Asian Journal of Agricultural Extension, Economics & Sociology

Volume 42, Issue 9, Page 82-102, 2024; Article no.AJAEES.115671
ISSN: 2320-7027

Analysis of Sustainable Market Conditions and Determinants Influencing Farmers' Involvement in the Commercialization of Cocoyam in Anambra State, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/ajaees/2024/v42i92544

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/115671

Original Research Article

Received: 08/02/2024
Accepted: 11/04/2024
Published: 05/09/2024

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Cite as: *Obianefo, Chukwujekwu A., Chinwe A. Isibor, Cecilia A. Nwigwe, Uzochukwu V. Uchemba, and Chijindu E. Nwankwo. 2024. "Analysis of Sustainable Market Conditions and Determinants Influencing Farmers' Involvement in the Commercialization of Cocoyam in Anambra State, Nigeria". Asian Journal of Agricultural Extension, Economics & Sociology 42 (9):82-102. https://doi.org/10.9734/ajaees/2024/v42i92544.*

ABSTRACT

This study on the analysis of sustainable market conditions and determinants influencing farmers' involvement in the commercialization of cocoyam in Anambra State, Nigeria focused on six specific objectives that ascertained the market conditions for cocoyam marketing, identified the commercialization index of the commodity, described the determinants of farmers' participation in the commercialization of the commodity, estimated the profitability of smallholder's cocoyam production/marketing, and its determinants, and identified the challenges to cocoyam production/marketing in the area. A multistage sampling technique involving purposive and simple random sampling was employed to collect data from 368 cocoyam farmers. The study used a combination of analytical tools such as descriptive statistics, the Lorenz curve, marketing margin analysis, and ordinary least square regression achieved from the SPPS version 25 and Microsoft Excel. The study revealed the farmers' average age and production/marketing experience as 19 years. The Gini coefficient value of 0.236 closer to zero shows a near-perfect condition in the area, with a 68.0% commercialization index. Gender (11.48)***, marital status (8.98)***, and cooperative membership (4.81)** are the positive factors influencing market participation. The farmers realized a profitability ratio of 0.74 and a return on investment of 1.85. This profitability ratios are positively determined by sex (16.45)***, farming experience (4.58)***, and number of extension contacts (6.48)***. The farmers face the following challenges; inadequate capital, limited access to improved cultivars, and bad road networks among others. However, policymakers should therefore prioritize intervention to address the identified bottlenecks hindering market participation, profitability, and scalability of cocoyam production and marketing.

Keywords: Market structure; participation; commodity; commercialization; cocoyam.

1. INTRODUCTION

Cocoyam (*Colocasia and Xanthosoma spp*) is a staple root crop in many developing countries of Africa, Asia, and the Pacific [1-2]. It is an important source of food, income, and employment for millions of smallholder farmers, especially in Nigeria, which is the largest producer of the crop in the world [3]. However, cocoyam has received little attention from both government and research communities, compared to other root and tuber crops such as cassava and yam [4-5]. As a result, the potential of cocoyam to contribute to food security, poverty reduction, and economic development has not been fully realized [6]. However, Osuafor et al. [7] and Jung [8] submitted that, ensuring food security in a country is often a safeguard against issues such as hunger and malnutrition, which can impede economic progress. Again, cocoyam processing into flour, chips, and other value-added products provides opportunities for entrepreneurship and the development of small-scale industries [9].

One of the key challenges facing cocoyam production and marketing is the lack of a well-developed and efficient market system, which has severally resulted in imperfect market competition or inequality in revenue allocation [3,10]. However, Anumudu et al. [11] noted that a well-functioning market is needed to promote agriculture-driven economic growth and uplift rural incomes. Regrettably in Anambra State in particular and Nigeria in general, the market conditions of cocoyam are characterized by low and unstable prices, high transaction costs, poor quality standards, limited access to market information and credit, and weak linkages among market actors [12]. Bedru and Motunrayo [13] confirmed that many cocoyam farmers lack access to formal credit facilities, making it difficult for them to invest in improved farming practices, such as the use of high-quality seeds, fertilizers, and mechanized equipment. Ifeanyi-Obi et al. [10], Temidayo et al. [14], and Zhao et al. [15] equally revealed that smallholder farmers often lack timely and accurate information about market demand, prices, and quality standards. Owusu-Darko et al. [16] believe that cocoyam is a perishable crop, and farmers often struggle with post-harvest losses due to inadequate storage facilities and poor transportation infrastructure. These factors limit the profitability and competitiveness of cocoyam and discourage farmers from investing in the crop and participating in the market. Kotchikpa, and Wendkouni [17] and Nkeme et al. [6] in their study argued that these factors affect the commercialization index of smallholder cocoyam farmers. Omotesho et al. [18] stated that these smallholder farmers are primarily responsible for the cultivation and supply of cocoyam commodity.

As an age-long practice of subsistent agriculture in Africa, many farmers produce for household consumption with little to sell to meet family needs [19], however, the Food and Agricultural Organization [20] submitted that smallholder farmers have been advised to take advantage of agribusiness opportunities to participate in direct marketing of their farm produce to reduce the interference of middlemen who reap off their profit in the agricultural enterprise. This is what differentiates this study from previous studies that focused on either the production or marketing aspect of the cocoyam value chain in Africa [21-23].

The African Continental Free Trade Area (AfCFTA) is a wonderful initiative that aims to create a single market for goods and services, business, and investment across the 55 member states of the African Union (AU) [24]. The AfCFTA has the potential to boost intra-African trade, enhance regional integration, promote industrialization and diversification, and foster economic growth and development [25]. The AfCFTA also offers a unique opportunity for cocoyam producers and marketers to access a larger and more dynamic market, improve their productivity and profitability, and increase their value addition and competitiveness [26]. For effective participation in a larger market like AfCFTA, there is a need to understand the farmers' managerial and socioeconomic characteristics that are either positively or negatively influencing their profitability, and the commercialization index which refers to the degree to which farmers sell their output in the market, as opposed to consuming it at home or exchanging it for other goods and services [27]. However, to realize the benefits of the AfCFTA, cocoyam stakeholders need to understand the market dynamics of cocoyam and the factors that influence the level of commercialization of the crop. This definition confirmed that commercialization has implications for farmers' income, welfare, and livelihood strategies, as well as for the overall performance of the cocoyam sector. The study by Boakye-Achampong et al. [28], Tariku et al. [29], Ridwan et al. [23] listed the determinants of commercialization as the level of education, household size, and farm size, and access to credit among others. A detailed analysis of this study's determinants will help policymakers design interventions that are tailored to promoting cocoyam commercialization in the Anambra State. Reiteratively, Ezeano et al. [30] argued that commercialization is influenced by various factors, such as market conditions, production factors, household characteristics, institutional factors, and policy environment. This study is among the recent studies to integrate the production and marketing of cocoyam to uncover the agribusiness opportunity in the sector. Though Omotesho et al. [18] and Nwafor [22] attempted to identify the variables influencing farmers' attitudes and choices regarding participation in the commercialization of cocoyam, they did not adequately describe the market conduct and structure conditions of cocoyam farming. This contributes to the novelty of this study. Therefore, this study aims to analyze the sustainable market conditions and determinants influencing farmers' involvement in the commercialization of cocoyam in Anambra State, Nigeria.

At the end of this study, the researcher(s) aims to gain a deep understating of the market condition of cocoyam marketing, quantify the level of commercialization, and uncover the factors influencing farmers' involvement in the commercialization process of cocoyam production and marketing. The study will contribute to the existing literature on cocoyam marketing and commercialization, and the policy discourse on the AfCFTA and its implications for the agricultural sector in Anambra State in particular and Nigeria and Africa in general.

1.1 Objectives of the Study

The specific objectives of the study are to:

i. ascertain the market conditions of cocoyam marketing in the study area;
ii. identify the commercialization index of the cocoyam commodity;
iii. describe the determinants of farmers' participation in the commercialization of the cocoyam commodity;
iv. estimate the profitability of smallholders' cocoyam production/marketing;
v. describe the determinants of profitability of smallholder cocoyam production; and
vi. identify the challenges of smallholder cocoyam production/marketing.

2. EMPIRICAL REVIEW

2.1 The Market Conditions of Cocoyam Marketing

Fadipe et al. [31] investigated cocoyam marketing in Sagamu Local Government Area,

Ogun State, Nigeria. They collected primary data from 120 traders using random sampling. Analysis of the Gini Coefficient revealed values of 0.433 for wholesalers and 0.506 for retailers, indicating an imperfect market condition

Similarly, Osalusi and Oloba [32] examined the market structure of yam in selected markets in Ibadan, Oyo State. Employing simple random sampling techniques, they surveyed 120 yam sellers and utilized Gross margin and Gini coefficient techniques for data analysis. Their study yielded a Gini coefficient value of 0.572, indicating an imperfect competitive market structure.

In another study, Opata et al. [33] examined the market structure and conduct of cocoyam in the industry in South East, Nigeria. Their research involved data collection from a random sample of 260 farmers, wholesalers, and retailers. They utilized concentration ratios, the Gini coefficient, and the Herfindahl-Hirschman index for data analysis. The Gini coefficient and Lorenz curve plotted from the data indicated values of 0.55 for farmers, 0.56 for wholesalers, and 0.70 for retailers, suggesting an inequitable distribution of market shares and income among marketers.

Similarly, Nwankwo et al. [34] conducted a study on the Structure and Profitability of Wholesale Marketing of Cocoyam in Southeast, Nigeria. Their research utilized multistage, purposive, and random sampling techniques to gather data, administering a structured questionnaire to 216 cocoyam wholesale marketers. Market concentration, indicative of the nature of competition, was assessed using the Gini Coefficient and Lorenz curve. Their findings revealed a Gini Coefficient value of 0.5642, suggesting a significant concentration of market revenue among a small number of wholesale marketers.

2.2 The Commercialization Index of the Cocoyam Commodity and its Determinants

Omotesho et al. [18] conducted a research project in Oyun Local Government Area, Kwara State, Nigeria, aiming to evaluate the potential for cocoyam commercialization. They utilized a two-stage random sampling method, resulting in 154 respondents. Data analysis involved descriptive statistics and multiple regression. The study disclosed that farmers' average age was 53.9 years, with an average farming experience of 22 years and a farm size averaging 4.3 acres. The awareness level regarding cocoyam's uses was high, with 73.52% of respondents displaying knowledge. Additionally, farmers generally showed a favorable attitude (mean score = 2.38) toward cocoyam commercialization, indicating significant potential in the area.

Similarly, Ogundele [35] investigated factors influencing output commercialization among small-scale farmers in Nigeria, utilizing panel data from the National Bureau to survey households in wave 2 and 3. The analysis incorporated the household commercialization index and Tobit regression. Findings revealed commercialization indices of 0.45 and 0.77 for wave 2 and 3 respectively, with determinants including age, sex, and farm size.

Hussayn et al. [36] conducted a study in Oyo State on the impacts of agricultural commercialization on the poverty status of smallholder cassava farming households. They employed a multistage sampling method to select 189 households, analyzing the data using the household commercialization index, FGT index, ordered probit model, and logistic regression model. Demographically, the study noted average age, household size, and farming experience of 42 years, 5 people, and 12 years respectively. The household commercialization index stood at 0.58, influenced by factors such as education level and farming experience.

2.3 The Profitability of Smallholders' Cocoyam Production/Marketing and Its Determinants

Afolami and Ogungbenro [37] conducted a study on the profit efficiency of smallholder cocoyam-based farmers and its determinants in Osun State, Nigeria. They utilized multistage and random sampling techniques to select 180 smallholder cocoyam farmers. The study employed the Cobb-Douglas stochastic profit function to achieve its objectives. Results indicated an average profit efficiency of 44.9%, suggesting a potential increase in farmers' profit by 55.1% with the same production cost. Determinants of profit included the level of education, access to credit, farming experience, household size, access to extension services, and marital status.

Similarly, Ridwan and colleagues [23] investigated the profitability of cocoyam production and its determinants in Cross River State, Nigeria. They employed primary data collected through a structured questionnaire and

conducted analyses using cost and return analysis, multiple regression, and the Likert rating scale. Their findings unveiled a return on investment of 3.17, resulting in a profit value of 428.04 USD per hectare. Determinants of profit identified in their study encompassed the level of education, household size, output, cooperative membership, access to credit, and farm size.

Anyiam and colleagues [38] conducted a study on the economics of cocoyam production in Orsu Local Government Area, Imo State, Nigeria. Their research focused on examining the economics of cocoyam production in the specified area. They collected primary data from 50 smallholder cocoyam farmers using a random sampling technique. The data underwent analysis through descriptive statistics, Gross Margin Model, Ordinary Least Square multiple regression analysis, and Profitability Index Model. The findings revealed an internal rate of return of 1.65, indicating that for every ₦1 invested in cocoyam production, ₦1.65kobo was realized. The study also identified several factors influencing cocoyam output, including the quantity of fertilizer, farm experience, access to credit, household size, and membership of cooperatives. Furthermore, the profitability index of cocoyam production was determined to be 2.44, indicating a high level of profitability.

2.4 The Challenges of Smallholder Cocoyam Production/Marketing

Wilcox et al. [39] investigated the efficiency of smallholder cocoyam farmers in South-South Nigeria. They employed multistage, purposive, and random sampling techniques to select 200 cocoyam farmers for their survey. Descriptive statistics and the Cobb-Douglas stochastic frontier cost function were utilized for data analyses. The study revealed various constraints affecting cocoyam production, including the scarcity of improved high-yielding corms, lack of capital, high labour costs, expensive transportation, inadequate storage facilities, and challenges posed by diseases and pests.

In a similar study, Ariyo et al. [40] conducted a study on the determinants of the input-output relationship of yam production in the Gboyin Local Government Area of Ekiti State, Nigeria. They utilized multistage sampling techniques to select 140 farmers for their research. The study employed descriptive statistics and multiple regression analysis for data analysis. The challenges identified in yam production within the study area encompass inadequate capital, high input costs, pest and disease incidence, insufficient planting materials, lack of storage facilities, poor soil conditions, unfavourable produce prices, inadequate transportation infrastructure, limited extension services, insufficient farmland, and difficulties accessing farm inputs.

2.5 Research Gap

Based on the researcher's review, several potential research gaps emerge from the existing literature:

1. Market Conditions of Cocoyam Marketing in Anambra State, Nigeria: Previous studies have predominantly focused on cocoyam marketing in the Southeast zone as a whole or other geopolitical zones, neglecting a specific examination of Anambra State. Comparing and contrasting the market structure, conduct, and performance of cocoyam marketing in Anambra State with other regions or crops using appropriate indicators and methodologies could provide valuable insights.

2. Commercialization Index of Cocoyam and Its Determinants in Anambra State, Nigeria: There is a dearth of empirical evidence on the commercialization index of cocoyam and its determinants within Anambra State. Researchers have an opportunity to measure the extent of cocoyam commercialization among farmers in the study area using a suitable index and explore factors influencing their participation in the market. Additionally, investigating the relationship between commercialization, income, food security, and poverty reduction among cocoyam farmers could offer valuable insights.

3. Profitability of Smallholders' Cocoyam Production/Marketing and Its Determinants in Anambra State, Nigeria: Limited research exists on the profitability of smallholder cocoyam production/marketing in Anambra State. Researchers could estimate the costs and returns associated with cocoyam production/marketing among small-scale farmers in the region and analyze factors affecting their profitability. Additionally, exploring opportunities and challenges related to value addition and processing of cocoyam products could enhance their profitability and competitiveness.

4. Challenges of Smallholder Cocoyam Production/Marketing in Anambra State, Nigeria: Further research is needed to identify and

prioritize the challenges faced by cocoyam farmers and marketers in Anambra State. Researchers could assess the availability and accessibility of extension services, credit facilities, input supplies, and market information for cocoyam stakeholders in the area, proposing solutions to overcome identified constraints.

These research gaps provide avenues for future studies to contribute to a deeper understanding of cocoyam production and marketing dynamics in Anambra State, Nigeria, ultimately informing policy interventions and enhancing the livelihoods of cocoyam stakeholders.

3. METHODOLOGY

3.1 Area of the Study

The study was conducted in Anambra State, which is located in the southeastern region of Nigeria. Anambra State is comprised of 21 Local Government Areas (LGAs) categorized into four agricultural zones: Anambra, Onitsha, Awka, and Aguata. It shares borders with Delta State to the West, Imo State and Rivers State to the South, Enugu State to the East, and Kogi State to the North [41]. The inhabitants of Anambra State primarily engage in farming activities and have a notable history of trade and commerce [42]. Geographically, Anambra State is situated between Latitudes 5°32' and 6°45'N and Longitudes 6°43' and 7°22'E. It spans an estimated land area of 4,865 square kilometers and experiences an average rainfall of 1544 mm. The region has an average temperature of 26.8°C [43]. The ecological conditions in Anambra State are favourable for cocoyam production and its subsequent commercialization.

3.2 Sample Size and Sampling Technique

Multi-stage and simple random sampling technique was employed to select adequate study representatives. In the first stage, an infinite sample size determination technique was applied to 60% of the proposed population at a 95 confidence level and 0.05 confidence interval. The formula adapted from Obianefo et al. [44] is defined as:

$$\mathrm{SS} = \frac{[\mathrm{Z}^2\rho(1-\rho)]}{\mathrm{C}^2}$$

Where:

SS = sample size
Z = given Z value
ρ = percentage of population
C = confidence level. Thus:

$$SS = \frac{[1.96^2 * 0.6(1-0.6)]}{0.05^2} = 368.49 \cong 368$$

In stage two, 2 agricultural zones were randomly selected, from where 2 communities were randomly selected to avoid bias sampling.

In the third stage, 2 villages were randomly selected from each community to make a total of sixteen (16) villages for the study. Finally, at stage four, twenty-three (23) cocoyam farmers were randomly sampled from each village to bring the sample size to three hundred and sixty-eight (368) respondents for the study. The breakdown of the sample selection is presented in Table 1.

Rahman et al. [45] advocated for the adoption of multistage sampling, highlighting its versatility in accommodating various stages of data collection to align with researchers' requirements. Similarly, Moher et al. [46] and Weinreb et al. [47] emphasized how this method facilitates the progression of the study from state to Local Government Area, and from community to neighbouring villages where cultivation occurs. To enhance the study's credibility, respondents were randomly selected from their respective villages.

3.3 Data Collection

Four research assistants were recruited and trained to help with the data collection to save time and ensure wider reach. The research assistants covered one LGA each. The fieldwork lasted from March 20th – April 14th 2023. An Android data collection tool kit ("*kobo-collect*") was used for the data collection. The structured questionnaire was coded into the App. According to Obianefo et al*.* [48], utilizing the Android App ("Kobocollect") for data collection not only aligned with the COVID-19 guidelines by minimizing physical contact but also enhanced the data quality by mitigating the risk of research assistants falsifying information. This was achieved through the direct linkage of the App's database with the analyst's SPSS package database.

Table 1. Sample selection from each of the selected LGA

Zone	LGAs	Community	Town	Sample size
Aguata	Nnewi South	Amichi	Okpala	23
			Udene	23
		Ukpor	Amihe	23
			Egbu	23
	Aguata	Achina	Ogboji	23
			Uga	23
		Umuchu	Ugwuakwu	23
			Umugama	23
Awka	Awka South	Ifite Awka	Akpana.	23
			Enugu	23
		Nibo	Ezeawulu	23
			Umuanum	23
	Awka North	Achalla	Amukabia	23
			Odawa	23
		Ebenebe	Obuno Okpuno	23
			Umuoye	23
Total				**368**

Source: Researcher's computation, 2023

3.4 Data Analysis

This study used a combination of different analytical tools which include descriptive statistics, a household commercialization index, a Gini coefficient, and a multiple regression analysis. Objective one (ascertain the market conditions of cocoyam marketing) was achieved with a Gini coefficient adapted from Nsikan et al. [49]. Objective two (identify the commercialization index of the cocoyam commodity) was achieved with a household commercialization index adapted from Mamo and Beguije [50] and Gebre et al. [51]. Objective three (describe the determinants of farmers' participation in the commercialization of the cocoyam commodity) was achieved with a multinomial logistic regression adapted from Shah et al. [52].

3.5 Model Specification

3.5.1 Gini coefficient (GC)

In the agricultural sector, the marketing of crops plays a crucial role in determining the economic well-being of farmers and stakeholders involved [53]. Cocoyam, a nutritious and versatile crop, holds significant importance in many regions worldwide. To evaluate the distribution of profits and understand the level of inequality within the cocoyam marketing system, the researcher employed a statistical tool called the Gini coefficient. The Gini coefficient is a widely used measure of income or wealth distribution within a given population [49], when applied to the cocoyam marketing sector, it helps us evaluate the concentration of profits among market participants, highlighting the potential inequalities by examining the distribution of incomes earned from cocoyam sales. This helps policymakers to gain valuable insights into the fairness of the marketing system and identify areas that require attention. Gona et al. [54] noted that a high Gini coefficient in marketing reflects a potential imbalance in the distribution of profits. It may indicate disparities in pricing, bargaining power, or access to markets and resources. Identifying the causes of inequality can guide policymakers, agricultural organizations, and market participants in implementing strategies to promote fairer trade practices, enhance market access for small-scale farmers, and ensure equitable income distribution.

The Gini coefficient adapted from Nsikan et al. [49] is defined by:

$$GC = 1 - \sum X_i Y_i$$

Where: GC = Gini coefficient, X = Cumulative percentage of cocoyam farmers/traders, Y = Cumulative percentage of total sales, ∑ = Summation sign. The Gini coefficient ranges between 0 and 1, where 0 represents perfect, and 1 represents maximum inequality or high level of market imperfection.

3.5.2 Ordinary least square (OLS) regression

Ordinary Least Square (OLS) regression analysis is a widely used statistical method for analyzing the relationship between a dependent variable and one or more independent variables. It is particularly useful when the relationship between variables is expected to be linear. In the context of cocoyam commercialization, OLS regression can help identify the key determinants that impact the production, marketing, and profitability of cocoyam products. This approach enables researchers to understand and predict outcomes based on multiple predictors. According to Adam and Estevez [55], OLS incorporates more than one independent variable. Gulden and Nese [56] further explain that OLS analysis is conducted to identify correlations and causal relationships between two or more variables. It also aids in making predictions related to examining the determinants of cocoyam market commercialization.

OLS regression analysis provides several advantages, including the ability to control for confounding factors, evaluate the combined impact of multiple variables, and determine the relative importance of independent variables in explaining the dependent variable. However, it is important to acknowledge certain limitations, such as the need for high-quality data, the potential presence of multicollinearity (high intercorrelation) among independent variables, and adherence to assumptions for reliable results. Researchers such as Gulden and Nese [56] and Piyal et al. [57] differentiate between univariate regression analysis, which involves a single independent variable, and multivariate regression analysis, which incorporates two or more independent variables. In OLS regression analysis, an attempt is made to simultaneously account for the variations of the independent variables in the dependent variable, commonly reported as the coefficient of multiple determination (R^2) [56]. Alexopoulos [58] adds that the primary objective of OLS is to predict the dependent variable (*Y*) based on the independent variable (*X*) or describe how *Y* is influenced by *X* (through a regression line or curve).

The simple OLS regression analysis model adapted from Srinidhi et al. [59]; and Adam and Estevez [54] is defined by:

$$Y_i=\beta_0+\beta_1X_{i1}+\beta_2X_{i2}+\cdots+\beta_p X_{ip}+\varepsilon$$

Where:

i = n observation
Y_i = dependent variable
X_i = explanatory variables
β_0 = Y-intercept (constant term)
β_p = slope coefficient for each explanatory variable
ε = the model's error term (also known as the residuals).

3.6 Summary of Data

Table 2 presents an overview of the variables utilized in the study to achieve the research objectives, facilitating the formation of a sound conclusion. The standard deviation of 0.50 is indicative of the level of variability for the variables: sex, marital status, cooperative membership, and access to credit. According to Obianefo et al. [60], a standard deviation exceeding 0.49 is considered significant in demonstrating the variability of farmers' responses, thus aiding decision-making. The mean age of the cocoyam farmers examined in this study was approximately 41 years, indicating that they are in the prime stage of their productive lives. Uchemba et al. [61] observed that younger farmers tend to be more risk-averse. Additionally, the average farming experience of 18.94 suggests that cocoyam farmers have dedicated over a decade to this enterprise, which enables them to grasp the fundamental principles of cocoyam production. This finding aligns with Nwafor's [22] discovery that a significant proportion (36%) of respondents had experience ranging from 11 to 20 years in cocoyam production. The average household size of 6.69 approximately means that each household is represented by 7 people in the study area. This number of people in farmer's households is high enough to support cheap family labour in the agricultural sector. On average, the cocoyam producers included in the study had approximately 1.92 extension contacts, indicating that each producer had around 2 interactions with extension advisors to enhance their production knowledge and experience.

Table 2. Summary of data included in the analysis

Variables	Mean	Standard deviation
Sex (dummy; 0 = female, 1 = male)	0.48	0.50
Age (year)	41.24	10.55
Marital status (dummy; 0 = single, 1 = married)	0.44	0.50
Years of formal education (year)	10.48	6.81
Farming experience (year)	18.94	7.19
Household size (Number of people)	6.69	3.57
Cooperative membership (dummy; 0 = no, 1 = yes)	0.49	0.50
Extension contacts (Number)	1.92	1.51
Farm size (ha)	0.186	0.098
Cocoyam produced (kg)	4166.1	991.2
Cocoyam sold (kg)	2817.7	978.0
Selling price (USD)	0.41	0.25
Access to credit	0.51	0.50
Revenue (USD)	84,749.89	34701.02

Source: Field survey, 2023

The study revealed that the average farm size, measured in hectares (ha), was 0.186 ha for cocoyam production. This indicates that cocoyam production in the study area is predominantly undertaken by marginalized farmers who may not own the land on which they cultivate cocoyam for commercial purposes. Marginalized land ownership can contribute to food insecurity as these farmers have limited access to land and resources, making it challenging for them to produce an adequate supply of food for themselves and their communities [62]. Furthermore, the study found that the total amount of cocoyam produced was 4166.1 kg, while the quantity sold was 2817.7 kg. This trade volume helps estimate the level of farmers' participation and commercialization in the sector, as defined by Gebre et al. [51] as the proportion of products offered for sale by the farmers. Lastly, the average selling price per kilogram was 0.41 USD. By calculating the total amount of goods offered for sale and multiplying it by the average selling price, the study determined that the average revenue generated was 1,167.5 USD.

4. RESULTS AND DISCUSSION

4.1 Ascertaining the Market Conditions for Cocoyam Marketing

The findings regarding market conditions for cocoyam marketing are displayed in Fig. 1 and Table 3. The study adopted the Gini Coefficient and Lorenz Curve approach suggested by Sitthiyot and Holasut [63] to avoid the necessity for error minimization techniques in estimating the curve. Using this method, Park and Kim [64] noted that a greater distance between the Lorenz curve and the line of perfect equality indicates higher income or wealth inequality.

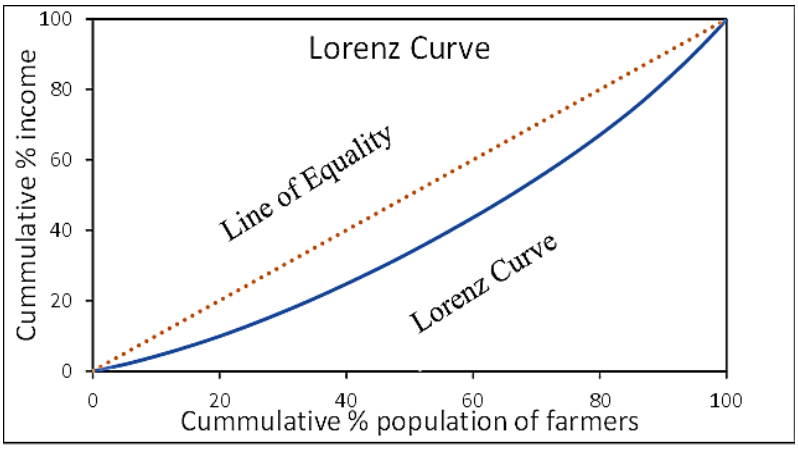

Fig. 1. Lorenz curve of income inequality

Table 3. Result of the Gini coefficient of smallholder cocoyam production/marketing

Income	Number of farmers	Proportion of farmers (X_i)	Proportion of Sales	Cumm. Sales (Y_i)	X_iY_i
1,444,740	20	0.054	0.046	0.046	0.003
2,987,990	33	0.090	0.096	0.142	0.013
957,920	12	0.033	0.031	0.173	0.006
5,394,170	59	0.160	0.173	0.346	0.055
7,887,980	92	0.250	0.253	0.599	0.150
12,515,160	152	0.413	0.401	1	0.413
31,187,960	368	1	1		0.639
$GC = 1 - \sum X_iY_i$: 1 – 0.639 = **0.361**					

Source: Field Survey, 2023

Table 4. The commercialization index of the cocoyam commodity

Items	Frequency	Percentage
0 - 0.49 (Low commercialization)	64	17.4
0.50 - 0.69 (Moderate commercialization)	134	36.4
0.70 - 1.00 (High commercialization)	170	46.2
Total	**368**	**100**
	Produced (kg)	**Sold (kg)**
Min	2516.0	1084.5
Max	5983.0	5562.3
Mean	4166.1	2817.7
Std. Dev	991.2	978.0
Commercialization index	0.68	

Source: Field Survey, 2023

Table 5. Determinants of farmers' participation in the commodity commercialization

Commercialization index	B	Std. Error	Beta	t-stat.
Constant	97.777	2.090		46.78
Gender	6.293	0.548	0.354	11.48***
Age	0.012	0.026	0.014	0.46
Marital status	4.932	0.549	0.275	8.98***
Education	-0.523	0.041	-0.400	-12.89***
Farming experience	0.072	0.039	0.058	1.87*
Household size	-0.222	0.079	-0.089	-2.82**
Cooperative membership	2.635	0.548	0.148	4.81***
Extension contacts	-2.167	0.187	-0.368	-11.60***
Farm size	-0.097	0.186	-0.016	-0.52
Unit selling price	-0.002	0.002	-0.046	-1.49
Access to credit	-3.932	0.548	-0.221	-7.18***
F-stat.	66.74***			
R^2	0.673			
Adjusted R^2	0.663			
Obs.	368			

*Source: Field Survey, 2023. * (Sig. @ 10%), ** (Sig. @ 5%), and *** (Sig. @ 1%)*

The results showed that the total income for the 368 smallholder cocoyam farmers was N31,187,960 at N700/USD, which equated to 44,554.23 USD. The Gini Coefficient value was calculated as 0.361, indicating that the cocoyam market was relatively equitable and suggesting a low level of income inequality among smallholder cocoyam farmers. Cocoyam production and sales are not heavily concentrated in the hands of a few individuals, as evidenced by the Lorenz Curve being closer to the line of equality. According to Nsikan et al. [49] and Chukwulobelu et al. [65], a Gini coefficient value below 0.5 is considered close to perfect competition. However, it is likely that the organization of farmers into a strong group, such as a farmers' cooperative, has enhanced their bargaining power, facilitated access to markets and

resources for small-scale farmers, and promoted a fairer distribution of income [54]. This result confirms that smallholder farmers are prepared to participate in the African Continental Free Trade Area (AfCTA) sustainably. This finding represents a significant improvement compared to the 0.564 reported by Nwankwo et al. [12] in their study in Southeast Nigeria.

4.2 Identifying the Commercialization Index of the Cocoyam Commodity

Table 4 presents the extent of commercialization within the cocoyam market. The table shows that the minimum cocoyam production was 2516.0 kg, with a corresponding 1084.5 kg offered for sale. On the other hand, the maximum production reached was 5983.0 kg, with a maximum volume offered to the market of 5562.3 kg. These results reveal a farmers' market participation index or commercialization value of 0.68 (68.0%). The researchers further discovered that a greater proportion (46.2%) of the farmers exhibited a high commercialization index ranging from 0.70 to 1.00, while an additional 36.4% had a moderate commercialization index ranging from 0.50 to 0.69. The remaining 17.4% demonstrate a low commercialization index of 0.00 to 0.49.

These findings revealed that cocoyam farmers in the study had a high degree of commercialization index since they sold 68% of their produce. This supports the assumption of Ukwu et al. [5], who noted that the demand for cocoyam is expanding both domestically and internationally due to its nutritional value and versatility in various culinary applications. However, the commercialization value of 0.68 is lower than the 0.77 reported in the work of Ogundele [35] for Nigerian small-scale farmers. Nonetheless, the fact that 68.0% of cocoyam production was offered for sale in Anambra State indicates that cocoyam production is not primarily for household consumption. This result convincingly demonstrates that farmers in the area possess a fair market orientation, promoting increased market participation.

4.3 The Determinants of Farmers' Participation in the Commercialization of the Cocoyam Commodity

The determinants of commercialization in the cocoyam market were analyzed using ordinary least square regression through the utilization of R software. The findings from this analysis are presented in Table 5. In terms of diagnostic evaluation, the F-statistics value of 66.74 was found to be highly significant at a 1% level of probability. This indicates that, among the variables included in the model, at least one of them significantly influences farmers' decision to participate in cocoyam commercialization in the area. Therefore, the initial assumption that the socioeconomic characteristics of respondents do not impact cocoyam commercialization was rejected, given the significance of the identified variables.

Given the significant F-statistics value, it can be inferred that the selected model is well-fitted to explain the relationship between the dependent and independent variables. Moreover, considering the substantial number of explanatory variables included in the study, the adjusted R^2 appears to be more appropriate for interpretation. The adjusted R^2 value of 0.663 indicates that farmers' socioeconomic characteristics account for approximately 66.3% of the variation in their decision to participate in the cocoyam commercialization project. The remaining 33.7% of unexplained variation may be attributed to external factors beyond the farmers' control, such as competition, inflation, pests and diseases affecting yield, soil fertility, product quality, and climate change effects, among others. For a more accurate result, the standardized coefficient (Beta) value was used in the reporting.

The coefficients for gender (0.354), marital status (0.549), and membership in a cooperative (0.548) were found to be positively and statistically significant at a 1% level of probability. This suggests that an additional male cocoyam farmer is associated with a 0.354 unit increase in the decision to engage in commercialization. Additionally, male farmers exhibit a stronger market orientation compared to their female counterparts. This observation aligns with the argument of Mkandawire et al. [65], who suggested that historically, men have played significant roles in agricultural production, income generation, and decision-making within households [66]. Similarly, an increase in the number of married cocoyam farmers by one is associated with a 0.549 unit increase in their decision to engage in commercialization. The statistical significance and positive influence of marital status support previous studies by Obianefo, et al. [67], as well as Uchemba et al.

[61], who proposed that marriage brings additional responsibilities, motivating married farmers to increase the quantity of their farm produce offered for sale to meet family demands. Moreover, an increase in the number of farmers belonging to a cooperative group is associated with a 0.548 unit increase in their decision to engage in commercialization. This finding is consistent with Mukaila et al. [68], who found a positive relationship between cocoyam farmers' participation index and cooperative membership.

The coefficients for education (0.041), extension contacts (0.187), and access to credit (0.548) were found to be statistically significant at a 1% level of probability and negatively associated with the decision to engage in cocoyam commercialization. This suggests that an increase in the number of years of education or the presence of more educated farmers in the study is associated with a 0.041 unit decrease in the likelihood of farmers engaging in cocoyam commercialization. Contrary to initial expectations, an increase in the number of extension contacts is associated with a 0.187 unit decrease in the decision to engage in cocoyam commercialization. Furthermore, an increase in the number of farmers with access to formal credit is associated with a decrease in the decision to engage in cocoyam commercialization.

The coefficient for farming experience (0.039) was found to be positive and statistically significant at a 10% level of probability. This suggests that an increase in the number of years farmers have been involved in cocoyam production by one unit will lead to a 0.039 unit increase in their likelihood of participating in cocoyam commercialization. Thus, farming experience plays a vital role in enhancing farmers' knowledge, resource management skills, adaptation to local conditions, market understanding, and risk management capabilities. It equips them to meet market demands and increases their chances of success in cocoyam commercialization [36].

Additionally, the coefficient for household size (0.079) was found to be negative and statistically significant at a 5% level of probability. This implies that a unit increase in the number of household members will lead to a 0.079-unit reduction in cocoyam commercialization. However, a negative relationship between household size and commercialization aligns with the report of Nwafor [22], who suggested that farmers with large family sizes allocate a significant portion of their farm produce for household consumption before considering what can be offered for sale. These findings underscore the importance of market orientation, gender dynamics, household characteristics, and collective action in shaping farmers' market behavior and commercial success, among other factors.

Finally, these significant variables collectively influence farmers' decisions regarding their involvement in cocoyam commercialization.

4.4 Profitability of Smallholder's Cocoyam Production/Marketing

The profitability analysis of smallholder cocoyam production and marketing is summarized in Table 6. Cocoyam sales generated a revenue of 1,167.5 USD. Input expenses totaled 252.3 USD, constituting 72.1% of the entire cost. Labour costs amounted to 56.0 USD, representing 16.0% of the total production/marketing cost, bringing the overall operating cost to 308.25 USD. The gross profit from cocoyam sales amounted to 859.21 USD. This observation is consistent with findings by Enibe et al. [69] and Nwankwo et al. [12], suggesting that the cocoyam business is profitable, especially considering its potential within international markets such as the African Continental Free Trade Area (AfCTA).

Approximately 20% (171.84 USD) of the gross profit was allocated for salary, resulting in an actual profit of 687.36 USD. This allocation of 20% of profit for salary is utilized as a proxy for profit after tax, considering that smallholder farmers are not subject to taxation. They can compensate themselves with a salary and reinvest the remaining 80% for business growth and sustainability. Additionally, the depreciated asset value amounted to 41.43 USD, which represents 11.8% of the total expenses. The net earnings from this venture totaled 645.94 USD. The profitability ratio identified in the study is 0.74 (74.0%), slightly below the 80.0% benchmark observed by Fadipe et al. [31]. Moreover, the return on investment (ROI) value of 1.85, as determined by the study, is lower than the 3.17 reported by Ridwan and colleagues [23]. These findings indicate a necessity for improvement to optimize output, particularly in light of the comparative advantage that the African Continental Free Trade Area (AfCTA) will provide.

Table 6. Profitability of smallholder's cocoyam production/marketing

Description of variables	SI unit	Quantity	Unit price/cost/unit (USD)	Cost/Value (USD)	Percentage
Sales Revenue (A):					
Yield	Kg	2818	0.41	**1,167.5**	
Physical cost					
Cocoyam sett	Kg	315	0.41	130.3	
Fertilizer	Kg	204	0.43	87.5	
Herbicide	Liter	1	5.14	6.4	
Organic manure	Kg	263	0.07	18.8	
Transportation	N			9.3	
Total				**252.3**	72.1
Labour:					
Land preparation	Man-day	6	3.14	18.6	
Planting	Man-day	2	4.57	10.2	
Fertilizer application	Man-day	4	2.00	7.1	
Hand weeding	Man-day	4	3.00	11.1	
Harvesting	Man-day	3	3.00	9.0	
Total labour				56.0	16.0
Total variable cost (TVC) (B)				308.25	
Gross profit before salary (C: A – B)				**859.21**	
Less 20% of C as salary				171.84	
Profit after salary (D)				**687.36**	
Dep. on fixed assets excluding land				41.43	11.8
Tot cost (TC)				349.68	
Net returns (NR)				645.94	
Profitability ratio (GM/TVC)				0.74	
ROI (NR/TC)				1.85	

Source: Field Survey, 2023. Note: N700/1 USD

Table 7. Determinants of smallholder cocoyam farmers' profitability

				Confidence interval (CI) for:	
Profit variables	**Coefficient**	**Standard Error**	**t Stat**	**Lower 95%**	**Upper 95%**
Intercept	634.939	17.567	36.14	600.391	669.486
Sex	90.285	5.489	16.45***	79.490	101.079
Age	-1.473	0.260	-5.67***	-1.983	-0.962
Marital status	-6.497	5.492	-1.18	-17.298	4.304
Level of education	-1.909	0.406	-4.70***	-2.709	-1.110
Farming experience	1.780	0.389	4.58***	1.016	2.545
Household size	0.283	0.788	0.36	-1.268	1.833
Cooperative membership	-71.857	5.490	-13.09***	-82.653	-61.060
Number of extensions contact	12.135	1.872	6.48***	8.454	15.816
Farm size	-4.820	1.857	-2.60**	-8.473	-1.167
Access to credit	-3.673	5.488	-0.67	-14.465	7.119
F-statistics	53.68***				
R-square	0.601				
Obs.	368				

*Source: Field Survey, 2023. * (Sig. @ 10%), ** (Sig. @ 5%), and *** (Sig. @ 1%)*

4.5 Determinants of Smallholder Cocoyam Farmers' Profitability

The determinants of smallholder cocoyam farmers' profitability are presented in Table 7.

The ordinary least square regression analysis yielded an F-statistics value of 53.68***, which is significant at a 1% level of probability. The analysis returned an R-square value of 0.601, indicating that the selected explanatory variables accounted for 60.1% of the profit, while the remaining 39.9% unexplained is attributed to factors beyond the control of the farmers.

The coefficient associated with gender was positive and significant at a 1% level of probability. This suggests that a marginal increase in the number of male farmers engaged in cocoyam farming will lead to a profit increase of 90.285 USD. Analyzing the 95% confidence interval (CI) as presented in Table 7, it can be inferred that smallholder farmers are currently earning a profit that is 10.794 USD lower than their maximum attainable profit of 101.079 USD.

Similarly, the coefficient of age was negative and significant at a 1% level of probability, implying that an additional one-year increase in the age of farmers will reduce their profit from smallholder cocoyam production by 1.473 USD. The researchers also observed from the 95% CI that the minimum reduction in profit expected from the farmers was 1.983 USD, a value slightly exceeded as the farmers are 0.510 USD above their minimal reduction point.

Furthermore, the relationship between education and profit, based on the coefficient, was negative and statistically significant at the 1% significance level. This indicates that for each additional educational qualification obtained by the farmers, there is a corresponding decrease in profit from cocoyam production by 1.909 USD. From a 95% confidence interval perspective, the farmers' profit is 0.800 USD above the lower acceptable profit margin of 2.709 USD. These variables (gender, age, level of education, farming experience, cooperative membership, number of extension contacts, and farm size) are largely consistent with the findings of Ezeano et al. [30], Afolami and Ogungbenro [37], and Anyiam and colleagues [38], who reported significant relationships between profit and cocoyam production in similar studies.

The relationship between farming experience and profit derived from smallholder cocoyam farming is positive and significant at a 1% significance level. This implies that with each year of additional farming experience, there is a profit increment of 1.780 USD. According to Table 7, farmers have not yet reached the expected peak profit gain of 2.545 USD. Moreover, the impact of cooperative membership on profit was negative and significant at a 1% significance level. This indicates that as the number of smallholder farmers outside cooperative societies increases, the profit from the venture decreases by 71.857 USD.

The coefficient for the number of extension contacts was positive and statistically significant at a 1% significance level. This suggests that a marginal increase in the number of extension contacts available to smallholder cocoyam farmers will lead to an increase in their profit by 12.135 USD. However, the farmers have not yet achieved the optimal profit margin of 15.816 USD, as indicated by a 95% confidence interval. Lastly, there is a negative and significant relationship between farm size and profit at a 5% significance level. This indicates that an increase in farm size will reduce the farmers' profit by 4.820 USD. Merely increasing farmers' access to land, without considering mechanization, will not lead to a meaningful impact, as suggested by Garzón Delvaux et al. [70].

However, identifying these determinants is crucial for understanding their impact on profitability in cocoyam farming. For example, age and level of education may also play a role, with older farmers potentially having more experience but possibly facing challenges adapting to new market dynamics, while higher education levels might lead to better decision-making but could also introduce higher costs.

4.6 Challenges to Cocoyam Production/Marketing

The challenges encountered by smallholder cocoyam farmers in both farming and marketing are depicted in Fig. 2. Drawing from fieldwork data visualization, the researchers discovered that farmers face numerous obstacles. Notably, a significant majority (91.0%) of the farmers struggle with inadequate capital. This corroborates the findings of Fadipe et al. [31] and Wilcox et al. [39], who observed that the lack of capital hinders farmers' ability to purchase essential inputs such as high-quality seeds, fertilizers, and pesticides, consequently compromising both yield and cocoyam quality.

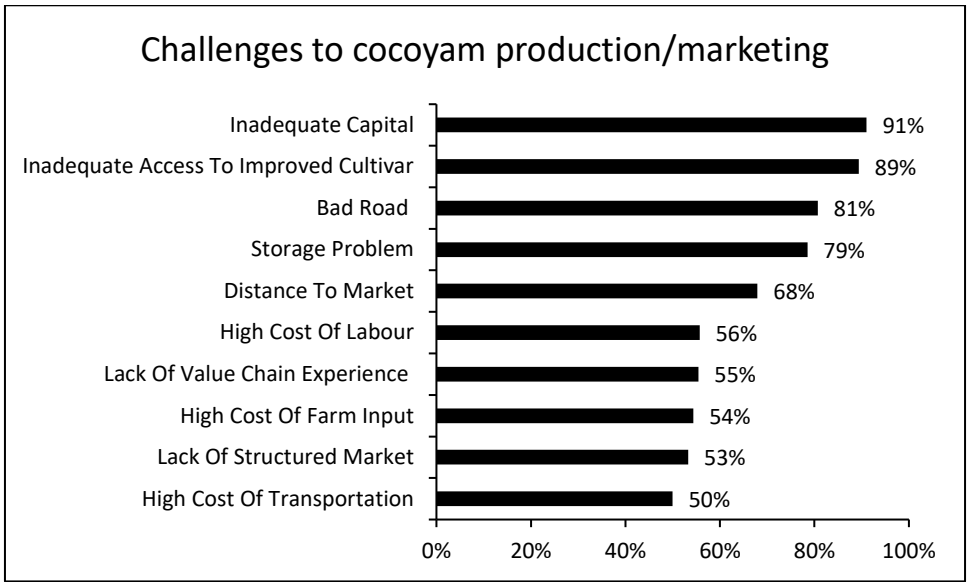

Fig. 2. Challenges to smallholder cocoyam production/ marketing

Furthermore, 89.0% of the farmers reported inadequate access to improved cocoyam cultivars. Regrettably, the prevalent cultivars available to farmers are native types, which are particularly susceptible to pests, diseases, and the effects of climate change. This observation aligns with the findings of Ifeanyi-Obi et al. [10] and Ariyo et al. [40].

Other significant challenges include poor road infrastructure (81.0%), inadequate storage facilities (79.0%), and long distances to markets (68.0%). Additionally, Ijioma et al. [71] argue that if farmers are unable to transport their produce to urban markets where demand is highest, they may experience reduced profits due to oversupply at the farm gate. Further challenges identified in the study encompass the high cost of labor (56.0%), lack of experience in the value chain (55.0%), expensive farm inputs (54.0%), absence of a structured market (53.0%), and costly transportation (50.0%). Addressing these issues is imperative if farmers aspire to transition from smallholder status to medium-scale operations in the long term.

5. CONCLUSION

The conclusion written from this study has consequences for both policy and practice in the agricultural sector, particularly in Anambra State, Nigeria. By analyzing sustainable market conditions and identifying determinants influencing farmers' involvement in cocoyam commercialization, the study offers valuable insights into the challenges and opportunities facing smallholder farmers and their ability to participate in the African Continental Free Trade Area (AfCTA).

In the first instance, the findings regarding market conditions, as indicated by a Gini Coefficient value of 0.361 and a 68.0% commercialization index, uncovered the importance of farmers' market orientation and negotiation skills. This revealed smallholder farmers' ability to engage effectively in commercial activities, which is crucial for their economic sustainability and livelihood improvement.

Furthermore, the study threw its weight on the financial implication of cocoyam farming, exposing that farmers allocate a significant portion (20%) of their profits to salary, which will help to improve their agribusiness sense and recapitalization. The recorded return on investment of 1.85 USD for every 1 USD invested demonstrates the profitability potential of cocoyam farming, which can motivate further investment and expansion in the sector.

Additionally, the identification of key determinants influencing commercialization index and profitability, such as sex, level of education, farming experience, cooperative membership, and extension contacts, provides actionable insights for policymakers and agricultural stakeholders. By addressing these determinants through targeted interventions and support

programs, policymakers can promote inclusive growth and sustainable development in the agricultural sector.

Moreover, the study pointed to several challenges faced by smallholder cocoyam farmers, including inadequate capital, poor infrastructure, high cost of labour, and lack of structured markets. Addressing these challenges is essential for enhancing farmers' productivity, market access, and overall well-being.

However, these findings will serve as a valuable resource for informing policy decisions, guiding agricultural development initiatives, and promoting the economic empowerment of smallholder farmers in Anambra State in particular and Nigeria in Nigeria. The study presents the need to address market constraints, improve access to resources, and enhance farmers' capacity to capitalize on emerging opportunities in the agricultural value chain.

5.1 Limitations of the Study

With financial constraints in mind, expanding the sample size to include more than 368 smallholder farmers across additional Local Government Areas could have provided a broader spatial and locational scope for the study. This expansion would have enhanced the potential for generalizing the findings to the entirety of Anambra State.

6. RECOMMENDATIONS

Based on the findings, the following recommendations were made:

1. The government and policymakers should introduce programs aimed at enhancing farmers' access to affordable credit and financial resources. This would alleviate constraints related to inadequate capital, enabling farmers to expand their markets and adopt innovative methods to scale up production and improve marketing capacity.

2. To enhance agriculture in Anambra State, the government should invest in improving rural infrastructure, including roads, transportation networks, and storage facilities. By reducing transportation costs and minimizing post-harvest losses, these improvements would increase the profitability of smallholder farmers.

6.1 Recommendation for Further Study

There is a need for other scholars to take up study to investigate the relationship between commercialization, income, food security, and poverty reduction among cocoyam farmers in Anambra State, Nigeria.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
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