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UNLEASHING ECONOMIC POTENTIAL: ENHANCING CASSAVA PRODUCTION EFFICIENCY IN NIGERIA.

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ABSTRACT
Purpose: This study is aimed at determining the economic efficiency of Manihot esculenta Crantz (Cassava) production in Nigeria’s Delta State. The study offers a detailed analysis of how socio-economic characteristics influence production output across both early and late farming seasons.
Design/ Methodology/ Approach: This study employed a multi-stage random sampling approach in selecting a diverse cohort of 500 cassava farmers engaged in both early and late-season cultivation. Through rigorous personal interviews, primary data was gathered that was both comprehensive and insightful. Advanced parametric statistics and the Cobb-Douglas stochastic frontier function were used for the analysis.
Findings: The mean economic efficiency scores were determined to be 0.63 for early-season farms, 0.78 for late-season farms, and 0.76 when considering all farms collectively. The output elasticities of material inputs, labour, and land were found to be 0.42, 0.61, and 0.05, respectively for all farms. For early-season farms, these values were 0.36, 0.68, and 0.04, whereas, for late-season farms, they were 0.31, 0.7, and 0.03.
Research Limitation/Implications: This work concentrated on Cassava production efficiency within and around Nigeria’s Delta area.
Practical Implication: Understanding the socio-economic factors that influence production during different seasons can help in designing strategies that maximize output in both early and late farming seasons.
Social Implication: This study would help agricultural development economists and policy-makers in addressing the economic problems of Cassava farmers both present and future generations.
Originality/Value: By examining both early and late farming seasons, the study provides a comprehensive understanding of how socio-economic factors vary across different agricultural cycles. This dual-season approach is relatively rare and offers more detailed insights into the dynamics of cassava production throughout the year.
Keywords: *Cassava. economic. efficiency. production. output. season*

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INTRODUCTION

The agricultural sector is a cornerstone of economic development, playing a pivotal role in food provision, poverty alleviation, employment creation, income generation, and the supply of raw materials to industries (Adetunji et al., 2022; Nwankwo et al., 2022; Nwankwo & Ukhurebor, 2021; FAO, 2007). The Food and Agriculture Organization (FAO, 2014) underscores agriculture as the solution to hunger, extreme poverty, and social unrest in Nigeria and other African nations (Osikemekha et al., 2022; Nwankwo et al., 2019). Historically, agriculture accounted for 37 to 41.7% of Nigeria's Gross Domestic Product (GDP) from 1981 to 2011 (Central Bank of Nigeria, 2012), providing both paid and self-employment for over 70% of the population (National Export Promotion Council (NEPC, 2009), cited in Ugwumba, 2011). Within the agricultural sector, the crop sub-sector, which includes both food and cash crops, is predominant. Major food crops such as rice, maize, yam, cassava, cocoyam, sorghum, millet, beans, and vegetables contributed approximately 28% of the GDP, accounting for over 75% of the agricultural sector's GDP contribution (CBN, 2012). This highlights the critical importance of agricultural productivity and efficiency in driving economic growth and sustainability in Nigeria.

Cassava, a woody shrub from the Euphorbiaceae family and the genus Manihot, is a dicotyledonous plant with over 200 wild species native to Latin America (Acquah, 2005). It was brought to Nigeria and Sub-Saharan Africa by early Portuguese traders in the 16th century. Cassava has become a staple crop. It is extensively cultivated in tropical and subtropical regions for its starchy tuberous roots (Hillocks, 2002). Cassava tubers are a significant source of dietary energy due to their high caloric content, although they are relatively low in protein and micronutrients. Despite these nutritional limitations, cassava plays a crucial role in food security for large populations in Nigeria and other tropical countries. Additionally, cassava leaves are consumed as vegetables in certain regions and are rich in vitamins and amino acids, contributing to their nutritional value (Agbato, 2009). This dual-purpose utility of cassava, both as a root crop and a leafy vegetable, underscores its importance in addressing food security and nutritional needs in the regions where it is cultivated. Understanding its agronomic characteristics and nutritional profile is essential for optimizing its cultivation and utilization to meet the dietary needs of growing populations.

In the southeast region of Nigeria, there has been a significant and growing disparity between the supply and demand for cassava lately (Nwike, 2012). According to the Central Bank of Nigeria (CBN, 2012), the region produced eight million tonnes of cassava tubers in 2009, which fell substantially short of the local demand of 14 million tonnes. This production shortfall is attributed to several factors, including the predominance of subsistence farming practices, high production costs, and declining soil fertility due to the absence of appropriate land management and replenishment techniques to enhance agricultural yields and income levels. The challenges of subsistence agriculture, which include reliance on traditional farming technologies, poor agricultural extension services, and inequitable distribution of agricultural inputs, contribute to the inefficiency and low productivity in cassava production (Ike & Inoni, 2006). These issues underscore the need for a strategic overhaul of farming practices and policies in the region to bridge the gap between cassava production and demand. Implementing modern agricultural techniques, improving extension services, and ensuring better distribution

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of inputs are critical steps towards achieving increased productivity and meeting the nutritional and economic needs of the region's population.

To achieve optimal economic output and maximize profit, it is imperative to utilize resources both optimally and efficiently. The capacity of cassava producers to adopt new technologies and maintain sustainable production levels is inherently linked to their economic efficiency. This efficiency is a crucial factor for productivity growth (Ugwumba, 2011). Enhancing cassava productivity necessitates a comprehensive analysis that deepens our understanding of the economic efficiency levels of cassava farmers, identifies the determinants of inefficiencies, and addresses the challenges impeding cassava production in Southeastern Nigeria. Notably, there is a significant lack of empirical data on the economic efficiency and profitability levels of cassava farmers engaged in both early and late-season production within this region. This study aims to fill that gap by examining the economic efficiency and profitability of cassava production during early and late season farming in Southeastern Nigeria.

The primary objective of this work is to ascertain the economic efficiency of cassava production in Delta State Nigeria. Specifically, we intend to: identify and define social and economic traits associated with local cassava farmers; examine the influence of socio-economic traits of farmers on the production rate of early and late seasons' farming; determine the levels of economic efficiency of all farms, early and late seasons' production; and assess the nature of returns to scale and elasticities of farms during early and late planting seasons.

MATERIALS AND METHODS

Location of the Study

The research was conducted in Delta State, located in the South-South geopolitical zone of Nigeria (See Figure 1). Created on August 27, 1991, Delta State covers an area of approximately 18,050 square kilometres, with 40% of this area being riverine and marshy. Geographically, the state is positioned between longitudes 5’ 00’E and 6’00’E and latitudes 5 00’N and 6’30’N, and it boasts a 163-kilometer coastline along the Atlantic Ocean. Delta State is bordered to the east by Anambra and Rivers States, to the north by Edo State, to the northwest by Ondo State, and the south by Bayelsa State and the Atlantic Ocean. The land area of Delta State is composed of 57% rainforest, 33% mangrove swamp forest, and 10% freshwater. Administratively, the state is divided into twenty-five local government areas, which are further grouped into three senatorial districts (see Figure 1). The primary ethnic groups in the state include Anioma, Urhobo, Isoko, Itsekiri, and Ijaw. According to the Nigerian Investment Promotion Commission (NIPC, 2023), Delta State has an estimated population of 6.037 million, accounting for 3% of Nigeria’s total population. Delta State encompasses about 1.9% of Nigeria’s landmass and contributes significantly to the country’s oil production, with over 30% of the nation's oil originating from the state, which contains approximately 52% of Nigeria's 159 oilfields (1,481 oil wells). The state's diverse economy is primarily driven by crude oil revenues, but it also has significant potential in agriculture, commerce, industry, and entertainment. Despite this, subsistence agriculture, particularly crop cultivation and animal husbandry, remains the economic backbone for over 80% of Delta State’s population. The state’s rich resource base offers it a comparative advantage over other regions in Nigeria.

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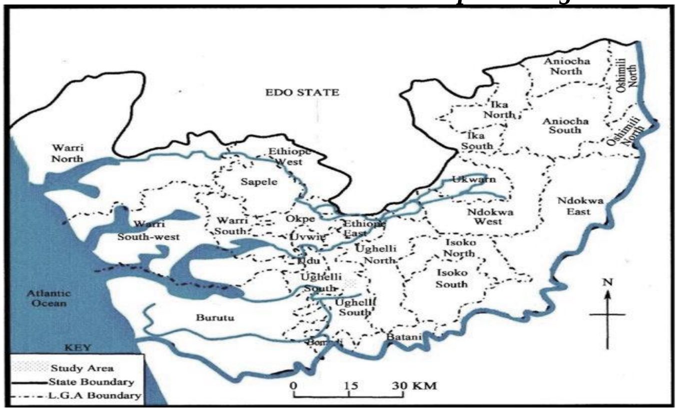

Figure 1: Map of Delta State showing the 25 Local Councils [Source: Ministry of Lands and Survey and Urban Development, Asaba, 2002]

Sampling Technique and Sample Size

The paper adopted a multi-stage random sampling approach to ensure a representative sample of the rural farming population. From each of the 25 local councils, a sample size of 20 farmers was randomly selected, resulting in a total sample size of 500 participants. To qualify for the study, participants must be actively engaged in cassava farming for at least the past three years, ensuring they possess relevant experience and insights into production practices. The inclusion criteria also stipulate that participants should be between the ages of 25 and 65 years, reflecting the economically active and knowledgeable segment of the farming population. This age range ensures the inclusion of both young and mature farmers, providing a comprehensive understanding of the socio-economic dynamics at play.

Data Collection

For early-season farms, cassava production output was significantly shaped by a spectrum of factors, including age, credit resources, educational, financial costs, experience, farm size, amount of credit obtained, cost of inputs, and the frequency of extension visits. Through rigorous personal interviews, primary data was gathered that was both comprehensive and insightful.

Data Analysis

A multiple regression analysis was conducted to evaluate the influence of various socio-economic factors on the production output of the respondents. These factors included gender (GE), age (AG), household size (HO), marital status (MA), farming experience (FA), farm size (FS), educational level (ED), amount of credit obtained (AC), cost of inputs (CI), extension visits (EX), and planting season (PL). The implicit form of the model used for this assessment is outlined as follows:

OP = f (GE, AG, MA, HO, ED, FA, FS, AC, CI, EX, PL) er. (1)

Where:

OP = Cassava output in Kilograms

GE = Gender (1 if male and 2 if female)

AG = Farmer's age given in years

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HO = size of household(number)
MA = Marital status (1 if married and 2 otherwise)
ED = Educational level given in years
FA = Farming experience given in years
FS = Farm size given hectares
AC = Credit accessed in Naira
CI = Cost of inputs in Naira
EX = Extension visits (number of times per production season)
PL = Planting season (1 if early and 2 if late)
E = error term

The four variants of the production function: linear, semi-log and double-log, exponential to be fitted with data are given as:

Linear: OP = βo+β1GE+β2AG+β3MA+β4HO+βsED+β6FA+ β7FS+β8AC+β9CI+β10EX+β11PL+e (2)

Exponential: In OP = βo+β1GE+β2AG+β3MA+β4HO+βsED+β6 FA+β7FAS+β8ACO+β,CI+β10EX+β11PL+e (3)

Semi-log: OTP = βo+β1In GEN+β2 In AG+β3 In MA+β4 In HO+βs In ED+β6In FA+β71n FS+β8 In AC+β9 ln CI +β10 In EX +β11IN PL +e (4)

Double-log: In OTP= βo+β1 In GE+β2 In AG+β3 In MA+β4ln HO+βs In ED+β6In FA+β7In FS+β8 In AC+β, In CI+β10 InEX +β11ln PL +e (5)

Where: OP, GE, AG, HO, ED, FA, FS, AC, CIN, EX and PL are as defined earlier. The βi are parameters to be estimated and represent the error term.

The raw and transformed values of the dependent and independent variables were input into the respective models and analyzed using the MINITAB statistical software. The regression results that yielded the most favourable outcomes—considering the number, sign, and magnitude of the parameter estimates, along with the values of the F-statistic, coefficient of multiple determination (R^2), and Durbin-Watson statistic—were selected as the primary equation.

RESULTS AND DISCUSSION

Enterprises Budgeting Analysis for Cassava Production

The enterprise budgeting method was one of the dual approaches utilized to determine the profitability of cassava cultivation in the region. This technique was employed to calculate various economic indicators, including total revenue (TR), total variable cost (TVC), total cost (TC), total fixed cost (TFC), net farm income (NFI), gross margin (GM), mean net farm income (MNFI), and net return on investment (NROI) for both early and late season cassava production. The detailed results are presented in Table 1.

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Table 1: Estimated profit for cassava production in South Eastern Nigeria

Variable	All farms Amount (₦)	%	Early planting Amount (₦)	%	Late planting Amount (₦)	%
Total Revenue (TR)	**83,765,583**		**42,119,086**		**41,646,497**	
Variable Cost:						
Cassava Stem	2,103,688	3.52	1,007,770	3.30	1,093,918	3.71
Fertilizer	11,100,752	18.58	49,988,702	16.50	6,112,050	20.17
Herbicide	4,451,347	7.45	2,270,187	7.51	2,181,160	7.34
Labour	37,046,582	62.01	19,501,746	64.52	17,544,836	59.45
Transport	2,728,562	4.57	1,309,709	4.33	1,418,853	4.81
Total Variable Cost (TVC)	**57,430,931**	**96.14**	**29,080,114**	**96.20**	**28,350,817**	**96.06**
Fixed Cost						
Dep. On Hoes	360,680	0.60	173,129	0.59	187,557	0.64
Dep. On Cutlass	401,556	0.67	200,300	0.66	201,256	0.68
Dep. On wheelbarrow	423,186	0.71	200,986	0.66	222,200	0.75
Dep. On Head pan	300,912	0.50	150,556	0.50	150,356	0.51
Dep. On bicycle/motorbike	401,588	0.77	235,401	0.78	226,178	0.77
Interest on loan	360,444	0.60	187,431	0.62	173,013	0.59
Total Fixed Cost (TFC)	**2,308,372**	**3.86**	**1,147,812**	**3.80**	**1,160,560**	**3.93**
Total Cost (TC) (TC=TVC+TFC)	**59,739,303**	**100**	**30,227,926**	**100**	**29,511,377**	**100**
Gross Margin (TR-TVC)	**26,334,652**	**-**	**13,038,972**		**13,295,680**	
Net farm Income (NFI) (NFI=TR-TC	**24,026,340**		**11,891,160**		**12,135,120**	
Mean Net Farm Income (MNFI=NFI/n)	**100,109.75**		**99,093**		**102,126**	
Net Return on Investment NROI-NFI/TC	**0.40**		**0.40**		**0.41**	
Gross Margin per hectare	**96,526**		**92,102**		**101,020**	
Net farm Income per hectare	**89,053**		**85,101**		**93,005**	

*Source: Field survey, 2023, *Dep. = Depreciation*

As indicated in Table 1, the total revenue obtained by all farms, early season and late season farms were ₦83,765,583, ₦42,119,086 and ₦41,646,497, respectively. The gross margin, net farm income, mean net farm income and net return on investment for the all farms were ₦26,334,652, ₦24,026,340, ₦100,109.50 and 0.40, respectively. The figures for early season farms were ₦13,038,972; ₦11,891,160; ₦99,093 and 0.40, respectively while those of late season farms were ₦13,295,680, ₦12,135,120; ₦102,126 and 0.41, respectively.

Thus, cassava farming in the study area, having recorded positive net farm income and return on investment for the different production seasons was adjudged as profitable. The profitability

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of cassava production was attested to by Onu and Edon (2009), Yakasai (2010), Oladeebo and Oluwaranti (2012) and Eze and Nwibo (2014) who variously recorded varying levels of profit amongst cassava farmers in different parts of the country. The net return on investment of 0.40 and 0.41 recorded by early season and late season producers, respectively, implied that the sum of ₦0.40 were returned for every ₦1.00 invested in the enterprise. The net return on investment (NROI) shortfall of ₦0.60 for cassava production in the area indicated that there was still room for improvement of the present profit level. This could be achieved through adoption of improved farming practices, use of mechanization in place of manual labour, improved access and efficient marketing of produce.

On gross margin and net farm income per hectare, early season planting recorded values of ₦92,102 and ₦85,101 respectively as against ₦101,020 and ₦93,005 for late season production. The result therefore indicted that cassava production was profitable in the study area. However, the higher gross margin and net profit from late season farms were attributable to lower production cost particularly labour cost. This finding is consistent with Onu and Edon (2009) who reported positive gross margin and net farm income per hectare of ₦26,384.62 and ₦21,908.87 respectively in a comparative study of local and improved cassava cultivars in Taraba State. Similarly, Nandi et al., (2011) recorded gross margin of ₦123,000 per house of cassava in Obubura LGA of Cross River State.

Production Elasticity and Economies of Scale

Production elasticity quantifies the degree of responsiveness between inputs and output. Returns to scale are assessed by the ratio of the percentage increase in output to the percentage increase in input, assuming all factors are increased proportionally. In the context of the Cobb-Douglas function, the elasticities of respective factors correspond to their exponents in the production function or regression equation. Summing these individual elasticities yields the scale coefficient, indicating the percentage increase in output if all factors are increased by one percent (Ugwumba, 2011). Based on these relationships, returns to scale (RTS) for this study were expressed as follows:

$$RTS = \Sigma x_1 + \Sigma x_2 + \Sigma x_3 \qquad (6)$$

Where:

$\Sigma x_1 + \Sigma x_2 + \Sigma x_3$ are the respective elasticities of the output against the variables (labour, land and material inputs). If $\Sigma x\iota > 1.0$, there is a rise in the returns to scale; If $\Sigma x\iota > 1.0$; there are depreciating returns to scale and if $\Sigma x\iota = 10$, the implication is a constant return to scale.

Returns to scale refers to the output response to a proportional change in inputs. In this study, the returns to scale for cassava farmers were computed as the sum of output elasticities concerning labour, land, and inputs (such as fertilizer, cassava stems, etc.). These inputs represent specific farm characteristics affecting economic efficiency. Returns to scale are classified as constant if the sum of input elasticities equals one ($\varepsilon xI = 1$), implying that doubling the inputs will double the output, and tripling the inputs will triple the output. A depreciating return to scale occurs when an increase in inputs results in a less-than-proportional increase in

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output (εxI < 1), meaning that doubling the inputs will yield less than double the output. Conversely, increasing returns to scale (εxI > 1) indicate that doubling the inputs will result in more than double the output. The coefficients of the inputs to cassava production are estimated with the Cobb-Douglas stochastic frontier production function analysis. The values of the inefficiencies (Table 2) revealed the respective elasticities of labour, land, and material inputs as 0.61, 0.05, and 0.42 for all farms; 0.68, 0.04, and 0.36 for early planting; and, 0.70, 0.03 and 0.30 for late planting farms. The returns to scale that is, the sum of all output elasticities of the inputs to production, shows a rising return to scale for all farm groups, as shown in Table 2. This suggests that the cassava farms in the study area are operating under conditions where increasing inputs lead to more than proportional increases in output.

Table 2: Elasticities of labour, land and material inputs

Variable	All farms	Early planting	Late planting
Land	0.05	0.04	0.03
Labour	0.61	0.68	0.70
Material inputs	0.42	0.36	0.30
Total	1.08	1.08	1.04
RTS	Increasing	Increasing	Increasing

**RTS = Returns to scale.*

For elasticities of the production inputs, vis-avis the farms' groups, with labour and land being constant, a 1% increase in the material inputs gave rise to a 0.42% rise in the output. Similarly, with material inputs and labour as constants, a 1% rise in land leads to a 0.05% rise in the output. It is noted that a 1% rise in labour resulted in a 0.61% increase in output, assuming land and material inputs remained constant. This inelastic production pattern was consistent across both early and late-season cassava production, implying that changes in input quantities led to proportionally smaller changes in output levels. This finding aligns with the research by Koutsoyiannis (2004) and Onweh (2013), who also observed the inelastic production of cassava in Ebonyi State, Nigeria.

Additionally, the analysis revealed that all cassava farm groups exhibited increasing returns to scale. This means that increasing inputs while holding others constant would yield a more than proportional increase in output, ceteris paribus. These results suggest that there is potential for output improvement among cassava farmers in southeast Nigeria. The maximum likelihood estimation of parameters from the Cobb-Douglas stochastic frontier production function indicated that labour and material inputs had a positive and statistically significant effect on the economic efficiency levels achieved by the farmers, while land was not significant. The inefficiency model further revealed that socio-economic factors such as educational level, farming experience, amount of credit, extension visits, and age significantly influenced economic efficiency, whereas household size was not significant. Output elasticity of production concerning labour, land, and material inputs were 0.61, 0.05, and 0.42, respectively,

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for all farms; 0.68, 0.04, and 0.36 for farms at early season; 0.70, 0.03 and 0.31 for farms at late season. This implies that all farm groups, regardless of the season, were operating under conditions of increasing returns to scale. The primary constraints to cassava production in the study area, ranked by severity, included high labour costs, inadequate capital, high costs of fertilizer and agrochemicals, insufficient farm mechanization, limited technical knowledge, low yields, poor market prices, scarcity and high cost of improved cassava stems, high transportation costs, fire outbreaks, inadequate cultivable land, poor road infrastructure, adverse weather conditions, pest and disease attacks, and low demand for cassava tubers.

CONCLUSION

Early and late-season cassava production is not only prevalent but also highly profitable in the South Eastern States of Nigeria. This profitability is substantiated by positive values of mean net farm income, net farm income, gross margin, and net return on investment achieved by the farmers. Despite demonstrating a commendable level of efficiency in production, there remain significant inefficiency gaps that warrant attention. Intriguingly, the study revealed no substantial differences in the means of net farm income and economic efficiency between early and late cassava growers, indicating similar profitability across both seasons. However, the production of cassava in the region faces numerous challenges, including high production costs, insufficient access to quality inputs, and suboptimal farming techniques. To bridge these gaps and elevate the production levels, efficiency, and net farm income of cassava growers, it is imperative to formulate and implement robust policies and programs. Addressing these constraints effectively will not only boost cassava production but also enhance the overall agricultural output and economic stability of the region.

The novelty lies in examining both early and late farming seasons, the study provides a comprehensive understanding of how socio-economic factors vary across different agricultural cycles. This dual-season approach is relatively rare and offers more detailed insights into the dynamics of cassava production throughout the year. Understanding these adaptive behaviors can inform the development of more resilient agricultural systems.

Practical Implications

Understanding the socio-economic factors that influence production during different seasons can help in designing strategies that maximize output in both early and late farming seasons. For example, planning for labour-intensive activities when labour is more readily available can optimize production. Leveraging mobile technology and other digital tools to provide real-time information on weather forecasts, pest outbreaks, and market prices can help farmers make informed decisions and optimize production.

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Social Implications

Increased cassava production can lead to more stable incomes for farmers, especially those from lower socio-economic backgrounds. This stability can reduce poverty levels and improve living standards. Higher production outputs ensure a more consistent supply of cassava, which is a staple food in Nigeria. This can help reduce food insecurity, particularly in rural areas.

Government and policymakers can formulate policies that specifically address the needs of different socio-economic groups. Policies could be designed to provide more support to smallholder farmers who may have limited access to resources.

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