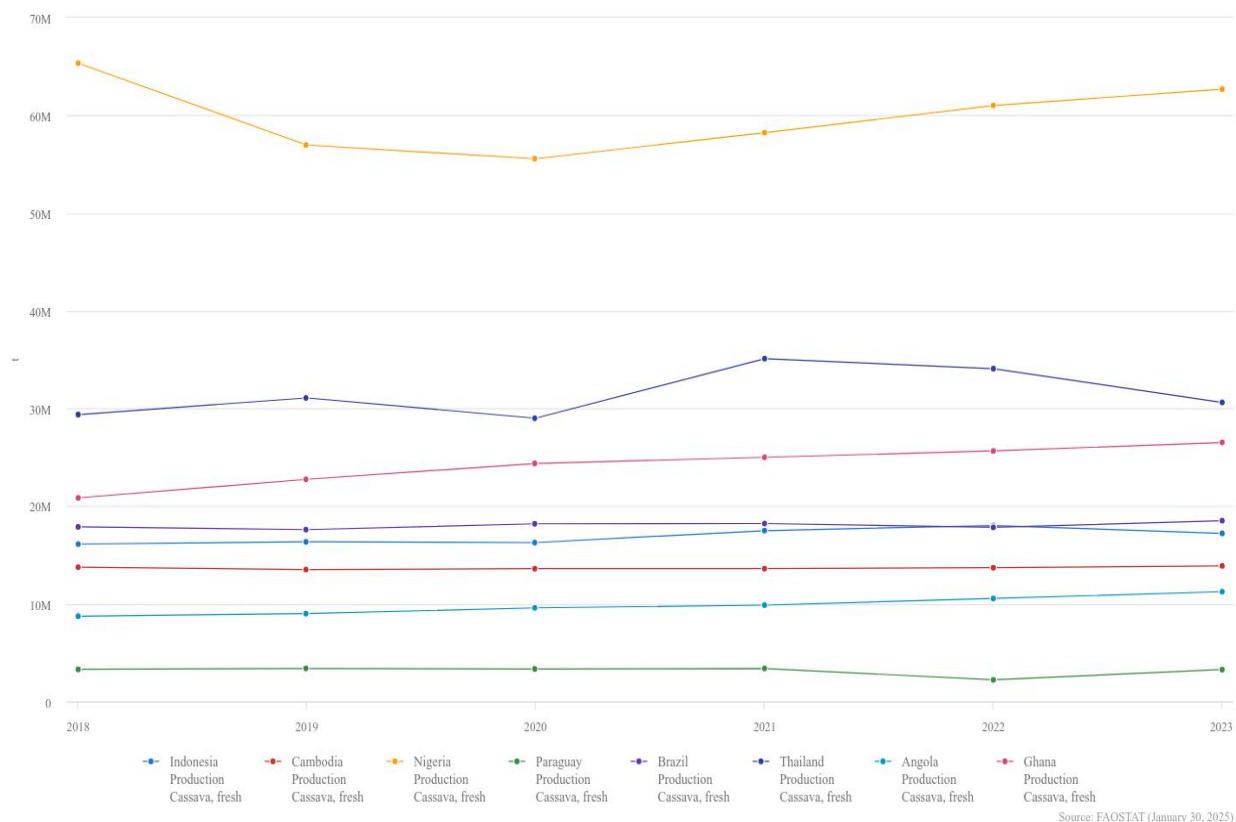


Table 1: Comparison between Cassava production (tonnes) and other crops in Nigeria

Year	Cassava	Rice	Maize
2019	56,969,160	8,433,551	12,598,945
2020	55,565,610	8,171,800	12,403,300
2021	58,237,500	8,342,000	12,744,450
2022	61,015,339	8,502,000	12,948,920
2023	62,690,091	8,902,200	11,053,000

Source: FAOSTAT (2025)

2.1 Conceptual and Theoretical Framework

2.1.1 Technical Efficiency

The ability of a business or firm to produce the highest or maximum output possible with a given a set of inputs and available technology is known as technical efficiency (TE) while technical inefficiency refers to the failure to produce the highest level of output attainable given the resources and technology available (Hansson, 2008).

As shown on Eq. (1) below, the analytical framework for the stochastic production frontier model proposed by Aigner *et al.* (1977) and Meeusen and Van den Broeck (1977 too old) (as used in Erhabor and Emokaro (2007); Idumah et al. (2018); Ogieriakhi and Emokaro (2018)), Y_i is output for the i th farm, X_i is vector of inputs associated with the i th firm, and ϵ_i is the composite error term comprising of v_i (random error term) and u_i (inefficiency parameter) which is a one sided error term.

Hence, Eq. (1) is re expressed as follows

$$Y_i = F(X_i, \beta) + (v_i - u_i) \quad (1)$$

TE will be stated as in Eq. (2) below

$$TE_i = \frac{Y_i}{Y_i^*} \quad (2)$$

Where;

TE_i is the technical efficiency score of the i th firm,

Y_i is the observed output

Y_i^* is the unobserved frontier output which assumes production is technically efficient

$$TE_i = \frac{f(x_i, \beta) + (v - u)}{f(x_i, \beta) + (v)} \quad (3)$$

The most probable influencing factors for TE include farming experience, education, age, cassava production, the number of dependents, availability to credit, access to extension agents, farm size, and distance to farm (Ajayi & Olutumise, 2018). When actual production is typically

lower than the frontier production, the range for TE is 0 to 1. 1 indicates that the farm is technically efficient because actual production is equal to the frontier production (Ahmed & Melesse, 2018). TE refers to the differences between individually achieved outputs and the highest possible output.

2.1.2 Economic Efficiency

Economic or cost efficiency refers to a farm's ability to maximize profit given a level of input and output prices, as well as the level of fixed factors of production in the farm, and it demonstrates the success of a specific farm enterprise. Economic efficiency aims at achieving maximum production per hectare at minimum cost. It is the overall value of the total inputs used in the production of a product. The production process is economically efficient if there is no alternative means of production that utilizes lesser cost (Chetroui and Calin, 2013). According to Farrell (1957) analysis, a farm uses resources in an economically efficient manner when it runs along the economic efficiency frontier. Farms that are economically inefficient, on the other hand, operate below the efficiency frontier.

The stochastic frontier cost function model shown in Eq. (4) is used to estimate cost efficiency (CE). The main variables of cost in the model definition for cost efficiency analysis are cost factors and output. These are the costs or prices for the CE model's inputs. CE take on values between 0 and 1, with an efficient farm represented by a CE value of 1 (Okello et al., 2019).

$$C_{ij} = F(W_i, Y_i, \gamma) \exp \epsilon_i \tag{4}$$

(i=1,2,3.....n farms)

C_{ij} = cost of production of the ith farm for production for the jth crop enterprise

F= functional relationship between cost, prices and output

W= Vector of input prices associated with farm i producing Y_i

Y_i = Output

γ = Vector of parameters associated with the production function

ϵ_i = Composite error term comprising of $(v_i + u_i)$

v_i = is the random error term associated with the i th farm cost of production

u_i = inefficiency for the i th farm associated with the cost of production

Eq.(4) can be restated as

$$C_{ij} = F (W_i, Y_i; \beta) \exp (v_i + u_i) \dots\dots\dots(5)$$

The analytical framework for the Stochastic Cost Function used for the analysis of cost efficiency (CE) will be specified in form of the stochastic translog cost function.

2.2 Stochastic Frontier Analysis (SFA)

Stochastic Frontier Analysis (SFA) serves as both a theoretical and practical framework aimed at aiding in the definition and estimation of production frontiers. The development of SFA was influenced by remote factors, yet it was primarily shaped by the theoretical framework addressing production efficiency that began in the 1950s (Dutra et al., 2009). Farrell (1957) was the pioneer in empirically measuring production efficiency. The roots of SFA can be traced back to two significant papers: Aigner et al. (1977) alongside Meeusen and van den Broeck (1977), followed by the research of Battese and Corra (1977). These three foundational works introduced a structurally composed definition of the error term within the context of production frontier analysis. Since that time, numerous researchers have expanded on SFA. The stochastic production frontier models focus on technical efficiency and acknowledge that random shocks,

which are beyond producers' control, can influence production outcomes. Consequently, these models allow for the distinction between the effects of random shocks (such as labor or capital performance) on output and the variations in technical efficiency.

In this research, the stochastic frontier approach was utilized to assess the technical and cost efficiency of smallholder cassava farmers in both lowland and upland areas. Each cassava farmer had their technical and cost efficiency evaluated by employing the stochastic production function alongside the stochastic cost function (SCF) framed in the transcendental logarithmic (translog) functional forms respectively. The model encompasses linear, quadratic, and interaction terms, providing flexibility in examining the relationships between inputs used and outputs as well as cost of inputs and total cost of production. The interaction terms illustrate how the combination of input costs impacts the overall production cost.

2.3 Translog Production Function

Translog production functions actually constitute a category of flexible functional forms for production functions. A significant benefit of this production function is that, in contrast to the Cobb-Douglas production function, it does not impose strict assumptions such as perfect or “smooth” substitution between production factors or ideal competition in the market for production factors. Furthermore, the translog production function allows for a transition from a linear relationship between output and the relevant production factors to a nonlinear one. Owing to its characteristics, the translog production function can serve for the second-order approximation of linear-homogeneous production, the calculation of elasticity of substitution, the assessment of the production frontier, or the analysis of total factor productivity dynamics

(Rahman et al.,2000). The generalized translog production function, which encompasses a variety of n inputs (factors of production), is expressed as follows:

$$\ln Y = \ln \beta_0 + \sum_{j=1}^n \beta_j \ln X_{ji} + \sum_{j=1}^n \frac{1}{2} \beta \ln X^2 + \sum_{j=1}^n \beta \ln X_j \ln X_{ki} \dots \dots \dots (6)$$

2.4 Empirical Literature

Ogundari and Ojo (2006) using data at the farm level empirically investigated the production efficiency of cassava farms in Nigeria's Osun state. The technical and economic efficiencies at the farm level were predicted using the stochastic frontier production and cost function model,

respectively. The mean technical efficiency, economic efficiency, and allocative efficiency values obtained from the analysis were 0.903, 0.89, and 0.807, respectively, showing that Technical efficiency appears to be more significant than allocative efficiency as a source of gain in economic efficiency.

Anyaeibunam et al. (2010) applied the stochastic frontier translog cost function model to evaluate the level of cost efficiency and its influencing factors in smallholder cassava farming within the South-east Agro-Ecological Zone of Nigeria. A multi-stage random sampling method was employed to select 320 cassava farmers in 2008. The maximum likelihood method was used to estimate the parameters of the stochastic frontier cost function. The analysis revealed that cost efficiency at the individual farm level was approximately 69%. The study identified that age and farm size had a negative and significant correlation with cost efficiency at a level of 1.0%. In contrast, farming experience and membership in cooperative societies exhibited a positive association with cost efficiency.

The resource productivity and efficiency of cassava farmers in Rivers State was studied by Anyanwu and Iyagba (2009) utilized were cross-sectional data collected from 200 cassava farmers chosen at random from ten of the fifteen upland Local Government Areas. The data were analyzed using multiple regressions. The results showed farmers' improper allocation of resource inputs. The study recommends that policies and program.

ms aimed at increasing the amount of land available be implemented. Also, cassava producers should also be given access to credit facilities so they may buy better planting supplies and hire more farm workers.

Ogundari and Brümmer (2011) conducted a study where they calculated an output distance function utilizing stochastic frontier techniques within a framework of multi-output and multi-input production technology. For the analysis, they employed unbalanced panel data from smallholder farms cultivating cassava and various other crops in Southwestern Nigeria, spanning the farming seasons of 2006/07 to 2008/09. The findings indicate that the marginal rate of transformation (MRT) between the “other crops” cultivated by the farmers and the cassava produced, concerning the output mix, is negative and statistically significant. It was also noted that cassava production in the region is characterized by increasing returns-to-scale and technical advancement. Additionally, fertilizer and pesticides were identified to have significant substitution effects on cassava production within the sample. The study uncovered that in pairs, farm size and pesticides, labor and fertilizer, as well as fertilizer and pesticides, demonstrated significant complementary effects on cassava production in the region. The analysis revealed an average technical efficiency level of 72.1 percent, suggesting an inefficiency level of approximately 38 percent.

Akpan et al. (2012) employed Cobb-Douglas stochastic profit function in order to estimate farm-level profit function, economic efficiency, and its determinants among homestead-based cassava farmers in the south-south region of Nigeria. In the study area, 300 cassava farmers who operate out of their homes were chosen using a two-stage random sample approach. The selected models' average economic efficiency, as determined by maximum likelihood estimates, is 61.22%. The study also discovered important influences on farm-level economic or profit efficiency in resource utilization including farmer education, experience, household size, level of agricultural

involvement, extension agent visits, soil management practices used by farmers, and farm size are significant factors affecting farm-level economic or profit efficiency in resource use among homestead based cassava farmers.

Ume et al. (2013) explored the economic efficiency levels and their determinants based on gender. A multi-stage random sampling method was employed to select 120 farmers involved in improved cassava cultivation. The stochastic frontier cost function was utilized for estimation, while descriptive statistics such as percentage responses were applied to analyze the socioeconomic characteristics of farmers, gender participation, and challenges in improved cassava production in Abia State. The findings revealed that the average economic efficiency for female farmers (0.78) was greater than that of male farmers (0.75). Factors such as fertilizer prices, cassava cutting prices, land rent, and output influenced the production costs for both male and female farmer groups. The level of education and access to extension services were positively and significantly related at the 5% level for both genders. Conversely, credit impact was negative but significant at the 5% level among female farmers.

Awerije and Rahman (2014) used Data Envelopment Analysis (DEA) on 315 farmers from three regions of Delta State, Nigeria, to assess the profitability, technical, economic, and allocative efficiencies of cassava cultivation. With large variations among geographies and farm size categories, the results showed that cassava production was lucrative (overall profit margin: 1.93). Technical, economic, and allocative efficiencies are assessed to be low on average at 40%, 29%, and 73%, with big variations among areas and farm size categories. Technical and economic efficiency are greatly reduced by subsistence strain.

The stochastic frontier production function approach was used by Anyanwu et al. (2014) to conduct an empirical investigation of technical efficiency among smallholder cassava farmers in Rivers State, Nigeria. The data generation exercise employed a multistage random sampling technique. In order to conduct interviews using a standardized questionnaire, 94 cassava farmers were randomly chosen from 10 of Rivers State's fifteen upland local government areas. The findings indicated that among cassava farmers in Rivers State, there was a strong positive and elastic association between output of cassava and farm sizes, family labour, cassava stem cuttings, and depreciated values of implements. Estimates of production elasticity revealed that the farmers were enjoying rising returns to scale (1.27). Age, household size, and farming experience are important factors in these farmers' technical inefficiency. The farms' average technical efficiency was 70%.

Itam et al. (2015) in their estimation of the technical efficiency of small-scale cassava producers in Cross Rivers State used the stochastic production frontier. The State's Ikom and Ogoja Agricultural Zones were used to choose 200 cassava producers using a multi-stage random sampling technique. For the study, structured questionnaires were employed to gather data. The technical efficiency of farmers in the study area was estimated using a stochastic production function and the Maximum Likelihood Estimation (MLE) method. The farmers of cassava had an average technical efficiency of 89%. The generalized Likelihood Ratio (LR) tests' findings that the cassava farmers were technically inefficient suggest that there is still space for improvement in technical efficiency given their current resource base and technology available.

Ndubueze-Ogaraku and Ekine (2015) explored the use of the stochastic production frontier function model to predict cassava production in Rivers State, Nigeria. This study was required in order to assess the physical productivity consideration (technical efficiency) in cassava farming in the floodplain. 170 responders were chosen at random. Both farm records and a questionnaire were used to gather data. The analytical methods employed were descriptive statistics and the stochastic production frontier function model. The findings showed that the farmers were primarily female and had an average age of 44. The majority of respondents (49.4%) had a primary school diploma, while 28.8% of farmers owned farms that were less than 0.4 hectares in size. The average family size was 8 people. The technical efficiency result showed that, at the 1% level of significance, the size of the farm and the amount of labour used had a positive influence on the technical efficiency. The estimated gamma parameter of the model was 0.62, which meant that changes in technological efficiency could be responsible for 62% of the overall variation in cassava yield across the producers. The average technical efficiency was 70%. The technical inefficiency of the farms was not significantly influenced by any of the model's factors. To reach the best frontier in cassava production in the study area, it was recommended that farmers can raise the volume of input used, farm size, and quantity of labour.

Ajayi and Olumitese (2017) used the Food Security Index, Data Envelopment Analysis (DEA), and Heckman probit model to explore the factors that affect the technical efficiency and food security of cassava farmers in Ondo State, Nigeria. 120 participants were chosen at random using a multistage sampling technique and primary data. According to DEA data, the average technical efficiency was 0.83, and roughly 80% of the respondents had technical efficiencies above 0.50. The Heckman probit model's findings also indicated that characteristics such as farming experience, education, age, cassava output, the number of dependents, availability to loans,

access to extension agents, farm size, and distance to the farm were the factors that influenced technical efficiency and food security in the study area.

Nwike et al.(2017) examined the economic efficiency, determinants of efficiency, returns to scale and constraints to cassava production in south east, Nigeria. Multistage and random sampling procedure and technique was use to select 240 respondents. Primary data was collected through structured questionnaire. Data was analyzed using descriptive and parametric statistics. Findings showed that mean economic efficiency 0.76 respectively for all farm group. Labour and inputs determined production output while farming experience, education, access to credit, extension workers visit and age of the farmers were significant sources of inefficiency. The most serious constraints to cassava production identified in the area were high cost of labour.

Okebiorun (2018) ascertained the resource use efficiency among cassava farmers in Ilesa West Local Government Area of Osun State, Nigeria, using descriptive statistics and a production functional analysis. The data acquired were analyzed and results indicated that due to the high cost of farm inputs including fertilizers, labour, and herbicides, cassava farmers in the study area are inefficient in their use of resources. Hence, the studied recommended that farmers should use more fertilizer, labour, and herbicides while using fewer cassava cuttings in the research region to boost the efficiency of their cassava output.

Adedeji et al. (2019) examined the technical efficiency of small-scale cassava farmers in Ondo North ADP, Ondo State, Nigeria. The primary data obtained through a structured questionnaire were analyzed using descriptive statistics and the stochastic frontier approach. According to the maximum likelihood estimates, the size of the farm , the type of planting material and the

amount of fertilizer applied were the key production parameters that were directly associated to the output of cassava. While household size and age decreased technical efficiency, with a mean technical efficiency of 0.822 (82.2%), farming experience, educational attainment, and association participation enhanced it. As the return to scale was 2.38, the estimations showed that the farmer had not completely exploited the variable resources, indicating that some degrees of inefficiency among the cassava farmers in the study area still existed.

Isitor et al (2017) noted that despite numerous cassava initiatives and policies aimed at enhancing the efficiency and productivity of farmers over the years, a significant number of farmers have yet to achieve the desired level of technical efficiency in cassava production due to inadequate access to essential farm inputs such as fertilizers and herbicides. This research aimed to examine the factors influencing the technical efficiency of smallholder cassava farmers in Anambra State, Nigeria. Data was gathered from 120 cassava farmers through a multi-stage sampling method during the 2013/2014 planting season. Descriptive statistics alongside a stochastic frontier function that included inefficiency effects using the Maximum Likelihood Estimation (MLE) approach were utilized for analysis. Findings indicated that the average age of farmers was 47.60 years, with a majority (63.3%) being male and married (63.9%). Approximately half of the respondents had completed primary education, while around 43.0% possessed more than 19 years of experience in cassava farming. The average size of the farms was 0.9 hectares, and the average household consisted of 7 individuals. The Maximum Likelihood Estimates from the production function revealed that the farmers' technical efficiencies were generally low, with an average of 51.5%, indicating that average cassava output was short by 48.5% of the highest attainable level. The study further found that only education (0.210) and access to credit (0.202) were significant factors impacting the technical inefficiencies

of cassava farms in the region. The research concludes that the technical efficiency of smallholder cassava farmers in the area is low, influenced by their educational levels and access to credit. Consequently, the study suggests that farmer training and enhanced access to credit should be prioritized.

Onubuogu and Esiobu (2019) assessed the allocative efficiency of cassava plantations in Imo state, Nigeria. The technique of multistage random sampling was employed to choose the respondents. A total of ninety (90) cassava farms made up the sample. Structured questionnaire was employed to collect the data. The cost function and stochastic frontier production model were used to examine the data. According to the estimated gamma parameter of the stochastic frontier production function, the study area's cassava farmers' 82.7% output variance was caused by varying levels of relative efficiency. 0.86 was the average allocative efficiency. The policy implication of these findings is that, given their scale of operation and the scarce resources in the research area, cassava farms were effective resource managers. It was advised that farmers, especially those who operate on their own, should wisely pool productive resources through a strong and stable cooperative society group as this would improve their respective cassava production efficiencies in the area.

Dogba et al. (2020) utilized an output-oriented approach to evaluate the economic efficiency of cassava farmers in Nimba County, Liberia. A multi-stage sampling method was used to collect a sample for analysis. Data concerning on-farm characteristics, socioeconomic conditions, and institutional factors were gathered from 216 cassava farmers. Stochastic frontier models, employing Translog functional forms for both production and revenue, were applied to assess the

level of revenue efficiency and its influencing factors. The findings revealed that a majority of the cassava farmers are male (60%). Many of these farmers are married, engaged, or cohabiting with a partner (83%), with an average household size of nine individuals. Land is mainly acquired through inheritance (95%), with an average farm size of 1.34 hectares, and a large portion of cassava farmers did not have access to agricultural credits (76%) or extension services (91%). The empirical data indicated that the revenue efficiency of cassava farmers ranged from 0.1% to 73.5%, with a mean revenue efficiency of 12.9%. This suggests that, on average, there exists a significant potential of 87.1% for enhancing the economic efficiency of cassava farmers in Nimba by improving both technical and allocative efficiencies. Among the key factors affecting revenue efficiency, age and group membership exhibited negative impacts, whereas farming experience, access to extension services, formal education, and average wage rates positively influenced revenue efficiency.

Akinola et al. (2020) evaluated the production efficiency and its influencing factors in cassava cultivation within Ogun State. A multistage sampling method was employed to select 174 farmers engaged in cassava-based farming for a cross-sectional analysis. The data were processed using descriptive statistics, Stochastic Production Frontier (SPF), and Stochastic Cost Function (SCF) models. The findings indicated that 79.3% of the cassava farmers were male, 89.1% were married, and 35.6% had only completed primary education. Additionally, the average age, farming experience, and the size of farms and households among the farmers were found to be 50 years, 22.9 years, 3 hectares, and 6 members, respectively. The average technical, allocative, and economic efficiencies recorded for the farmers were 0.8054, 0.8414, and 0.6835, respectively. Moreover, factors such as farm size, the quantity of fertilizer used, cassava stem

cuttings, and the amount of insecticide applied were found to significantly affect cassava production outputs.

Ogunniyi et al. (2020) examined the Maximum Likelihood Estimate (MLE) of efficiency in agricultural production, particularly focusing on the crop subsector, to assess the efficiency levels of households in their farming practices. The study aimed to quantify the technical efficiency (TE) of cassava farming, identify the factors affecting technical efficiency, and recognize the production challenges faced by cassava farmers in Nigeria. Utilizing cross-sectional data collected from cassava farming households in Nigeria, the research applied Stochastic Frontier Analysis (SFA) within the Cobb-Douglas production framework, along with Tobit regression and the Benefit-cost ratio, to fulfill the study's objectives. The estimated technical efficiency identified in this analysis was approximately 65.1 percent. The variance parameter of the model (γ) was estimated at 0.92, suggesting that around 92 percent of the variability in cassava output can be attributed to farmers' practices involving all assessed variables. Findings revealed significant inefficiency in the way productive resources are allocated among cassava growers in Oyo state, with many of these resources being excessively used, indicating sub-optimal resource utilization. The research highlighted that several key factors, including years of production, land size cultivated, household size, cassava variety planted, total stem cuttings used for planting, and the amount of agrochemicals applied per hectare, significantly affect technical efficiency levels. The assessment of allocative efficiency revealed that a majority of the resources were not optimally utilized. Additionally, high input costs (such as labor) were identified as major constraints for cassava farming in the studied region.

Morgan et al. (2021) studied the "economics of cassava production in Ogbia LGA of Bayelsa State, Nigeria". The study's goals included describing the socioeconomic traits of cassava farmers, analyzing cassava production costs and returns, determining technical efficiency, identifying factors that affect cassava farmers' technical efficiency, and identifying obstacles to cassava production in the study area. From ten settlements in Ogbia, a sample of ninety-four cassava farmers was selected, and structured questionnaires were used to gather information from the farmers. The data were analyzed using descriptive statistics, the translog stochastic frontier production model (SFPM), and a budgetary model. An examination of the stochastic frontier production function was used to determine the distribution of the farmers' technical efficiency indices. The outcome showed that on average, farmers sampled in the research area had lower technical efficiency than the maximum border output. The range of technological efficiency revealed that the most efficient farmer was producing at an efficiency level of 18% (0.18), leaving great potential for improvement, while the least efficient farmer was only producing at the maximum frontier production of 1.0, which was 1.05. Since the average technical efficiency was 72%, cassava farmers' output could still be enhanced by 28% to attain the highest possible level of technical efficiency. According to the farmers' frequency distribution of level efficiency, 18.09% of them were working at a level of efficiency between 0 and 0.2, 18.09% were operating at a level between 0.21 and 0.40, and 20.21% were operating at a level between 0.41 and 0.60.

Ume et al. (2020) exained the technical efficiency of pro-vitamin A cassava farmers in South East Nigeria using a normalized trans-log production frontier function model. A total of one hundred and twenty farmers were selected through purposive and multistage random sampling

methods. Data for the study were collected using a structured questionnaire and oral interviews. The study employed mean and normalized translog stochastic frontier production function models to achieve its objectives. The findings indicate that among the production factors analyzed, only farm size, labor, and planting materials were found to be positive and significant. Additionally, education level, farm size, and farming experience emerged as determinants of the farmers' technical inefficiency. There is a pressing need to improve farmers' access to education, extension services, and larger farm sizes. The second-order coefficients of labor inputs squared and the interaction of labor and depreciation squared were significant at the 1.0% and 5.0% alpha levels, respectively. This suggests that a 1.0% and 5.0% increase in labor inputs squared and the interaction of labor and depreciation squared would result in an increase in technical efficiency of approximately 0.820% and 2.124%, respectively. Moreover, farm size squared, fertilizer squared, and the interaction between fertilizer and depreciation squared showed a direct relationship with technical inefficiency, being significant at various probability levels. The analysis of factors affecting technical inefficiency indicated that the coefficient of farmers' age had a negative correlation with their technical inefficiency and was significant at the 5.0% probability level. Furthermore, the coefficient reflecting the level of education of the household head was positively related to technical inefficiency and was significant at the 1.0% alpha level. This suggests that farmers who have pursued more years of education tend to exhibit greater technical inefficiency compared to those with less education. This pattern may stem from the observation that in many developing nations, the more educated farmers often prefer 'white collar' jobs over farming as a career.

Okorie et al. (2021) examined the profitability of smallholder cassava farmers in Nigeria's Enugu State. In order to choose the 240 cassava farm households that are registered in the Enugu State

Fadama III project for the 2019 growing season, the study used a multi-stage random sampling technique. An interview schedule and a standardized questionnaire were used to collect the data. Using descriptive statistics and a stochastic frontier profit function model, the data acquired were examined. The findings indicated that men made up the majority of household heads (73.3%), with a mean age of 52. The majority (78.5%) had one spouse, and the average farm size was 0.3125 ha. Nine years were spent in formal education, and the largest source of capital (83.1%) came from individual savings. Further analysis revealed that profit efficiency ranged from 34.19% to 99.98%, with a mean efficiency of 73%, indicating that around 27% of the profit loss was attributable to a confluence of technical and allocative inefficiencies.

Ologbon et al. (2021) conducted an analysis of the economic returns and technical efficiency within cassava-based agricultural systems in specific communities along the Yewa axis of Ogun State. They collected data from 120 cassava farmers using a two-stage sampling method. The analysis employed descriptive statistics, budgetary techniques, and the stochastic frontier model. The average level of technical efficiency for cassava production systems was found to be 79 percent, indicating a 21% gap to achieve optimal production potential. It was suggested that policy initiatives aimed at improving cassava farmers' access to more arable land, enhancing educational opportunities (through adult literacy programs), and incorporating labor-saving technologies would significantly contribute to the advancement of cassava production systems in the region. These measures would also aid in increasing the farmers' profitability and efficiency in cassava cultivation.

Esheya (2022) examined the allocative efficiency of TMS cassava cultivation in Ebonyi State, Nigeria. The allocative efficiency analysis revealed that none of the respondents used resources

with absolute efficiency, either by underutilizing or over utilizing farm resources. Fertilizer, farm size, and capital were overused resources, whereas labour and cassava stem cuttings were underused. This demonstrated that none of the production inputs were allocated or used in the best possible way. The cassava farmers' returns to scale, which was 1.324, showed that they were producing at stage one of the production function

CHAPTER THREE

3.0 METHODOLOGY

3.1 Area of Study

The study was conducted in Ogbia LGA which is located in Bayelsa State, Nigeria. Bayelsa State consist of eight (8) local government areas, it falls within the geographical location of Latitudes 4° 20'N and 5° 20'N and Longitudes 5° 20'E and 6° 40'E (Berezi et al., 2019).

Geographically, Bayelsa State is situated near the southernmost point of Nigeria in the delta of the River Niger. The vegetation of the State consist of four ecological zones namely freshwater swamp, mangroove rainforests, coastal barriers and inland forests. With a brief dry season in between, rainfall is intense and occurs from March to November. With the exception of a few elevated areas, the majority of the State's southern regions are below sea level, while its northern edges are above sea level and home to both food and cash crops. The topography of the State is flat, with the presence of sandy, loamy, and clay soils which are medium and fine grained textured (Berezi and Nwankwoala, 2023). Bayelsa State covers a total land area of 10,773km² with an estimated population of over 2,704,515 million people (Bayelsa State government [BSG] n.d).

Ogbia Local Government Area (LGA) consists of forty-nine (49) independent communities. The LGA is made up of more than three-quarters water, with the only land spanning from Epebu to Amakalakala to the southeast. The southern portion is spanned by a network of creeks that flows through the villages of Akassa and Brass and into the Atlantic Ocean. The area has mangroves on the lower delta while on the northern part has thick forests with arable lands. Rain fall is heavy throughout the area. The dry season lasts from November to March interrupted occasionally by sporadic down pours and the area is connected with other towns and villages in the State by a network of roads (Awelewa, 2017). The LGA has a land area of 1698km² with an estimated total population of 549,774 people in 2024 (Wikipedia, n.d)

Ogbia LGA is located at Latitudes 4⁰ 33'N and 4⁰ 45'N and Longitudes 6⁰ 15'E and 6⁰ 29'E. The region features a predominantly low-lying landscape, with elevations that vary from below sea

level in the southwestern part to approximately 20 meters above sea level further inland. This area falls within the geomorphic units of salt and freshwater swamps in the Niger Delta sedimentary basin. It is traversed by several tributaries and creeks that connect to the River Nun, including the Orashi River and Kolo Creek (Oyinkuro & Rowland, 2017; Obiorie & Nwankwoala, 2012). In terms of farming, crops that are commonly grown include cassava, cocoyam, sugarcane, plantain and vegetables. Others include rice, rubber and oilpalm. The Bayelsa State Raison palm plantation occupying many hectares of land is located at Elebele community and a substation of the Nigerian Institute for Oil Palm Research (NIFOR) for Rapphia mandate crop (although not maintained by the federal government) at Onuebum community. It is worthy to note that Nigeria's first commercial oil well is located in Ogbia LGA.

3.2 Sampling Procedure

A multistage sampling procedure was utilized in the selection of respondents for this study as shown below;

Stage one: Three clans namely Kolo, Anyama and Oloibiri were purposively selected from the four clans (Kolo, Anyama Oloibiri and Abureni) that make up the indigenous administrative units of Ogbia L.G.A. This is due to the difficulty in accessing the communities that make up the Abureni clan in terms of transportation network.

Stage two: This involved the purposive selection of four communities from each of the three clans selected in stage one. This is based on the availability of upland used for cassava cultivation and lowland by virtue of the presence of rivers, streams, creeks and flood prone wetlands. Ayakoro, Otuogori, Onuebum, and Otuokpoti were selected for the Anyama clan;

Otuaba, Otuabulla II, Ewoi and Otuoke were selected for the Oloibiri clan; and Emeyal II, Kolo II, Elebele, and Imiringi communities were selected for the Kolo clan.

Stage three: The sampling frame for the study was obtained from the list provided by the Bayelsa State ADP. According to the State ADP, there are a total of 238 and 317 registered lowland and upland cassava farmers respectively in Ogbia LGA. The formula developed by Yamane (1967) was used to calculate the sample size for study as shown below. The total number of farmers registered in each of the selected communities was used to calculate the number of respondents for each of the communities.

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

Where: n is the sample size

N is population size

e is the desired level of precision (5%).

Stage four: The farmers were identified in the selected communities using snowballing technique.

The total number of registered farmers per community and the number of respondents used for the study is shown on Table 3.1 below.

Table 3.1: Total number of farmers per community and number sampled

Community	Total Lowland	Total Upland	Sample lowland	Sample upland
Otuoke	12	17	11	16
Otuaba	12	16	11	15
Ewoi	14	16	13	15
Otuabula II	15	14	14	13
Otuogori	12	17	11	16
Ayakoro	15	13	14	12

Onuebum	14	15	13	14
Otuokpoti	13	18	12	17
Kolo II	13	15	12	14
Emeyal II	12	14	11	13
Imiringi	15	15	14	14
Elebele	14	18	13	17
Total	161	188	149	176

Source: Authors computation

3.3 Method of Data Collection

Primary data were collected through the use of semi-structured questionnaire administered to the lowland and upland smallholder cassava farmers. While secondary data were gotten from publications in journals, books, websites among others. The questionnaire was designed to elicit questions on socioeconomic factors (age, education, farming experience, household size, marital status, gender etc), input-output data such as quantity of inputs used in production and their corresponding cost. Other information included is nature of farming, duration of harvest amongst others. Cross sectional data from the 2023/2024 cassava planting season were collected from a total of three hundred and twenty- five (325) farmers. From the retrieved questionnaire, a total of 143 and 132 for the upland and lowland farmers respectively with complete information were utilized for the econometric analysis in R programe. Response rate for upland farmers was 81.2% while that of lowland farmers was 88.5%

3.4 Data Analysis

This section entails the analytical techniques and specified models used for the analysis of the objectives of the study. The tools include descriptive statistics and stochastic frontier translog and cost functions.

3.4.1 Profiling of the Socioeconomic Characteristics

The socio-economic characteristics of smallholder lowland and upland cassava farmers was profiled using descriptive statistics such as frequency distribution, percentages, mean, maximum and minimum.

3.4.2 Estimation of Technical and Cost Efficiency

The stochastic frontier translog function was specified to estimate the technical efficiency levels of cassava farmers of lowland and upland farming systems. Meanwhile, the stochastic translog cost frontier model was used to estimate cost efficiency of cassava production among smallholder farmers in both upland and lowland areas within the study area.

3.4.3 Specification of the Translog Production Function

The translog production frontier function used to estimate technical efficiency as used by Islam et al. (2023) is specified below:

$$\ln Y = \ln \beta_0 + \sum_{j=1}^4 \beta_j \ln X_{ji} + \sum_{j=1}^4 \frac{1}{2} \beta_{jj} \ln^2 X_{ji} + \sum_{j=1}^6 \beta_{jk} \ln X_{ji} \ln X_{ki} \dots \dots \dots (7)$$

$$\ln Y_i = \ln \beta_0 + \beta_j \ln X_{ji} + 1/2 \beta_{jj} \ln^2 X_{ji} + \beta_{jk} \ln X_{ji} \ln X_{ki} + (V_i - U_i) \dots \dots \dots (8)$$

Where;

subscript i refers to the ith cassava farmers in the sample

X_{ji} = amount of inputs j used by the cassava farmers

Y = Output variable

ln = natural logarithm

Vi and Ui are the error terms

The estimated model could be explicitly written as follows

$$\ln Y_i = \beta_0 + \beta_1 \ln X_{1i} + \beta_2 \ln X_{2i} + \beta_3 \ln X_{3i} + \beta_4 \ln X_{4i} + 1/2\beta_5(\ln X_{1i})^2 + 1/2\beta_6(\ln X_{2i})^2 + 1/2\beta_7(\ln X_{3i})^2 + 1/2\beta_8(\ln X_{4i})^2 + \beta_9 \ln X_{1i} \ln X_{2i} + \beta_{10} \ln X_{1i} \ln X_{3i} + \beta_{11} \ln X_{1i} \ln X_{4i} + \beta_{12} \ln X_{2i} \ln X_{3i} + \beta_{13} \ln X_{2i} \ln X_{4i} + \beta_{14} \ln X_{3i} \ln X_{4i} + V_i - U_i \dots\dots\dots (9)$$

Where;

lnYi : Natural logarithm of the observed quantity of cassava output (in tonnes).

lnX1: Natural logarithm of farm size cultivated (in hectares).

lnX2i : Natural logarithm of the quantity of cassava stem cuttings (in meters).

lnX3i : Natural logarithm of the quantity of labour used (in man-days).

lnX4i : Natural logarithm of the volume of herbicides used (in liters).

Vi : Two-sided stochastic error term, assumed to be independently and identically normally distributed

Ui : One-sided stochastic error term, assumed to capture inefficiency and follow a half-normal distribution

B0 = intercept term

$\beta_1 - \beta_4$: Coefficients of the linear terms (first-order effects of each input)

$\beta_5 - \beta_8$: Coefficients of the quadratic terms (second-order effects, capturing non-linearities).

$\beta_9 - \beta_{14}$: Coefficients of the interaction terms between the inputs.

3.4.4 Determinants of Technical Inefficiency

Earlier studies on efficiency adopted a two-stage approach for estimation. The estimation of the effects of exogenous variables on technical efficiency levels can either be done through a two-step or one step approach. For the two-step approach, a standard stochastic frontier model is estimated in the first step followed by the estimation of relationship between estimated inefficiency (U) and exogenous (Z) variables. However, the two-step approach has been attributed to produce biased results because it understates the effect of the Z variables on efficiency levels (Kumbhakar & Lovell, 2000; Wang & Schmidt, 2002). Battese and Coelli (1995) adopted a one stage approach in which explanatory variables are incorporated directly into the inefficiency error component. This approach is believed to be more reliable.

Hence, in order to know the possible sources of technical inefficiency, in this study, the technical inefficiency model was estimated using the one stage approach as used by Ajibefun et al. (2003), Drogba et al. (2020), Igbafua et al. (2022) and Islam et al. (2023)

$$Y_{it} = \exp (X_{it} \beta + V_{it} - U_{it}) \dots\dots\dots (10)$$

Technical inefficiency effect in the stochastic frontier model could be specified as follow

$$U_{it} = Z_{it} \alpha + W_{it} \dots\dots\dots (11)$$

$$TE_{it} = \exp (-U_{it}) \dots\dots\dots (12)$$

$$TE_{it} = \exp (Z_{it} \alpha + W_{it}) \dots\dots\dots (13)$$

Stochastic translog production function estimated as follow;

$$\ln Y_i = \ln \beta_0 + \beta_j \ln X_{ji} + 1/2 \beta_{ij} \ln X_{ji}^2 + \beta_{jk} \ln X_{ji} \ln X_{ki} + (V_i - U_i) \dots \dots \dots (14)$$

where technical efficiency effects assumed to be defined by

$$U_i = \alpha_0 + \alpha_1 Z_1 + \alpha_2 Z_2 + \alpha_3 Z_3 + \alpha_4 Z_4 + W_i \dots \dots \dots (15)$$

Where;

α = unknown parameters to be estimated

W_i = truncation of the normal distribution with zero mean

Z_1 = Age

Z_2 = Education

Z_3 = Experience

Z_4 = Household size

The gamma coefficient γ is given by $\alpha_v^2 / \alpha_v^2 + \alpha_u^2$. It is bounded between zero and one. It measures the deviation of the output from the frontier due to inefficiency. If $\gamma = 0$, then all deviations from the frontier are due to noise.

3.5.5 Estimation of the Translog Cost Function

The analytical framework for the stochastic cost function used for the analysis of CE was specified in the form of the stochastic translog cost function is explicitly written as follows;

$$\begin{aligned} \ln C_i = & \beta_0 + \beta_1 \ln Q_{1i} + \beta_2 \ln P_{1i} + \beta_3 \ln P_{2i} + \beta_4 \ln P_{3i} + \beta_5 \ln P_{4i} + 1/2 \beta_6 (\ln Q_{1i})^2 + 1/2 \beta_7 (\ln P_{1i})^2 + \\ & 1/2 \beta_8 (\ln P_{2i})^2 + 1/2 \beta_9 (\ln P_{3i})^2 + 1/2 \beta_{10} (\ln P_{4i})^2 + \beta_{11} \ln Q_{1i} \ln P_{1i} + \beta_{12} \ln Q_{1i} \ln P_{2i} + \beta_{13} \ln Q_{1i} \ln P_{3i} + \\ & \beta_{14} \ln Q_{1i} \ln P_{4i} + \beta_{15} \ln P_{1i} \ln P_{2i} + \beta_{16} \ln P_{1i} \ln P_{3i} + \beta_{17} \ln P_{1i} \ln P_{4i} + \beta_{18} \ln P_{2i} \ln P_{3i} + \beta_{19} \ln P_{2i} \ln P_{4i} + \\ & \beta_{20} \ln P_{3i} \ln P_{4i} + W_i + V_i \dots \dots \dots (17) \end{aligned}$$

Where;

$\ln C_i$: Natural logarithm of the total cost of cassava production for the i-th farm (in Naira).

$\ln Q_{1i}$:= Cassava output produced (tonnes).

$\ln P_{1i}$ = Natural logarithm of the price (land rent) of the farm size cultivated (in Naira).

$\ln P_{2i}$: Natural logarithm of the price of labour (in Naira).

$\ln P_{3i}$: Natural logarithm of the price of cassava stems used (in Naira).

$\ln P_{4i}$: Natural logarithm of the price of herbicides used (in Naira).

W_i : One-sided cost inefficiency term, assumed to be half-normally distributed, representing inefficiency effects.

V_i : Two-sided stochastic error term, assumed to be normally distributed ($V_i \sim$ capturing random shocks and measurement errors).

β_0 : Intercept term.

$\beta_1 - \beta_5$: Coefficients of the linear terms, representing the elasticity of total cost with respect to each input price.

$\beta_6 - \beta_{10}$: Coefficients of the quadratic terms, capturing the non-linear effects of input prices on total cost.

$\beta_{11} - \beta_{20}$: Coefficients of the interaction terms, capturing the interactions between different input prices.

Note: labour cost in this research comprises of hired and family labour. The market value for family labour was imputed and used for the research.

3.4.6 Constraints Faced by both Uplands and Lowland Cassava Farmers

Constraints faced by both lowland and upland cassava farmers were identified and ranked using a 4 four-point Likert-type Scale. Where 4 indicates very serious, 3 indicates serious, 2 indicates moderately serious, and 1 not serious. A mean of 2.5 was used to identify the severity of the constraints. Thus a mean score of 2.5 and above was used to rank a constraint as very serious while mean score less than 2.5 was ranked not serious.

CHAPTER FOUR

4.0 RESULT PRESENTATION AND DISCUSSION

Chapter four presents the findings and discussion of the study.

4.1. Socioeconomic Characteristics of the Farmers

Table 4.1 provides findings of the socioeconomic characteristics of lowland and upland smallholder cassava farmers in the study area. The result provides insights into the demographic and farming-related differences between the two groups.

Table 4.1: Socioeconomic characteristics of upland and lowland smallholder farmers

Variable		Frequency (upland) N=143	Percent upland	Frequency (lowland) N=132	Percent lowland
Gender category	Male	59	41.26	44	33.33
	Female	84	58.74	88	66.67
Marital status	Married	85	59.44	69	52.27
	Single	19	13.29	24	18.18
	Separated	15	10.49	16	12.12
	Divorced	14	09.79	11	8.33
	Widow/widower	10	6.99	12	9.09
Farming nature	Full time	87	60.84	68	51.51
	Part time	56	39.16	64	48.48
Farming experience (years)	1-10	38	26.57	43	32.58
	11-20	42	29.37	50	37.88
	21-30	41	28.67	26	19.70
	31-40	20	13.99	12	9.09
	41-50	2	1.40	1	0.76
	Mean		20.55		17.40
Age (years)	18-28	8	5.59	15	11.36
	29 -39	26	18.18	33	25.00
	40-50	60	41.96	50	37.88
	51-61	34	23.78	27	20.45
	62-72	15	10.49	7	5.30
	Mean		47.58		43.58

	Household size (persons)	0-5	83	58.04	92	69.70
		6-11	60	41.96	40	30.30
		Mean	5		5	
	Variety planted	Local	0	0	0	0
		Improved	143	100	132	100
Source: Field summary yearly data 2024	Farm size(ha)	0.01-0.11	0	0	10	7.57
		0.12-0.20	21	14.68	38	28.78
		0.21-0.40	79	55.24	69	52.27
		0.41-0.67	43	30.06	15	11.36
		Mean	0.34		0.26	
	Harvest duration (months)	< 6 months	0	0	12	5.30
		6 months	15	10.48	96	21.96
		7-9 months	32	22.37	17	72.72
		10 months > 1 year	96	67.13	0.00	0.00
	Years of schooling	1-5	23	16.08	16	12.12
		6-10	70	48.95	67	50.76
		11- 15	20	13.99	20	15.15
		16-20	23	16.09	18	13.64
		21-25	7	4.89	11	8.33
		Mean	10		11	
4.1.1	Labour source	Family	50	34.97	40	30.30
		Hired	23	16.08	18	13.64
		Family/hired	70	48.95	74	56.06
Ge	Fertilizer usage	Yes	0	0	0	0
		No	143	100	132	100

Gender Category

Female farmers constituted a larger proportion (58.58%) than male farmers (41.26%), indicating higher female involvement in upland cassava farming. Similarly, for lowland cassava farming, majority were females (66.67%), compared to 33.33% male farmers. The findings corroborates with MADE (2019) which found that female involvement in cassava cultivation in Bayelsa State is 68.34% implying that women grow cassava than men in the State.

4.1.2 Marital Status

The majority of the upland farmers were married (59.44%), followed by smaller proportions who were single (13.99%), separated (10.49%), divorced (9.79%), and widowed (6.99%) whereas the

largest group for the lowland farmers were married (52.27%), with smaller proportions who were single (18.18%), separated (12.12%), divorced (8.33%), and widowed (9.09%). The result showed that percentage of married individuals engage in cassava farming in both upland and lowland areas is higher. This result corroborates with the findings of Morgan et al.(2021) that majority of the cassava farmers in Ogbia LGA were married.

4.1.3 Nature of Farming

Results presented in Table 4.1 shows that 60.84% of upland cassava farmers engaged in full-time farming while 39.16% farmed on a part-time basis, while a smaller proportion (51.51%) of lowland farmers engaged in full-time farming compared to 48.48% engaged in part-time farming. Upland farmers are more likely to farm full-time than their lowland counterparts, possibly due to the risk involved in lowland farming. As shown from the result, the percentage of part-time cassava farmers is quite high in comparison with the upland farmers. This is because many farmers in the study area engage in other activities such as public and private employment as well private businesses.

4.1.4 Farming Experience

Upland farmers' mean farming experience was 20.55 years, with most of the farmers having between 11–20 years of experience (29.37%) and 21–30 years (28.67%) respectively. Lowland cassava farmers recorded a mean farming experience slightly lower than that recorded for upland farmers at 17.40 years. Most farmers (37.38%) had 11–20 years of farming experience, followed by those within the 6–10 years bracket (32.58%) as shown in Table 4.1. Results corroborates

with Jato et al. (2020) and Isitor et al. (2017) that cassava farmers in their study have an average of 16 and 19 years farming experience respectively.

4.1.5 Age Distribution of Farmers

The mean age for upland farmers is 47.5 years, with the majority (41.96%) within the 40–50 age group. 15.59% were aged 18–28years, while 10.49% were 62–72 years old. For the lowland farmers, the mean age was lower than that of the upland farmers at 43.5 years. 37.88% of the lowland farmers were in the 40–50 age groups, 25% in the 29-39 age group range , 11.36 % were aged 18–28, while only 5.30% were 62–72 years old. Cassava farming is predominantly undertaken by middle-aged individuals in both upland and lowland areas, with low participation from younger farmers. This trend echoes a generational gap in agriculture as younger individuals increasingly seek non-agricultural opportunities. This result is similar to the findings of Ndubuez-Ogaraku et al. (2015), Isitor et al. (2017) and Akinola et al. (2020), who reported that average age of cassava farmers in their studies in Rivers, Ogun and Anambra States were 44, 47.6 and 50 years respectively.

4.1.6 Household Size

58.04% of upland cassava farmers as shown in Table 4.1 had a household size of 0–5 members, while 41.96% had 6–11 members. Also, (69.70%) of lowland farmers had a household size of 0–5 members and 30.30% reported 6–11 members. Household size has been found to influence labour availability on the farm, with larger households potentially providing more family labour. The findings aligns with the study of Akinola et al. (2020), who reported that average household size of cassava farmers was six persons and Morgan et al. (2021).

4.1.7 Variety Planted

Both upland and lowland farmers planted improved cassava varieties (100%) as shown in Table 4.1 above. This uniformity indicates high adoption rates of improved cassava varieties by the smallholder farmers in the study area. This findings is in line with Kainga et al.(2018) who found that cassava is the one of crops in which improved varieties were mostly adopted by farmers in the Fadama III project in Bayelsa State.

4.1.8 Farm Size

As shown in Table 4.1, the average farm size for upland farmers was 0.34 hectare, with 55.24% operating farm sizes of (0.21–0.40 hectare) and 30.06% having farm sizes of (0.41–0.67 hectare). The smallest of the farm sizes (0.12–0.20 hectare) were less common (14.68%). For the lowland farmers, the mean farm size for lowland farmers was 0.26 hectare. Most of the farmers (52.27%) had a farm size within 0.21–0.40-hectare range, while 28.78% had smaller farms (0.12–0.20 hectare). Only 11.36% farms of (0.41–0.67 hectare). Upland farmers generally had larger average farm sizes compared to their lowland counterparts, which may be due to the relative availability of arable upland compared to lowland areas prone to flooding. The result corroborates with the findings of Morgan et al. (2021) that smallholder cassava farmers in Ogbia LGA have farm sizes that are less than 0.5 ha of land and also similar to the findings of FAO (2018) that average farm size of smallholder farmers in Nigeria is 0.5ha.

4.1.9 Harvest Duration

Most (67.13%) of the upland farmers harvested their cassava roots when its 10 months to more than a year while 22.38% harvested theirs within 7–9 months, and 10.48% within six months. No farmer harvested in less than 6 months for the upland farmers as shown in Table 4.2. For the lowland farmers, (72.73%) harvested their crops within 7 -9 months, 21.96% harvested within six months while 5.30%, harvested in less than six months. Lowland farmers were found to harvest earlier than the upland farmers, most probably as a mitigation measure against risks associated with flooding.

4.1.10 Years of Schooling

Upland farmers (13.99%) had 11–15 years of schooling (formal education), while 48.95% had 6–10 years. In comparison, 50.76% of lowland farmers had 6–10 years of education, 15.15% had 11-20 years, and 12.12% had 1-5years. Notably, 8.33% had 20-25 years of schooling. Education is critical for adopting modern agricultural practices and understanding improved farming techniques. This result is similar to that of Morgan et al.(2021) which found that majority of smallholder farmers in Ogbia LGA acquired formal education up to the secondary school. The results of this study also shows that majority of the farmers in both production systems had about 6-10 years of schooling which indicates that they had acquired some level of secondary school education.

4.1.11 Source of Labour

The study found that the sources of labour of the upland and lowland smallholder cassava farmers in the study area comprise of family labour, hired labour and a combination of family and hired labour. For the upland farmers, 48.95% utilized both family and hired labour, 34.97% utilized

family labour only while 16.08% utilized hired labour only. For the lowland farmers, 56.06% used a combination of family and hired labour, 30.30% utilized family labour only while 13.64% used hired labour only. Results corroborates with Morgan et al. (2021) whose study found that most of the smallholder cassava farmers in Ogbia LGA utilized a combination of hired and family labour on their farms.

4.1.12 Fertilizer Usage

The study found out that 100% of the lowland and upland smallholder cassava farmers do not apply fertilizer on their farms. Some of the farmers claimed that the soil is fertile hence no need for fertilizers to be applied especially the lowland farmers. The lowland farmers who farm by river banks claimed that the debris brought by the floods makes the soil very fertility.

4.2. Estimation of the Production Function of Cassava Farmers

The estimation of the stochastic frontier translog production function (SFTPF) was based on the Maximum Likelihood Estimator (MLE). The results are presented in section 4.3.1. Four production resources were used for the estimation of the model. They include land (farm size cultivated), quantity of labour, and length of cassava stem cuttings and volume of herbicide applied.

4.3.1 Maximum Likelihood Estimates of the Stochastic Frontier Translog Production Function of Lowland and Upland production systems.

Table 4.2 below provides the maximum likelihood estimates of a stochastic frontier translog production function for smallholder farmers growing cassava on upland and lowland areas. The

model assesses the relationship between production inputs (land, labour, cassava stems, herbicide) and output, considering inefficiency effects influenced by socioeconomic factors (age, education, experience, and household size). The analysis highlights critical insights into input contributions, interaction effects, and inefficiency determinants for both cassava farming systems.

Table 4.2: Maximum likelihood estimates of the stochastic frontier translog production function for upland and lowland smallholder cassava farmers.

	Upland			Lowland		
	Coeff	S.E	Prob	Coeff	SE	Prob
Intercept	120.9	69.05	0.07	10.72	4.40	0.01*
Land(farm size)	34.1	16.32	0.03*	5.26	4.23	0.21
Labour	-35.7	12.18	0.003**	-3.03	3.00	0.31
Cassava stems	-7.20	14.19	0.61	-2.74	1.68	0.10
Herbicide	-11.6	6.79	0.08	18.14	7.34	0.01*
½ land ²	4.61	2.15	0.03*	1.11	1.18	0.34
½ labour ²	0.01	0.93	0.98	-0.88	0.74	0.23
½ herbicide ²	-0.47	0.79	0.54	-0.37	0.57	0.51
½ cassava stems ²	-1.85	1.86	0.31	-0.18	0.35	0.61
Land x labour	-3.96	1.42	0.005**	0.13	0.21	0.52
Land x cassava stem	-1.62	1.42	0.25	-0.83	0.71	0.24
Land x herb	-1.27	0.89	0.15	2.28	1.07	0.03*
Labour x cassava stem	4.43	143	0.001**	1.20	0.70	0.08
Labour x herb	-0.35	0.58	0.54	-1.64	0.59	0.006**
Cassava stem x herb	1.71	0.84	0.04*	-1.30	0.43	0.002**
Z intercept	-2.45	5.88	0.67	1.01	0.13	2.6e-13***
Z age	0.02	0.05	0.64	-0.006	0.001	3.1e-06***
Z education	-0.02	0.06	0.67	-0.019	0.005	0.0004***
Z experience	0.005	0.02	0.80	0.002	0.003	0.45
Z household	0.04	0.12	0.71	0.05	0.013	4.2e-5***
Sigmasq	0.32	0.49	0.51	0.13	0.028	1.47e-06***
Gamma	0.80	0.30	0.008*	0.99	0.009	2.2e-16***
Mean TE	0.83			0.45		

Source: R (2024)

significant codes: ‘***’ 0.001(0.1%) ‘**’ 0.01(1%) ‘*’ 0.05 (5%) ‘.’ 0.1 (10 %)

inputs are in natural logarithm, SE = standard error, prob = probability value

As shown in table 4.2 above, for the linear terms in upland farming, land is positive and significant at 5% probability level. This means that an increase in farm land size leads to an increase in cassava output while for the lowland farming, land is not significant. Labour has negative and significant for upland farming. This means that an increase in labour input leads to a decrease in cassava output. The negative coefficient and significance of labour indicates diminishing returns to labour. This implies that excessive labour use without mechanization or efficient tools may reduce productivity especially as land is fixed. For lowland farming, labour input is not significant to influence output. Herbicide use in upland farming is negative and significant at 10% probability level. The negative relationship suggests that an increase in herbicide will decrease output. This implies that when excessive herbicides are used, it may damage some of the crops if not properly applied in right amount. While for lowland farming, herbicide is positive and significant at 5% probability level. This means that an increase in herbicide use in lowland farms' increases cassava output. This highlights the role herbicide use in controlling weed to increase output if used in the right proportion and applied properly.

The result for the squared terms is as follow; for upland farms, the squared term for land is positive and statistically significant at the 5% probability level. This term indicates a positive quadratic effect of land on output. The positive coefficient suggests that the relationship between land and cassava output increases at an increasing rate as more land is used. In other words, at higher levels of land input, there might be increasing returns to scale, meaning each additional unit of land adds more to production than the previous one. For lowland farming, was not statistically significant in influencing output. This non significance of the land squared term for

lowland could be because of the land terrain such that even if land is doubled, output will not increase. Squared terms for labour, herbicide, and cassava stems were not significant.

For the interaction terms, result shows that for upland farming, the interaction between land and labour is negative and significant. This means that the land jointly used with labour has a negative impact on output. This negative interaction implies that if land is fixed and more labour is used on the same piece of land, output will diminish. The output produced will no longer increase because the yield has attained maximum level from that piece of land. For lowland farming, there is no significant interaction between land and labour.

For lowland farming, the interaction between land and herbicide was significant and negative. This implies that an increase in the joint use of land and herbicide increases output. It shows that when herbicide is used in the right proportion on land, weeds are removed preventing competition with the cassava plants thereby increasing output. While for upland farming, the interaction terms of land and herbicide is not significant in influencing output.

Also, for upland farming, interaction term of labour and cassava stem was positive and significant. This implies that an increase in the joint use of labour and cassava stems increases output. This could be because, the joint use high skilled labour and high yielding cassava stems variety will lead to increase in cassava output. For lowland farming, interaction term of labour and cassava stems was not significant.

Furthermore, for lowland farming, labour and herbicide have a significant negative interaction suggesting diminishing returns when labour and herbicides are used together. This means that an

increase in the joint use of labour and herbicide will reduce output. While for upland the interaction of labour and herbicide was not significant to influence output.

Finally, the interaction term of cassava stems and herbicide for upland farming was positive and significant implying that an increase in their joint use increases output. While for lowland farming, the interaction term of cassava stems and herbicide was negative and significant. This implies that increase in their joint use is likely to reduce output. This may be because lowland farms are often weeded more than upland farms. Hence in order to reduce the cost of labour for manual weeding, farmers resort to using herbicides to control weeds of which if not careful and properly done may result to damage of some of the cassava stems thereby reducing output.

4.4 Technical Inefficiency Sources in the Stochastic Frontier Production Function

Results of technical inefficiency sources in upland and lowland cassava production in the study area to identify the sources of inefficiency is presented in Table 4.3. The results of the diagnostics as shown in Table 4.3 for the sources of the inefficiencies in the stochastic frontier production function indicates that there were technical inefficiency effects in cassava production for both lowland and upland areas. This is shown by the significant value of the gamma coefficient of 0.80. This implies that 80% of the variation in output of cassava production for the upland farmers is attributed to inefficiencies while 20% is due to random effects (noise). Similarly, the gamma coefficient for lowland farming is 0.99 and significant. This also infers that 99% of the variation of cassava output for lowland farmers is due to inefficiency while 1% is due to random effects.

For the upland farmers, age, education, experience and household size did not significantly affect inefficiency while for lowland farming, Age, education and household size significantly affected inefficiency, highlighting their critical role in lowland farming.

Age has a negative coefficient but was significant for lowland farmers. This implies that an increase in age led to a decrease in technical inefficiency. This could be attributed to the fact that older farmers are likely to have more experience in farming hence more technically efficient. The average age for the lowland farmers was 43.5 years which is still an active age for farmers. This finding is in agreement with Anyanwu et al. (2014) and Ajayi and Olutmise (2017) but in contrast with Adedeji et al. (2017).

Education also had a negative coefficient and significant (1% prob). This means that an increase in years of schooling led to a reduction in inefficiency and an increase in technical efficiency. This confirms apriori expectation that the more a farmer is educated, the more the ability to be technically efficient with regards to adoption of new technologies and application of knowledge and skills to farming. This finding is in line with the findings of Ajayi and Olutmise (2017) and Adedeji et al. (2019) that education increases technical efficiency.

Finally, household size was also significant with a positive coefficient implying that an increase in household size led to an increase in technical inefficiency. This does not confirm with apriori expectation as household size ought to increase technical efficiency. However, the result obtained could be as a result of using unskilled household members to work as well as delays in completion of the farm production activities when using household members in some cases. This

finding is in agreement with Adedeji et al. (2019) that household size decreases technical efficiency.

4.2.1 Distribution of Technical Efficiency of Lowland and Upland Cassava Farmers

Table 4.4: Distribution of Cassava Farmers by Technical Efficiency scores

Efficiency level	Technical efficiency (upland)		Technical efficiency (lowland)	
	Frequency	Percentage	Frequency	Percentage (%)
0.10-0.20	0	0.00	1	0.77
0.21-0.30	0	0.00	22	16.92
0.31-0.40	0	0.00	36	27.69
0.41-0.50	2	1.40	33	25.38
0.51-0.60	4	2.80	14	10.77
0.61-0.70	6	4.20	14	10.77
0.71-0.80	21	14.69	5	3.85
0.81-0.90	76	53.15	2	1.54
0.91-0.99	34	23.78	3	2.31
Total	143	100	132	100
Mean TE		0.83		0.45

Minimum TE	0.48	0.12
Maximum TE	0.95	0.99

Source: Author's compilation ,2024

Results of the analysis of the distribution of technical efficiency scores of the cassava farmers under lowland and upland production systems is presented in Table 4.4 and figure 3 above. The scores were distributed into class intervals to form frequency distributions of the efficiency levels. Minimum, mean and maximum efficiency scores are also displayed. The efficiency scores range from 0.10 to 0.99, with higher scores indicating greater efficiency. The table highlights significant differences in technical efficiency between upland and lowland farmers.

The technical efficiency of upland farmers is highly concentrated in the upper range: 53.15% of upland farmers achieved efficiency scores between 0.81–0.90, and 23.78% fell in the 0.91–0.99 range. A small fraction (14.69%) had scores in the 0.71–0.80 range. Lower efficiency categories (<0.70) were minimally represented, with just 2.80% of farmers scoring 0.51–0.60, 4.20% scoring 0.61–0.70, and only 1.40% scoring 0.41–0.50. The mean technical efficiency for upland farmers was 0.83, with a minimum score of 0.48 and a maximum of 0.95. These results suggest that upland cassava farmers were highly efficient in their use of inputs. The high efficiency may reflect the suitability of upland conditions for cassava farming. The mean technical efficiency score of 0.83 (83%) for upland farmers, implies that there is 17% inefficiency. The upland farmers' mean technical efficiency score is in agreement with the findings of Ajayi and Olumitse (2017), Adediji et al. (2019) and Akinola et al. (2020) whose studies found mean technical efficiency score for cassava farmers to be 0.83, 0.82 and 0.80 respectively. Other studies such as Ndubueze-Ogaraku and Ekine (2013), Ogundari and Brummer (2011), Ume et al. (2013),

Ogunniyi et al. (2020), Morgan et al. (2021), Ologbon et al. (2021) reported mean technical efficiency of cassava farmers as 0.90, 0.78, 0.70, 0.65, 0.72, and 0.79 respectively.

Lowland cassava farmers exhibited a broader and less efficient distribution of technical efficiency scores: Only 1.54% of lowland farmers fell in the highest efficiency category (0.81–0.90), and 2.31% scored in the 0.91–0.99 range. The majority of lowland farmers (27.69%) had scores between 0.31–0.40, followed by 25.38% scoring 0.41–0.50 and 16.92% scoring 0.21–0.30. A small proportion (0.77%) of lowland farmers scored in the lowest category (0.10–0.20). The mean technical efficiency for lowland farmers was 0.45, with a minimum score of 0.12 and a maximum of 0.99. This implies that the least technically efficient lowland farm produced 12% of what was expected; with a production gap of 88%. The mean technical efficiency of lowland farmers of 0.45 (45%) implies that farmers could reduce their input use by 55% while maintaining the same level of output if they were to produce cassava consistent with the best farmers. Also, the most technically efficient lowland farm has a technical efficiency score of 0.99 indicating a 1% room for improvement. The relatively low efficiency scores for lowland farmers may be attributed to environmental constraints such as flooding, poor drainage, or waterlogging, which limit the efficiency of input utilization. Additionally, access to resources such as labour and improved farming techniques might be more constrained for lowland farmers.

4.5 Estimation of the Cost Function of Smallholder Cassava Farmers (Lowland and Upland)

The maximum likelihood estimates of the stochastic frontier cost function of lowland and upland production systems based on the translog functional form is presented in Table 4.5. The linear terms represent the direct relationship between the input costs and total cost of production. Squared terms in the translog stochastic cost frontier model represent the squared values of the

explanatory variables. They were included to capture nonlinear relationships between input costs and total production costs.

Table 4.5: maximum likelihood estimates of translog frontier cost function for upland and smallholder cassava farmers.

	Coeff	Upland S.E	P value	Coeff	Lowland S.E	P value
Intercept	0.11	0.154	<2.2e-16***	0.117	0.016	<2.2e-16***
Output	0.008	0.176	0.96	0.019	0.022	0.40
Land rent	0.173	0.085	0.04*	0.078	0.027	0.00 **
Price of labour	0.62	0.224	0.00**	0.60	0.036	<2.2e-16 ***
Price of cassava stems	-0.23	0.159	0.88	0.21	0.037	1.08e-16***
Price of herbicide	0.135	0.105	0.19	0.08	0.033	0.01 *
½ output ²	0.012	0.102	0.89	0.12	0.052	0.02 *
½ land rent ²	0.083	0.051	0.10	0.08	0.057	0.12
½ price of labour ²	0.42	0.217	0.04 *	0.28	0.061	3.3e-06
½ price of cassava stems ²	0.13	0.366	0.72	0.154	0.048	0.00 **
½ price of herbicide ²	0.18	0.227	0.63	0.104	0.063	0.10
Output*land rent	-0.057	0.051	0.26	0.016	0.042	0.68
Output*price of labour	-0.011	0.124	0.92	0.010	0.057	0.85
Output* price of cassava stems	0.16	0.091	0.06 .	-0.073	0.046	0.11
Output*price of herbicide	-0.02	0.070	0.42	0.035	0.049	0.47
Land rent*price of labour	-0.024	0.098	0.80	-0.006	0.060	0.90
Land rent*price of cassava stem	-0.068	0.061	0.26	-0.048	0.049	0.32
Land rent*price of herbicide	0.015	0.044	0.25	-0.051	0.054	0.33
labour price*price of cassava stems	-0.28	0.130	0.02 *	-0.15	0.067	0.02 *
Labour price * herbicide price	0.025	0.216	0.90	-0.042	0.071	0.71
Cassava stem price * herbicide price	-0.157	0.326	0.63	-0.042	0.052	0.42
Sigmasq	0.157	0.00006	<2.2e-16***	0.139	0.00019	<2.2e-16***
Gamma	0.99	0.00037	<2.2e-16***	0.99	0.002	<2.2e-16***
Mean CE	0.97			0.98		

Source: R (2024)

Signif. codes: ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1

A detailed interpretation of the results provided in Table 4.6 is provided below. The maximum

likelihood estimates of the translog frontier cost function in table 4.6 shows that for the linear terms, land rent was positive and significant (5% prob level) for both upland and lowland farmers. This implies that an increase in land rent leads to higher total cost of production. Labour cost was also found to be positive and significant for the lowland and upland farming systems. It implies that an increase in labour cost will increase total production costs. The cost of cassava stems and the cost of herbicides were also found to positive and significant for lowland farming. This implies that increase in the prices of these inputs will lead to an increase in the total production costs. For upland farming cost of cassava stems and herbicides were not significant to influence total production costs.

For the squared terms, the squared term of output for lowland farming is significant at 5% probability level and positive. This implies that as output doubles, the total cost of production increases. While for upland farming, the squared term for output is not significant.

The squared effect of labour on total production cost is for is positive and significant for upland farming . The positive coefficient suggests that as labour input increases, the marginal cost of labour begins to rise. This reflects diminishing marginal returns to labour—as more labour is used, the cost increases at an accelerating rate. For instance, this could occur due to inefficiencies over-reliance on manual labour without complementary inputs (e.g., tools or machines). Also, the scarcity of labour in some rural communities could contribute to this as most people who render hired labour services are focused on working on their personal farms. However, for lowland farming, the squared effect for labour cost is not significant.

The squared term for cassava stems cost is positive and is highly significant for lowland farmers. The positive coefficient implies a nonlinear effect, specifically diminishing marginal returns to cassava stem costs. As the expenditure on cassava stems increases, the total production costs rise at an increasing rate. This could reflect inefficiencies, such as overspending on cassava stems which could be due to cassava stems scarcity or the desire to purchase other cassava varieties from other farmers.

As for the interaction terms, labour cost and cost of cassava stems had a significant negative interaction term for both upland and lowland farming, suggesting complementarity between labour cost and cost of cassava stems. The interaction shows the combined effect of labour and cassava stems costs reduces the total production costs. This could reflect better resource utilization or efficiency when labour and cassava stems are used in tandem. The result implies that for example, paying for a high skilled labour force and purchasing high yielding cassava stems variety at a higher cost used together might reduce the total production costs as wastage or excessive use of cassava stems is eliminated while achieving higher productivity (optimizing input use). The other interaction terms for both upland and lowland as shown on table 4.5 were statistically insignificant, as indicated by their high p-values. This implies no meaningful interaction and their combined use did not significantly influence total production costs. The non-significance of these terms implies that the combination of these specific input pairs did not influence total costs. This absence of interaction may reflect independent cost structures, where the impact of one input cost does not depend on the level of the other.

4.7 Efficiency Parameters of the Stochastic Frontier Translog Cost Function

Sigma squared for upland and lowland farming are highly significant as shown in table 4.5. This indicates that the stochastic noise plays a role in production cost variability. Gamma values of 0.99 for both upland and lowland farming which is close to 1 implies that most of the variation in production costs is due to inefficiency rather than random noise. The high mean cost efficiency score of 0.97 and 0.98 suggests that, on average, both upland and lowland farmers operated near their cost frontier, indicating high levels of cost efficiency.

4.8 Distribution of Cost Efficiency of Lowland and Upland Cassava Farmers

The distribution of cost efficiency scores of lowland and upland smallholder cassava farmers is presented on table 4.6.

Table 4.6: Cost efficiency scores distribution for upland and lowland smallholder farmers

Efficiency level	Cost efficiency (upland)	Cost efficiency (lowland)
0.83-0.99	143	132
Total	100	100
Mean CE	0.97	0.98
Minimum CE	0.83	0.91
Maximum CE	0.99	0.99

Source; Author compilation, 2024

The cost efficiency (Table 4.6) in cassava production in the study area for upland farmers ranged between 0.83 and 0.99 for minimum and maximum score respectively. The mean cost efficiency of upland farmers was 0.97 which implies that farmers can reduce their costs by about 3% while maintaining the same level of output. Based on the results, the most cost-efficient farm realized 99% of the expected maximum output while minimizing its total cost of production. It implies

that the most cost-efficient farm can still increase her production by 1% while minimizing its total cost of production. On the other hand, the least cost-efficient farm achieved 83% of the expected maximum cassava output while minimizing its total cost of production. In other words, the least cost -efficient farm can still increase her production by 17% at minimum cost.

The cost efficiency as shown in Table 4.6 for cassava production in the study area for lowland farmers ranged between 0.91 and 0.99 for minimum and maximum score respectively. Mean cost efficiency score is 0.98 for lowland farmers. It implies that farmers can reduce their costs by 2% while maintaining same level of output. Based on the results, the most cost-efficient farm realized 99% of the expected maximum output while minimizing its total cost of production. It means the most cost-efficient farm can increase production by 1% while minimizing its total cost of production. On the other hand, the least cost-efficient farm achieved 97% of the expected maximum cassava output while minimizing its total cost of production. In other words, the least cost-efficient farm can still increase her production by 3% at minimum cost. The cost efficiency result in this study is in contrast with the findings of Awerije and Rahman (2014) and Anyaegbunam et al. (2010) in which mean cost efficiency of cassava farmers in their studies was found to be 0.29 and 0.69 respectively. This wide variation in the cost efficiencies could be attributed to the method of estimation used in the above studies compared to what was used in this study. Also, the farm sizes and inputs used in production could also be a reason. This is because this study focused only on smallholder cassava farmers and inputs such as fertilizer were not used in the production. The mean farm size for upland farms is 0.34 hectares while mean farm size for the lowland farms used in this study is 0.26 hectares. Smallholder holder farmers with small sizes of farms are likely to be prudent to ensure they produce at minimum cost since

finance is a very serious constraint. Also, the non-use of inputs such as fertilizer is also likely to reduce production cost significantly hence making the farmers cost efficient.

4.9 Comparison of Technical and Cost Efficiency of Lowland and Upland Farmers

The efficiency scores for both lowland and upland smallholder cassava farmers were compared employing a student T test to ascertain for the equality of the means for both systems as shown on table 4.7 below. The technical efficiency of upland and lowland smallholder farmers were found to be 0.83 and 0.45 respectively. The T statistic of -21.72 and p value of 1.57e-60 which is extremely close to zero and less than the significant level of 0.05 implies that there is a statistically significance difference between the mean technical efficiency scores of upland and lowland farmers. Also, the T statistic of 3.10 and p value of 0.0021 which is less than the significant level of 0.05 implies that there is a statistically significance difference between the mean cost efficiency scores of upland and lowland farmers.

Table 4.7: T test for equality of means for technical and cost efficiencies of upland and lowland farmers

	Status	Mean	T	P-value
Technical efficiency	Upland	0.83	-21.72	1.57e-60
	Lowland	0.45		
Cost efficiency	Upland	0.97	3.10	0.0021
	Lowland	0.98		

Source : Authors computation , 2024

4.10 Production Constraints for Upland and Lowland Smallholder Cassava Farmers

The study identified production constraints faced by upland and lowland smallholder cassava farmers in the study area, using data generated from a four-point Likert-type scale as shown on table 4.8. The scale ranges from "very serious" (4) to "not serious " (1). The mean score of 2.5 and above was ranked very serious while less than 2.5 was ranked not serious for various constraints highlight the severity of challenges in the two farming systems. Below is a detailed explanation and presentation of the results presented in Table 4.8.

Table 4.8: Production constraints of upland and lowland cassava farmers

Constraint	Upland		Lowland		Decision
	(Mean)	SD	Mean	SD	
Insufficient funds	3.93	0.30	3.93	0.30	Very serious
Insufficient land	3.54	0.64	3.55	0.79	Very serious
Absence of mechanized farming tools	3.07	1.05	3.54	0.67	Very serious
Farm insecurity	1.00	0.00	1.00	0.00	Not serious
High transportation cost	3.30	0.89	3.42	0.88	Very serious
Farm theft	1.39	0.77	1.00	0.00	Not serious
High labour cost	4.00	0.00	4.00	0.00	Very serious
Flooding	-		4.00	0.00	Very serious

Field survey, 2024; SD (Standard deviation)

4.10.1 Insufficient Funds

The constraint of insufficient funds was rated as very serious by upland farmers having a mean score of 3.93. This high score indicates that a lack of financial resources was one of the most significant barriers to cassava production. Similarly, lowland farmers also rated insufficient funds as a very serious challenge with a mean score of 3.93. This corroborates with Igbaifua et al. (2022) and Morgan et al. (2021) that inadequate finance is a constraint to cassava farmers. This challenge disproportionately affects productivity and expansion in subsistence farming.

4.10.2 Insufficient Land

Upland smallholder farmers perceived land availability as a very serious constraint with a mean score of 3.54. The high demand for land in upland areas for both agricultural and non-agricultural purposes, such as residential and industrial uses, increases competition for land. For lowland farmers, insufficient land is also a serious issue (mean =3.55). While lowland areas are typically more fertile (especially river banks), they are prone to seasonal flooding, which limits the usable land for cassava farming. Land availability remains a critical constraint for smallholder farmers in Nigeria, particularly in regions where agricultural land is being converted for urbanization. Finding is in line with the findings of Morgan et al. (2021).

4.10.3 Inadequate Mechanized Farming Tools

Upland farmers considered the absence of mechanized farming tools as a very serious constraint (mean =3.07). Traditional farming method is used in both lowland and upland farms, with no mechanization but reliance on manual labour (hoes and cutlasses). Lowland farmers (mean = 3.54) however, rated this constraint as also very serious. This disparity may reflect the additional

challenges of farming in waterlogged or flood-prone areas, which require specialized tools or techniques that are often unavailable and also not affordable.

4.10.3 Farm Insecurity

Upland and Lowland Farmers (Mean = 1.0) rated insecurity as "Not serious." This result suggests that cassava farming in Ogbia Local Government Area was relatively unaffected by security challenges in the farms such as communal clashes or banditry, which are prevalent in other parts of Nigeria.

4.11.4 High Transportation Cost

Upland Farmers (Mean = 3.30): Transportation was identified as a very serious constraint for upland farmers. Poor road infrastructure, especially during the raining season increases cost of labour as farmers have to pay people to move cassava tubers to their homes for processing or sale. Lowland Farmers (Mean = 3.42) rated transportation as also very serious constraints. The difficulty of navigating waterlogged areas or river banks, combined with inadequate transport facilities (canoes, speed boats), increases the challenge of moving farm produce to their houses or markets. This result aligns with the findings of Morgan et al. (2021).

4.10.5 Farm Theft

Upland farmers perceived farm theft as not a serious constraint having a mean score of 1.39. The low score suggests a relatively low incidence of theft in upland cassava farms. Lowland farmers also rated theft (mean =1.0) as "not serious." This could be attributed to natural barriers such as rivers and swamps, which make lowland farms less accessible to potential thieves.

4.10.6 High Labour Cost

Both groups rated high cost of labour as a very serious constraint with a mean score of 4.0. This may be due to Labour-intensive cassava farming practices, coupled with seasonal labour shortages, drive up the cost of hiring workers. This is a critical issue for smallholder farmers who rely on family and hired labour for planting, weeding, and harvesting. Labour costs in Nigeria's agricultural sector have been rising due to urban migration and aging rural farming populations. This is in agreement with the findings of Igbaifua et al. (2022), Nwakpu (2024) and Ume et al. (2013) that high labour cost is a major constraint in cassava farming.

4.10.7 Flooding

This constraint was not applicable to upland farmers, as upland areas are generally less prone to flooding. Lowland Farmers rated flooding as a very serious (mean = 4.0) constraint. Seasonal yearly floods in the study area damage crops and reduce arable land, significantly impacting cassava yields (Onu et al, 2013). Flood-prone areas face reduced agricultural productivity due to waterlogging, which affects crop growth and harvest.

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

This chapter provides the summary, conclusion and recommendations of the study.

5.1 Summary

The study explored the farm level efficiency of lowland and upland smallholder cassava production in Ogbia LGA, Bayelsa State. It was observed from the results that lowland and upland farmers display some noteworthy differences as well as similar socioeconomic characteristics. The socioeconomic characteristics of upland and lowland smallholder cassava

farmers in Ogbia LGA as shown in Table 4.1 revealed that upland farmers tend to have larger farms (mean size = 0.34ha) and longer harvest durations than lowland farmers that operates smaller farms (mean = 0.26ha) and face flooding (waterlogging) constraints that may influence harvest timing. Despite these differences, both groups have fully adopted improved cassava varieties. Similar demographic and socioeconomic characteristics but differ slightly in aspects such as farming experience and the proportion of full-time farmers. Female involvement is obvious in both systems (58.74% upland, 66.67% lowland), while married individuals (59.44% upland, 52.27% lowland) leads the farming workforce. Most farmers have moderate levels of education, and farming experience (mean = 20.55 upland, mean = 17.40 lowland) is generally high, indicating a seasoned farming population. However, the aging (mean = 47.58, upland, mean = 43.58 lowland) farmer demographic raises concerns about the future of cassava farming in the region.

In comparing the technical efficiency and cost efficiency scores using T test, result showed that there is a significant difference between upland and lowland cassava farmers mean technical efficiency and cost efficiency. Upland farmers have a mean TE score of 0.83 while lowland farmers have a mean TE score of 0.45. Also the mean CE of upland farmers is 0.97 while that of lowland farmers is 0.98

The study also identified the production constraints faced by upland and lowland cassava farmers. High labour costs, insufficient funds, insufficient land, transportation and inadequate tools affect both farming systems while, constraints like flooding affects lowland farms only.

5.2 Conclusion

It can be concluded from this study that the inability of Bayelsa State to attain cassava sufficiency despite large cultivation of the crop in the upland and lowland areas of the State is due to technical inefficiency. This is reflected in the mean technical efficiency scores of upland and lowland farmers found to be 0.83 and 0.45 respectively. While the two production systems are not technically efficient, there is room for improvement to increase production.

It can also be concluded from the results that upland and lowland farmers are cost efficient. This is also reflected in the mean cost efficiency scores of 0.98 and 0.97 for lowland and upland farmers respectively. Furthermore, there is a significant difference between the mean technical efficiency and cost efficiency scores of upland and lowland farmers in the study area as shown by the T test.

Finally, amongst other constraints identified such as insufficient funds and land, inadequate tools and transportation constraints faced by upland and lowland farmers, flooding was found to be a major constraint for lowland farmers only.

5.3 Recommendations

On the basis of the findings from the study, the following recommendations are made;

1. There should be targeted interventions to train and encourage young people to get involve in cassava farming as the current cassava farmers are aging.
2. Government should create an enabling environment for the enhancement of cassava production and productivity such as provision of land, finance and construction of access roads to farmlands.

3. Farmers should be trained adequately on skills and innovative technologies with regards to cassava production in order for them to utilize available inputs efficiently to achieve maximum yield.
4. Farmers should employ the use of specialized or skilled labour together with high yielding cassava stems varieties. This will reduce the cost of production through the elimination of waste.
5. High cost of labour is a very serious constraint for both systems. Hence, the acquisition of mini mechanized tools for smallholder farmers can reduce the high cost. Such tools can be provided by the government.
6. The provision of high yielding fast maturing six months and water resistant cassava varieties will enable lowland farmers to harvest their crops before the emergence of the yearly flood water and also reduce pre-harvest losses.

5.4. Contribution to Knowledge

1.3. Contribution to knowledge

The study has contributed to knowledge in the following ways:

1. Smallholder lowland cassava farmers in the study area have a wider production gap to attain maximum cassava output compared to smallholder upland farmer's counterpart having a mean TE of 45% and 83% respectively.
2. Upland and lowland cassava farmers in the study area are cost efficient.
3. Flooding is a very serious constraint for lowland cassava farmers in the study area.

REFERENCES

- Adedeji, A., Yusuf, A. O., Adeyemo A. A., Umar, S.M., & Madaki, M. J. (2019, October 21 -25). *A stochastic frontier approach of the technical efficiency of small scale cassava farmers in Ondo North ADP, Ondo State, Nigeria* (paper presentation). 53th Annual Conference of Agricultural Society of Nigeria. NCRI, Badeggi, Nigeria.
- Ahmed, M., & Melesse ,K .(2018). Impact of off-farm activities on technical efficiency: evidence from maize producers of eastern Ethiopia. *Agricultural and Food Economics* 6(3). <https://doi.org/10.1186/s40100-018-0098-0>
- Aigner, D. J., Lovell, C. K., & Schmidt, P. (1977). Formulation and estimation of stochastic. *Review of Economics and Statistics*, 80(3), 454-465.
- Ajayi, C.O., & Olutumise, A. I. (2017). Determinants of food security and technical efficiency of cassava farmers in Ondo state, Nigeria. *International Food and Agribusiness Management Review*, 21(7). <https://doi.org/10.22434/IFAMR2016.0151>

- Ajayi, C.O., & Olutumise, A. I. (2018). Determinants of food security and technical efficiency of cassava farmers in Ondo state, Nigeria. *International Food and Agribusiness Management Review*, *21*(7). <https://doi.org/10.22434/IFAMR2016.0151>
- Ajibefun, A.I., & Abdulkadri, O.A. (1999). An Investigation of technical inefficiency of production of farmers under the national directorate of employment in Ondo state, Nigeria. *Applied economics Letter*, *6* (111-114).
- Ajuwa, H. in Adedoke, A. (2020). Bayelsa Moves Against Middlemen In Anchor Borrowers Scheme. <https://insidebusiness.ng/25240/bayelsa-moves-middlemen-anchor-borrowers-scheme/>. retrieved 15 feb 2023.
- Akinola A.O., Obayelu A. E., Shittu, A. M., & Akinbode, S. O.(2020). Production efficiency and its determinants in cassava-based production in Ogun State, Nigeria. *Ife Journal of Agriculture*, *32*(1), 1-12
- Akpan, S.B., Okon, U.E., Jeiyo, E.N., Nkeme, K.K., & John, D.E. (2013). Economic efficiency of cassava based farmers in southern wetland region of Cross River State, Nigeria: A Translog Model Approach. *International Journal of Humanities and Social Science*,*3*(12), 172-181.
- Akpan. S.B., & Patrick, I.V., & Udoka, S.J. (2012). Stochastic profit efficiency of homestead based cassava farmers in southern Nigeria. *Asian Journal of Agriculture and Rural Development*, *2*(3), 498 - 505.
- Anyaeibunam, H. N., Okoye, B. C., Asumugha, G. N., & Madu, T. (2010). A translog stochastic frontier analysis of plot size and cost inefficiency among smallholder cassava farmers in south-east agro-ecological zone of Nigeria. *Nigeria Agricultural Journal*, *40*(1-2). <https://doi.org/10.4314/NAJ.V40I1-2.55516>.
- Anyanwu, S. O, Kalio., A. E., Olatunji, S. O. and Akonye, L. (2014). A Stochastic frontier production function approach to technical efficiency among cassava farmers in Rivers State, Nigeria. *Asian Journal of Agricultural Extension, Economics & Sociology*, *3*(6), 746-755.
- Anyanwu, S. O, Kalio., A. E., Olatunji, S. O., & Akonye, L. (2014). A Stochastic frontier production function approach to technical efficiency among cassava farmers in Rivers State, Nigeria. *Asian Journal of Agricultural Extension, Economics & Sociology*, *3*(6), 746-755.
- Anyanwu, S. O., & Iyagba, A.G. (2009). Resource productivity and efficiency among cassava farmers in rivers state, Nigeria. *Journal of Agriculture, Forestry and Social Sciences*,*7*(1),1-11.

- Awelewa, A.A. (2017). Wetlands and livelihood sustainability: Qualitative evaluation of the impact of oil exploitation in Ogbia Local Government, Bayelsa State, Nigeria *Journal of Geography, Environment and Earth Science International* 5(2), 1-12.
- Awerije, B. O., & Rahman, S. (2014). Profitability and efficiency of cassava production at the farm-level in Delta State, Nigeria. *International Journal of Agricultural Management*, 3 (4), 210-218. <https://doi.org/10.5836/ijam/2014-04-04>
- Bando, D.C., Prince, E.O., Sunday, O.G., Ephraim, D.H., Jesse, P.S., & Nuhu, I. (2022). An Investigative screening of heavy metal contamination of *Amaranthus* spp grown along Ibi river-bank, Taraba State, Nigeria, *African journal of biological, chemical and physical sciences*, 1(1), 34-38.
- Battese, G. E. and T. J. Coelli. (1995). A model for technical inefficiency effects in a stochastic frontier production function for panel data. *Empirical Economics* 20, 325- 332.
- Battese, G.E. and G.S. Corra. (1977). Estimation of a production frontier model: with application to the pastoral zone of eastern Australia.” *Australian Journal of Agricultural Economics* 21, 169–179.
- Battese, G.E., Coelli, T.J. (1992). Frontier production functions, technical efficiency and panel data: With application to paddy farmers in India. *J Prod Anal* 3, 153–169. <https://doi.org/10.1007/BF00158774>
- Bawa, B.I, Sharif, N., Hashim, T., Ahmad, B. B., Abbas, L. S., Shehu, I. S., & Njinga, N. S. (2015). Concentrations of some heavy metals in *lycopersicon esculentum* and *allium cepa* grown in Abarma River Bank, Gusau- Nigeria. *International Journal of Science for Global Sustainability*, 1(1), 61-68.
- Bayelsa state government. (n.d). Bayelsa state at a glance. Accessed may 2025. Retrieved from www.bayelsastate.gov.ng
- Berezi O.K., & Nwankwoala H.O. (2023). Application of Geo-information Technologies for Flood Vulnerability Mapping in Bayelsa State, Southern Nigeria. *Southern Nigeria, J Eng Tech & App Sci*, 1(1), 01-11.
- Berezi, O. K., Obafemi A. A., & Nwankwoala H. O. (2019). Flood Vulnerability Assessment of Communities in the Flood Prone Areas of Bayelsa State, Nigeria. *International Journal of Geology & Earth Sciences*, 5(3), 19-36.
- Bravo-Ureta B., & Pinheiro A. (1997). Technical, economic and allocative efficiency in peasant farming: evidence from the Dominican Republic. *The Developing Economics* XXXV(1):48–67. <https://doi.org/10.1017/S1068280500000320>
- Chepng'etich, E., Bett, E. K., Nyamwaro, S. O., & Kizito, K. (2014). Analysis of technical efficiency of sorghum production in lower eastern Kenya: a data envelopment analysis (DEA) approach. *Journal of Economics and Sustainable Development*, 5 (4), 58-65.
- Chetroui, R., & Călin, I. (2013). The concept of economic efficiency in agriculture. Accessed may 2024. *Munich Personal RePEc Archive*. Retrieved from https://mpra.ub.unimuenchen.de/55007/1/MPRA_paper_55007.pdf

- Chiaka, J.C., Zhen, L., Yunfeng, H., Xiao, Y., Muhirwa, F., & Lang, T. (2022). Smallholder farmers contribution to food production in Nigeria. *Frontiers in Nutrition*, 9(9), 1-10.
- Department of International Development.(n.d).Mapping of cassava clusters in Niger Delta states of Nigeria. *monograph series* volume 23.
- Dogba, K. B., Oluoch-Kosura, W., & Chumo, C. (2020). Economic efficiency of cassava production in Nimba County, Liberia: An output-oriented approach. *International Journal of Agricultural and Biosystems Engineering*, 14(12), 168-174.
- Donkor,E., Onakuse, S., Bogue, J., & Carmenado, I.D.(2017). The impact of the presidential cassava initiative on cassava productivity in Nigeria: Implication for sustainable food supply and food security, *Cogent Food & Agriculture*,3(1),1-14. <https://doi.org/10.1080/23311932.2017.1368857>
- Dutra, P., Leiva, M., & Bastiaan de Rivera , E. B.(2009). Cobb-Douglas, Translog Stochastic Production function and data envelopment analysis in total factor productivity in brazilian agribusiness. *The Flagship Research Journal of International Conference*, 2(2), 20-34.
- Erhabor P.O., & Emokaro, C. O. (2007). Relative technical efficiency of cassava farmers in the three agroecological zones of Edo State, Nigeria. *Journal of Applied Sciences*, 7(19), 2818-2823. <https://doi.org/10.3923/jas.2007.2818.2823>
- Esheya, S.E. (2022). Allocative efficiency of TMS (Tropical Manihot Selection) cassava production in Ebonyi State, Nigeria. *Nigerian Agricultural journal*, 53(1), 35-39.
- Esiobu, N.S.(2019). Understanding the Allocative Efficiency of Cassava Farms in Imo State, Nigeria. *Journal of Economics and Sustainable Development*,10(19),82-93.
- [Farrell](#) .M.J. (1957). The measurement of productive efficiency. *Journal of the Royal Statistical Society: Series A (General)*. 120(3), 253-281. <https://doi.org/10.2307/2343100>
- [Food and Agriculture Organisation^b](#).(2025).FAOSTAT. www.fao.org/faostat/en/search/cassava%2c%20fresh
- [Food and Agriculture Organization^a](#).(2018). Small family farms country fact sheet. www.fao.org/family-farming/themes/mall
- Hamadina, M., & Hamadina E.I. (2015).Smallholder Farmers and Sustainability Issues: the Case of Fadama III Sub-Projects in Bayelsa State of Nigeria. *Journal of Multidisciplinary Engineering Science and Technology*,2(4), 854-859.
- Hansson, H. (2008).Are larger farms more efficient? A farm level study of relationship between efficiency and size on specialized dairy farms in Sweden. *Agricultural and Food Science*,17,325-337. <https://doi.org/10.1353/jda.2020.0045> <https://doi.org/10.3389/fnut.2022.916678>

- <https://doi.org/10.7176/JESD/10-19-09>
<https://doi.org/10.9734/JGEESI/2016/22943>
- Idumah, F.O., Owombo, P.T., Ighodaro U.B., & Mangodo, C. (2018). Economic analysis of plantain production under agroforestry system in Edo State, Nigeria. *Applied Tropical Agriculture*, 21(1), 138-144.
- Igbaifua, W.E., Adeniyi, O.R., & Omolehin, R.A. (2022). Analysis of technical, allocative and economic efficiencies of vitamin a cassava farmers with other Improved cassava farmers in Benue State, Nigeria *Journal of Agricultural Policy*, 5(1), 1 – 23. www.carijournals.org
- Ikuemonisan, E.S., Mafimisebi, T.E., Ajibefun, I., & Adenegan, K. (2020). Cassava production in Nigeria: trends, instability and decomposition analysis (1970–2018), *Heliyon*, 6(10), 1-9. <https://doi.org/10.1016/j.heliyon.2020.e05089>.
- Isitor, S. U., Adeyonu, A. G., & Aniegboka, U. N. (2017). An analysis of technical efficiency of smallholder cassava farmers in Anambra State, Nigeria. *Applied Tropical Agriculture*, 22(2), 10-15.
- Islam, S., Mitra, S., & Khan, M.M. (2023). Technical and cost efficiency of pond fish farms: Do young educated farmers bring changes?, *Journal of Agriculture and Food Research*, 12, 1-9. <https://doi.org/10.1016/j.jafr.2023.100581>.
- Itam, K.O., Ajah, E.A., Ofem, U.I., & Abam, O.E. (2015). Technical efficiency analysis of small scale cassava farmers in Cross River State, Nigeria: A stochastic production frontier approach. *Applied Economics and Finance*, 2(4), 10-18. <http://dx.doi.org/10.11114/aef.v2i4.1028>
- Jatto, A., & Oke J. (2020). Economic analysis of cassava (*Manihot esculenta* Crantz) production in Akinyele local government area of Oyo State, Nigeria. *Sust. Agric & Envir* 18(1), 87-100.
- Jondrow, J., Lovell, C.A.K., Materov, I.S., & Schmidt, P. (1982). On the estimation of technical inefficiency in the stochastic frontier production function model. *Journal of Econometrics* 19, 233–238.
- Kainga, P.E., Familusi, L.C., & Oguer, I. E. (2018). Assessment of the rate of adoption of improved crop technology in the fadama iii project in Bayelsa state, NIGERIA, *Global Approaches to Extension Practice*, 13(1), 55-61.
- Kumbhakar, S. C. and C. A. K. Lovell. (2000). *Stochastic Frontier Analysis*. Cambridge University Press.
- Kumbhakar, S.C. (1990). “Production frontiers, panel data and time-varying technical inefficiency.” *Journal of Econometrics*, 46, 201–211.

- Market Development in the Niger Delta (MADE)(2019). Mapping of cassava clusters in Niger Delta states of Nigeria. *Monograph series*,23;1-38.Retrieved from <https://pindfoundation.org/>. Accessed January 2025.
- Meeusen, W., & Van den Broeck, J. (1977). Efficiency estimation from Cobb-Douglas production functions with composed error, *International Economic Review* 18, 435-444.
- Moluabi, J.E.,& Ibitoye, S.J. (2024). Cassava production and agricultural growth in Nigeria: Analysis of effects and forecast. *GSC Advanced Research and Reviews*, 21(01), 037– 046
- Morgan, N.C., Wasini, D.A., & Larry I.E. (2021). Economic analysis of cassava production in Ogbia Local Government Area, Bayelsa State . *International Journal of Life Science*
- Ndubueze-Ogaraku, M.E., & Ekine, D.I. (2015). Application of the stochastic production frontier function model to cassava production in the floodplain area of Rivers State, Nigeria. *Journal of Biology, Agriculture and Healthcare*, 5(4), 17-26.
- Nwakpu, C. C. (2024). Resource productivity and allocative efficiency on improved cassava-based mixed cropping system in Ebonyi State, Nigeria. *Nigerian Agricultural Journal* ,55 (1),334-340. <https://www.naj.asn.org.ng>
- Nwike, M. C., Okoli, T. O., Oghenehogagame, P., & Ugwumba, C. O. A. (2017). Economic efficiency and returns to scale of cassava production in Southeast Nigeria. *International Journal of Agriculture Innovations and Research*, 6(1), 2319-1473.
- Nwokocho, I.N.,& Anyaegbunam, H.N. (2020).Profitability analysis of root and tuber crops production in oil polluted and non-oil polluted areas of bayelsa state, nigeria. *Journal of Agricultural Economics,Extension and Science*,6(2),211-220.
- Obiorie, E., & Nwankwoala. (2012). Relationships between geoelectrical and groundwater parameters in parts of ogbia, bayelsa sate, central Niger delta. *Continental J Earth Sciences* 7(1), 29-39. DOI: [10.5707/cjearthsci.2012.7.1.29.39](https://doi.org/10.5707/cjearthsci.2012.7.1.29.39)
- Ogieriakhi, M. O., & Emokaro, C. O. (2018). Effect of lift above poverty organization microcredit on economic efficiency of cassava farmers in Edo State, Nigeria. *Journal of Forestry, Environment and Sustainable Development*, 4(1), 116-125.
- Ogundari K., & Ojo, S.O.(2006). An examination of technical, economic and allocative efficiency of small farms: the case study of cassava farmers in Osun State of Nigeria. *Journal of Central European Agriculture*. 7(3), 423-432.
- Ogundari, K.A & Brümmer, B . (2011), Estimating technical efficiency, input substitution and complementary effects using Output Distance Function: A study of cassava production in Nigeria . *Agricultural Economics Review* ,12(2), DOI: [10.22004/ag.econ.178223](https://doi.org/10.22004/ag.econ.178223)

- Ogunniyi, A., Omotoso, O., Ayeni, J., Olufadewa, M., Rufai, M., Abiodun, O.O., & Olagunju, K. O. (2020). Resource-use efficiency and production constraints among cassava farmers in Nigeria: insight, linkage and pathway. *The Journal of Developing Areas*, 1-14.
- Okebiorun E.O., Maikasuwa,M.A.,Ala, A.L., & Atiku,A. (2018). Resource use efficiency among cassava farmers in Ilesa west local government of Area of Osun State, Nigeria. *Asian Journal of Agricultural Extension, Economics & Sociology*,25(4),1-9.
- Okello, D.N.,Bonabana-Wabbi, J., & Mugonola. B (2019). Farm level allocative efficiency of rice production in Gulu and Amuru districts, Northern Uganda. *Agricultural and Food Economics* ,7(1)-19. <https://doi.org/10.1186/s40100-019-0140-x>
- Okonkwo, C. N. P., Kumar, L., & Taylor, S. (2015). The Niger Delta wetland ecosystem: What threatens it and why should we protect it? *African Journal of Environmental Science and Technology*, 9(5), 451-463. <https://doi.org/10.5897/AJEST2014.1841>
- Okorie, O., Umaru, I., Obetta, A., & Awoyelu, F. (2021). Profit Efficiency of Cassava Production By Small Holder Farmers in Enugu State, Nigeria. International Association of Agricultural Economists (IAAE) > 2021 Conference, August 17-31, 2021, Virtual. DOI: [10.22004/ag.econ.315406](https://doi.org/10.22004/ag.econ.315406)
- Ologbon, O.A.C.,Oyebanjo,O.,Oluwasanya, O.P., Ilori,A.R.,& Fadipe,M.O.(2021).Economic returns and technical efficiency in cassava-based farming systems in yewa communities of Ogun State, Nigeria. *Journal of Agricultural Science and Environment*, 21(1 &2),27- 39.
- [Onu,B](#), [Price,T](#), [Surendran](#),S.S & Timbri, A (2013). Peoples' perception on the effects of flood in the riverine areas of Ogbia local government area of Bayelsa state, Nigeria. *Knowledge Management* 12(2):22-43. <https://dx.doi.org/10.18848/2327-7998/CGP/v12i02/50793>
- Onubuogu, G.C., & Esiobu, N.S. (2019). Determinants of allocative (pricing) efficiency of cassava farms in Imo state, Nigeria. *Journal of Agriculture and Food Sciences*, 17 (2), 86-99. <https://dx.doi.org/10.4314/jafs.v17i2.8>
- Onyegbulam, L.A., Alleluyanatha, E., Mbanasor, J.A., & Gabolu, E. (2018). Analyses of resource use, productivity and technical efficiency among local rice farmers in Bayelsa state, Nigeria. *Nigerian Agricultural Journal*, 49(1), 231-239.

- Otekunrin, O.A., & Sawicka, B. (2019). "Cassava, A 21st century staple crop: How can Nigeria Harness its Enormous Trade Potentials?". *Acta Scientific Agriculture*, 3(8), 194- 202. <https://doi.org/10.31080/ASAG.2019.03.0586>
- Otung, I.A., & Akpaeti, A.J. (2016). Identification of efficient cropping zones for cassava production in Nigeria. *Journal of Agriculture and Ecology Research International*, 8(2), 1-7. <https://doi.org/10.9734/JAERI/2016/26821>
- Ovharhe O. J. (2019). Determinants of the socioeconomic profile of fadama III project beneficiaries in three States of Niger Delta area of Nigeria. *International Journal of Agricultural Science*, 4, 29-34.
- Oyinkuro, O.A., & Rowland, E.D. (2017). Spatial groundwater quality assessment by WQI and GIS in Ogbia LGA of Bayelsa State, Nigeria. *Asian Journal of Physical and Chemical Sciences*, 4(4), 1-12.
- R Core Team (2024), R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria. <https://www.R-project.org>
- Rahman, K.M.M, Schmitz, P.M., & Wronka, T.C. (2000). Measurement of economic efficiency in the production of rice in bangladesh-a translog stochastic cost frontier analysis. *Bangladesh J. Agric. Econ.* 23(1&2), 35-49. <https://doi.org/10.22004/ag.econ.202072>
- Research*, 01(02), 01–08. <https://doi.org/10.53771/ijlsra.2021.1.2.0065>
- Schmidt, P. & C.A.K. Lovell. (1979). Estimating technical and allocative inefficiency relative to stochastic production and cost frontiers. *Journal of Econometrics* 9, 343–366.
- Ume, S. I., Okoye, F. U., Onwujiariri, U. J., & Achebe, U. (2020). Analysis of Intensity of Adoption of odourless fufu processing technology by Pro vitamin A cassava variety processors in Anambra State of Nigeria; An Implication to Health and Nutritional Food Security. *International Journal of Science and Healthcare Research*, 5(7), 34-45.
- Wang, HJ., & Schmidt, P. (2002). One-Step and Two-Step Estimation of the Effects of Exogenous Variables on Technical Efficiency Levels. *Journal of Productivity Analysis* 18, 129–144 (2002). <https://doi.org/10.1023/A:1016565719882>
- Wauton E. O., Odinwa A. B., & Ekeogu C. O. (2022). Evaluation of Agricultural Projects and Extension Services of the Bayelsa State Agricultural Development Programme (ADP), *Asian Journal of Agricultural Extension, Economics & Sociology*, 40(9), 273-284. <https://doi.org/10.9734/AJAEES/2022/v40i931004>

Wikipedia. (n.d). Ogbia. Accessed May, 2025. Retrieved from <https://en.wikipedia.org/wiki/Ogbia>

Yamane, T. 1967. Statistics, An Introductory Analysis, 2nd Ed., New York: Harper and Row

APPENDIX

QUESTIONNAIRE

DEPARTMENT OF AGRICULTURAL ECONOMICS AND EXTENSION SERVICES

FACULTY OF AGRICULTURE, UNIVERSITY OF BENIN, BENIN CITY, NIGERIA

Sir/Madam

This Questionnaire is designed to elicit information on: **Farm Level Efficiency of Smallholder Lowland and Upland Cassava Production in Ogbia Local Government Area, Bayelsa State, Nigeria.** The information you provide will be handled with strict confidentiality and the findings will be used solely for academic purpose. Your responses will be highly appreciated.

Nyaluaziba Samuel ITESI

A. Socioeconomic characteristics

1. Sex: Male [] Female []
2. Married status: Married [] Single [] Separated [] Divorced [] Widow/Widower []
3. Household size _____ Husband () Wife () Children () Others ()
4. Level of Education: Primary () Secondary () Tertiary () no formal education
5. Nature of Farming: Fulltime [] Part time []
6. Years of Experience in Cassava farming _____
7. Farmers Age _____
8. Variety of Cassava cultivated: (a) Unimproved variety (Local) [] (b) improved variety (Agric TMS 30572, Yellow cassava Pro vitamin A, Sweet Cassava Pink Apaya) []

9. Location of farm: (a) Lowland (along river bank , Flood prone area) [] (b) Upland []
10. Duration before harvest: (a) before 6months [] (b) 6 months (c) 7 to 8months [] (d) 9 months to after one year.
11. Source of Labour : (a) Family [] (b) Hired [] (c) Both []
12. Fertilizer usage: Yes/No

B. Efficiency Measures

13. Size of Farmland: (a) No of Portions [] (b) No of acres [] (c) No of hectares []
14. Cost of land rent _____

15. Quantity and Cost of variable inputs used

Variable input	Quantity Used	Cost per unit	Total cost
Cassava stems (metres)	Bundles		
Herbicide (litres)	Litres		
Pesticide (litres)	Litres		
Others			
Total cost of variable inputs			

16. Cost of labour for each farm operation

Operations	Amount paid	No of portions/mould/cuttings planted	No of hours/days worked	No of workers
Land clearing /portion				
Land tillage /mould				
Planting /stem cutting				
Weeding /portion				
Herbicide application / portion				
Pesticide application/portion				
Harvesting /portion				
Others				

Total				
-------	--	--	--	--

16. Quantity of cassava harvested/cost

Area	Quantity (25kg bags)	Quantity (50kg bags)	Cost/bag	Total cost
Portion				
Acre				
Hectare				

17. Fixed cost for the production period

Fixed inputs Equipment	Number of tools used in the farm	Cost for each tool	When did you buy it	Useful life	Depreciated value
Cutlass					
Hoe					
File					
Knapsack sprayer					
Canoe/paddle					
Total					

18. Production Constraints faced by both Lowland and Upland Cassava Farmers

Constraints	Very serious	Serious	Not serious	Not a problem
Insufficient funds				
Insufficient land				
Inadequate mechanized farming tools				
Insecurity on farmlands e.g herdsmen				
High transportation cost				
Farm theft				
High labour cost				
Flooding				
Others				

