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PROFITABILITY OF RICE PRODUCTION IN ANAMBRA STATE OF NIGERIA

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Abstract

Rice (Oryza sativa) is a staple food crop in Anambra State of Nigeria and could be found in the homes of the higher class, the middle-income earner and the poor. The rice farmers in Anambra state in 2024 rain-fed cropping season were aged (about 46 years) and have been in the farming business for more than 20 years and the youths were not willing to take up rice production as a means of livelihood because they consider it an unprofitable enterprise. This study carried out a gross margin analysis of rice production enterprise in Anambra State in the 2024 rain-fed cropping season as a second-best approach to determine the profit level of the enterprise and it applied Monte Carlo Simulation techniques to estimate the expected average gross margin and its distribution for a typical rice farmer in the state. This study used secondary cross-sectional data which was primarily collected in a survey carried out in eight Local Government Areas (LGAs) in the state during the 2024 rain-fed cropping season by the state's Value Chain Development Programme (VCDP). The survey design was a multistage stratified sampling design. In the first stage, 8 LGAs out of the 21 LGAs in the state were selected for further sampling. The sample size of 543 was apportioned to the selected LGAs with proportionality to their sizes. In each of the selected LGA, systematic sampling was used to select the desired number of farmers from the sampling frame which was the updated listing of all VCDP beneficiary farmers in the LGA. The data was collated and managed with Microsoft excel spread sheet and statistical analysis was carried out using the Statistical Package for the Social Sciences (SPSS).

The study computed the frequency of response of categorical variables and the descriptive statistics of the continuous variables. The estimated deterministic value of the gross margin was ₦ 3,201,954.16. On simulating with the monte Carlo technique, after 2000 iterations the resultant expected gross margin was estimated at ₦ 3,236,890 only. The average of the expected gross margin was ₦3,206,500; the expected minimum was ₦ 767,194; and the expected maximum was ₦ 5,748,844; and the expected class interval was estimated at ₦ 498,165. The constraints identified in the study were: insufficient funds, scarcity and high cost of labour, scarcity and high cost of improved rice seeds, and difficulty of obtaining credit. Some of the recommendations made by the study were: (i) government should subsidize farming inputs like fertilizers and herbicides to reduce the cost burden on farmers and financial institutions should make credit facilities available and affordable to the farmers. (ii) Government should increase the ratio of the number of extension agents to farmers so that the farmers will have more frequent contact with extension agents.

Background

Rice (Oryza sativa) is a staple food in Anambra State of Nigeria and could be found in the homes of the higher class, the middle-income earner and the poor (Onya, Okezie, and Ejiba, 2019). Rice is not only food for the people but it is also a major source of income for the states' farmers because farmers sell 80 per cent of total production and consume only 20 percent. The increasing demand for rice may be attributed to its numerous uses and importance. Nutritionists revere rice because of its ease of digestion: the sick, elderly and babies can digest this grain easily if cooked. Rice provides 21% of global human per capita energy and it is low in fat and protein, compared to other cereal grains. Rice also provides minerals, vitamins and fiber although; all constituents except carbohydrates are reduced by milling. Rice is used for industrial purposes, for beverages, roofing materials, flour and starch, livestock feed, medium for growing tropical mushroom and compost (Effiong, 2005; Idiong, 2005).

Nigeria has the potential to be self-sufficient in rice production, both for food and industrial raw material needs and for export. The Federal Government of Nigeria (FGN) with the assistance of the International Fund for Agricultural Development (IFAD) is implementing rice Value Chain Development Programme (VCDP) in nine states of the Federation, namely: Anambra, Benue, Ebonyi, Niger, Ogun, Nasarawa, Kogi, Enugu and Taraba states (IFAD, 2017). The objective of the Programme is to improve the livelihoods of smallholder farmers involved in rice and cassava value chains in these nine states. Obiekwe N., et.al., (2024) indicated that the profitability of rice production by the farmers would improve if adequate policy measures are adopted to mitigate certain constraints especially insufficient funds, scarcity and high cost of labour, scarcity and high cost of improved rice seeds. The governments' support to encourage the production of rice in Anambra State, notwithstanding no study has been taken to determine the profitability of rice production under the VCDP areas of intervention in the state in 2024 rain-fed farming season.

Problem Statement

Nigeria is Africa's leading producer of rice, consumer of rice, and incidentally one of the largest rice importers in the world. (FAO, 2017). Due to its increasing contribution to the per capita calorie consumption, the demand for rice has been increasing at a much faster rate than domestic production in Nigeria and more than in any other African country since mid-1970s (FAO, 2004). Recent studies by Obiekwe N, et.al. (2024) and Nwalieji H. U.

(2016) found out that the rice farmers were aged and have been in the farming business for an average of 19 years while youth participation in rice production remained low, as many youths do not perceive it as a viable source of livelihood. If this development is left uncontrolled, not only will the scarce foreign exchange be depleted on food importation, but the problems of youth unemployment, the menace of ingesting hard drugs, robberies, kidnappings and insecurity will be aggravated in the state. This study is aimed at determining the profitability of rice production in Anambra State to show that in spite of fluctuating input and output prices rice production enterprise is still profitable and worthy of undertaking as a means of livelihood by the youths in the state. If adequate policy measures are adopted to mitigate certain constraints especially insufficient funds, scarcity and high cost of labour, adulteration and fluctuating output and input prices, the teeming population of unemployed youths will take up rice production enterprise as a means of livelihood.

The Objective

The aim of this study was to carry out a gross margin analysis of rice production enterprise in Anambra State as a second-best approach to determine the profit level of the enterprise. The specific objectives were to determine the expected input and output values of an average rice farmer and apply Monte Carlo Simulation techniques to estimate the expected minimum, maximum and average gross margin of a typical rice farmer in the state.

Scope and Limitations of the Study

This Study was limited to VCDP rice farmers in Anambra State that participated in the rain-fed cropping season in year 2024. The primary survey carried out by the VCDP in Anambra State did not have this study in mind, consequently some variables such as labour were overly aggregated and the value of production used at home or given out as gift, cost of packaging and transportation were not explicitly captured in the survey.

Significance of the Study

Adequate knowledge of the profitability of rice production will enable the youths and prospective entrepreneurs to rank rice production properly among other candidate enterprises (for selection) to implement as a means of livelihood. The pursuit of rice production as a means of livelihood will assist in ameliorating the scourge of unemployment, which is one of the underlying causes of insecurity, robbery, kidnapping, prostitution, and other vices bedeviling Anambra State.

Methodology Study Area

Anambra is a state in the Southeastern region of Nigeria bordered by Delta to the west, Imo and Rivers to the south, Enugu to the east and Kogi to the north. The State is located between latitude 5^0 30' ' and 6^0 40' ' North of the equator and also between longitude 6^0 40 ' ' and 7^0 20' ' East of the Prime Meridian. The state's capital is Awka and its most populous city is Onitsha. Its second most populous commercial city is Nnewi. The state covers a land area of 4,844 km^2 and the main languages of the State are Igbo and English. Anambra State has the following 21 local government areas (LGAs) namely: Anambra East, Anambra West, Ayamelum, Ogbaru, Onitsha North, Onitsha South, Oyi, Awka North, Awka South, Anaocha, Dunukofia, Idemili North, Idemili

South, Njikoka, Aguata, Ekwusigo, Ihiala, Nnewi North, Nnewi South, Orumba North and Orumba South. (Nnamdi Azikiwe University, 2025). Agriculture is an important economic sector in Anambra. oil palms, maize, rice, yams and cassava are among the crops grown. Fishing is also part of the economic mainstay of Anambra State more especially for communities along the riverine areas. Anambra is a home of innovation and creativity.

Sampling Design

This study used secondary cross-sectional data. The data was primarily collected in a survey carried out in eight LGAs in the state during the 2024 rain-fed cropping season by the state's VCDP. The LGAs were: Anambra East, Anambra West, Awka North, Ayamelum, Orumba North, Orumba South, Ihiala, and Ogbaru. The survey was referred to as, "Productivity and Gross Margin Analysis Survey".

The survey was conducted electronically using a structured questionnaire and the electronic application was called "kobo application". The survey design was a multistage stratified sampling design. In the first stage, 8 LGAs out of the 21 LGAs in the state were selected for further sampling. The sample size of 543 was apportioned to the selected LGAs with proportionality to their sizes. In each of the selected LGAs (stratum), systematic sampling was used to select the desired number of farmers from the sampling frame.

The sampling frame was the updated listing of all VCDP beneficiary farmers in the LGA. The rice producers in the sample were 226 farmers located in the 8 sample LGAs. The data was collated and managed with Microsoft excel spread sheet and statistical analysis was carried out using the Statistical Package for the Social Sciences (SPSS). The LGAs of the sample rice farmers were presented in table 1.

Table 1: Selected Rice farmers by LGAs

LGA	Frequency	Percent
Anambra East	24	11%
Anambra West	26	12%
Awka North	22	10%
Ayamelum	71	31%
Ihiala	20	9%
Ogbaru	20	9%
Orumba North	23	10%
Orumba South	20	9%
Total	226	100%

Source: Study Data Analysis

Literature Review

This study reviewed the literature about rice production in Anambra state of Nigeria and elsewhere under the following headings; Observations of notable institutions about rice production in Nigeria; Studies about rice production in Nigeria and elsewhere; Analytical framework for the study; Gross margin analysis and Monte Carlo simulation technique.

Observations of notable Institutions about Rice production in Nigeria

The consumption of rice in Nigeria was dependent mainly on imported rice with low percentage of local rice production to augment the citizen's food need. This was a matter of great concern since Nigeria is blessed with vast fertile land for rice production. WARDA is spear-heading the research on finding low-input varieties of rice but when such a technology becomes available, there may be no formal extension system for its rapid dissemination to farmers. In spite of the problems militating against local rice production, Nigeria still has a leading role in rice production in West Africa as it ranks highest as both producer and consumer of rice in the West African sub- region (WARDA, 2016). AfricaRice plays a vital role

in transforming the rice sector in Nigeria by promoting innovation, enhancing productivity, and fostering sustainable practices. AfricaRice partnered with the Government of Nigeria and the International Fund for Agricultural Development (IFAD) assisted Value Chain Development Programme in training 180 youth seed producers in rice seed production businesses across the Nigerian states of Anambra, Benue, Ebonyi, Niger, Ogun, Taraba, Enugu, Nasarawa, and Kogi.

According to *Daily Sun Newspaper*, (2018), the Central Bank of Nigeria institutionalized the "Anchor Borrowers" Programme to enhance rice production. Available records showed that in 2006 alone within the space of 5 months, a total of 24,992 metric tons of rice valued at N2,335,131,093 were imported through the land borders. *Sunday sun*, (2019) recorded that in spite of so many successes recorded in rice production, a lot of factors still militate against the government diversification programs on rice production. They included non-access to reliable supply of high-quality local paddy; flooding and other natural factors like birds; lack of subsidies; and lack of production loans. It suggested that the Central Bank of Nigeria should work with farmers as cooperatives and not necessarily disbursing funds to state governors. The Food and Agriculture Organization (FAO) recognized.

Nigeria's progress in rice production, but highlighted the persistent gap between domestic production and demand, necessitating imports. Despite progress made, challenges included: insufficient access to high-quality seeds and fertilizers; non-maintenance of irrigation facilities and access to improved farming equipment, especially for post-harvest operations; relying on old processing machines and methods which limited efficiency and farmers' incomes. The FAO, in collaboration with partners like the Africa Rice Center, supported Nigeria by training farmers, establishing demonstration plots, and improving access to quality seeds.

Studies about Rice production in Nigeria and elsewhere

Several studies were conducted about applying the Gross Margin Analysis to assess the profitability of rice production in Anambra State of Nigeria and elsewhere. Notable studies in this area included: Obiekwe N. et.al., (2024), Nwalieji, H.U. et.al. (2015), Oloyede, W.O. et.al. (2020), Keghter, V. S., et.al (2023) and Nwike, M.C et. al. (2015). The studies used primary data which were collected from rice farmers in the states. The studies applied various levels of multistage sampling design to select some rice producing LGAs. They allocated their chosen sample size to the selected LGAs in proportionality to their sizes. Within the LGAs they applied random sampling and purposive sampling to select the required number of respondents to be interviewed. The sampling frame in the LGAs were constructed from updated list of VCDP farmers in the state.

They used a mixture of structured questionnaires administration and rapid rural assessment (RRA) techniques to elicit information from respondent farmers. The responses were collated and summarized using Microsoft Excel spread sheet while detailed descriptive analysis were carried out with varied statistical packages especially the statistical package for the social sciences (SPSS). Generally, the constraints identified in the studies were: insufficient funds, scarcity and high cost of

labour, scarcity and high cost of improved seeds, climate change and associated irregular rains; inadequate fund for start-off, difficulty in obtaining credit, inadequate improved processing and milling machinery, high cost of privately sold agro-inputs such as fertilizers, poor road network, difficulty in forming co-operative societies, poor extension services to farmers, high cost of rice seeds, inadequate finance to purchase inputs, problems of pests and diseases, and unfavorable climatic conditions. The constraints included high labor costs, lack of access to credit, small farm size, and non-availability of improved seeds.

The following recommendations were made by the studies: (i) government should subsidize farming inputs like fertilizers and herbicides to reduce the cost burden on farmers and financial institutions should make credit facilities available and affordable to the farmers. (ii) government should train farmers on the benefits of using the combined rice production system. (iii) Government should increase the ratio of the number of extension agents to farmers so that the farmers will have more frequent contact with extension agents. (iv) Government should provide subsidy inform of inputs used for rice production such as fertilizer, agro-chemicals like herbicides and pesticides to prevent under-utilization due to high cost, and ensure small scale rice farmers procure them at minimal cost. (v) Government should attract both indigenous and foreign investors to invest in rice production. (vi) Government should discourage the rising rate of rural-urban drift of labour through the provision of good feeder rural roads, education, health and electricity to make life more meaningful for the youths, attract private investors and create more job opportunities in the rural areas; it also recommended the introduction of high yielding varieties of rice that are resistant to pests and disease's attacks. (vii) Government and private sector input dealers should ensure timely and affordable supplies from reputable research institutions and seed companies.

Specifically, Obiekwe N, et.al. (2024) studied the Profitability and Determinants of Output of Rice Production in Anambra State. The study population comprised all the rice farmers in the selected four agricultural zones (AZs) of the state namely Onitsha, Aguata, Awka and Anambra. The study found out that per hectare gross margin figures were ₦315,300, ₦ 285,600, ₦ 302,800 and ₦ 301,233 for Anambra, Aguata and Awka Agricultural zones, and the State (study area) respectively. Net return on investment figures were 1.49, 1.23, 1.30 and 1.35 respectively. The study concluded that rice production in Anambra State was profitable. Nwalieji H, U. et.al., (2015) conducted a comparative Profit Analysis of Rice Production Enterprise among Farmers in Anambra and Ebonyi States, Nigeria.

The findings of the study showed that majority of rice farmers were within their active and productive ages; and had very long years of rice farming experience. The gross margin (GM)/net profit of farmers in Anambra State was estimated at ₦ 59,105 and ₦ 55,355 for transplanting and broadcasting methods, respectively. In Ebonyi State, farmers made net profit of ₦ 53,800 and ₦ 48,100 from transplanting and broadcasting methods in 0.5 ha, respectively. Rice production enterprise in the two states was profitable and lucrative. The study noted that the varieties of rice grown were diverse and included local and improved varieties of traditional African rice

such as NERICA rice (Bayou Farms 2009). Most rice farmers (90 percent of total) in Nigeria were smallholders, applying low input strategy to agriculture, consequently obtaining low output (IFAD, 2012).

Nigeria rice productivity was among the lowest in comparison with neighboring countries, with average yields of 1.51 tonne/ha (FAO, 2013). Onimaes (2013), noted that with the prevailing market price of rice in the country it can be grown profitably in the forest and savannah areas of Nigeria. Longtau (2011), recalled that the establishment and growth of Agricultural Development Projects (ADPs), River Basin Development Authorities (RBDAs), and cheap fertilizers were responsible for the increase in rice production through large-scale farming and mechanization in the country. Oloyede, W.O. et.al. (2020), described the socioeconomic characteristics of rice farmers, identified the production system used by the farmers, compared the profitability of rice production systems, identified the factors influencing the choice of production systems among the farmers as well as the constraints to rice production systems.

The study revealed variability in yield, profit and income across the rice production systems. According to the study, the gross margins for lowland, upland and combined rice production systems were ₦65,735.73, ₦67,900.89 and ₦78,015.57 per hectare respectively. Keghter, V. S., et.al (2023) investigated profitability and technical efficiency of rice farming in Quan' Pan Local Government Area of Plateau State, Nigeria using a multistage sampling method with 120 respondents. The study found out that the farmers were 40 years old on the average. The men were higher in numbers constituting 81.0% of the study population. About 83% of the people were married and a greater number (81%) of them had at least some form of formal education with a typical household size of 9 persons. The findings from the study showed that the farmers owned an average of 2.0 hectares of farmland and had an average farming experience of 12 years. For the most of them (78.0%), farming was their primary occupation. The result also demonstrated that 78.0% never accessed credit or bank loans for farming and majority (63%) of the respondents acquired their farmlands through inheritance. The entire cost (total cost) of farming operation/ha incurred by the farmers was ₦ 139,733 while the average output obtained per hectare was 699kg at a selling price of ₦ 285/kg. The total revenue (TR) in naira valued ₦ 199, 215. Nwike M.C. et. al.,(2015), studied the profitability of rice production in the Aguata Agricultural Zone of Anambra State, Nigeria, and found that rice farming was a profitable enterprise. The study utilized a profit function approach and found that labor costs accounted for a significant portion of the total cost of production.

This study was in agreement with the methodologies, sampling, and data collection instruments of the reviewed studies and will adapt some of them to accomplish the set objectives. This study appreciated the breakdown of profitability by zones and the estimation of return on investment by zones by some studies reviewed, these details were regarded as unnecessary empiricism consequently this study will assess state-wide profitability without breaking down into zones. All the studies presented the gross margin and return on investment deterministically as if they were obtained from controlled experiments devoid of the influences of

fluctuations in outputs and prices. This study noted that in agriculture quantities and prices fluctuate due to several reasons some of which cannot be controlled. This study will take into consideration the fluctuations in quantities and prices by applying Monte Carlo simulation techniques to take care of fluctuating prices and outputs and estimate expected gross margin and its distribution.

Analytical Framework

The analytical framework for this study was based on the theory of the firm particularly the Farm income analysis which was well documented in economic text books such as; Gittinger J.P. (1983), and Upton M. (2005). These authors dwelt on farm income analysis. According to Gittinger J.P. (1983) the objective of farm income analysis is to assess the current performance of the farm; the analytical period is often one years or a production season; the numeraire is current market prices; capital items are incorporated through annual depreciation charges; the off-farm income is excluded while the production consumed at home is imputed and included and the value of money over time is undiscounted. The performance criteria were the gross margin and profits which could be estimated as a percentage of net worth; and return to capital and labour engaged on farm. This study assessed the average farm via the gross margin.

Gross Margin Analysis

According to (Upton, 1978), the gross margin (GM) is a measure of profitability in the short run. It is a tool for comparative analysis of enterprises and farm planning. Economic theory indicated that the firm will stay in production once it is able to cover the variable costs hoping that over time as the surplus accumulates it will off-set the fixed costs (Henderson and Quandt, 2010). Adhering to Olukosi and Erhabor (2004) this study estimated the gross margin (GM) as total revenue (TR) minus total variable costs (TVC) that is GM = TR – TVC. Total revenue was calculated as the value of rice sold plus the value of rice consumed at home or given out as gifts (these were imputed and added). The variable costs were the costs that vary with the scale of operation. They were regarded as avoidable costs (Olukosi and Erhabor, 2004). The variable costs in this study included values of: rice seeds, fertilizers applied, agrochemicals applied and aggregated labour. The cost of packaging, and transportation were imputed because they were not captured in survey. The prices used were current market prices.

Monte Carlo Simulation technique

Monte Carlo simulation relies on repeated random sampling and statistical analysis to compute results. It is a type of random experiments. It may be considered as a methodical way of doing so- called “what-if” analysis. Monte Carlo simulation therefore involves:

i. identifying key determinant variables of enterprise costs and benefits;
ii. establishing the probability distributions of these variables;
iii. randomly selecting values of these variables from their probability distributions;
iv. combining these selected values with base case values of all other variables and parameters to estimate the expected gross margin;
v. repeating steps (3) and (4)

numerous times to provide a large number of expected gross margin estimates and to establish their respective probability distribution.

If probability distributions of variables are unknown, the triangular distribution is applied as the second best. Three parameters completely describe the triangular distribution: the modal value, the minimum possible value, and the maximum possible value. The expected value of a triangular distribution is one-third of the sum of the three parameters. Simulation has the advantages of overcoming the shortcomings of sensitivity analysis and estimating more reliable expected gross margin. This study will apply the Monte Carlo simulation analysis.

Results and Discussion

This study analyzed the frequency of response to some of the questions in the survey using the SPSS analytical package. The variables were: gender of the respondents; ability of the respondents; marital status; highest educational qualification; secondary occupations; receipt of agricultural extension services; the variety of rice planted and the month rice was transplanted. The results were summarized below.

Gender of the Respondents

Out of the 226 valid responses 118 (52%) were males and 108 (48%) were females. This observation was in line with the findings of Keghter, V. S., et.al (2023) that there were more males than females in rice farming. Out of the 226 sample respondents 224 (99%) were "able bodied" while only 2 (1%) respondents were "persons with disability (PWD)". On marital status, there were 226 valid responses in the sample and 192 or 85% were married, 18 or 8% were single and 16 or 7% were widowed. On the highest educational qualification attained by the rice farmers, 11 respondents or 5% had no formal education; 86 respondents or 38% had primary education; 104 respondents or 46% had secondary education and 24 respondents or 11% attained tertiary educational qualification.

Secondary Occupation

Secondary occupation keeps the farmer busy during the farming off-season and it generates additional income as well as serving as insurance against hunger. The main secondary occupations engaged in by the rice farmers was trading practiced by 41 percent of the farmers and artisanship involved in by 26 percent of the farmers and 19 percent of the rice farmers had no secondary occupation. The details are in table 2. Concerning the variety of Rice planted during the farming season, there were 224 responses and all the farmers or 100% planted Faro 44 variety. On the receipt of agricultural extension services, out of the 226 respondents, 225 rice farmers (almost 100 percent of the farmers) indicated that they received agricultural extension services while only one respondent indicated non receipt of agricultural extension services.

Table 2: Secondary Occupation

Occupation	Frequency	Percent
Artisan	51	26%
Farming	11	6%
Fishing	13	7%
None	37	19%
Teaching	4	2%
Trading	81	41%
Total	197	100%

Source: Survey data analysis

Month of the year during which the rice crop was planted

There were particular months of the year during which if rice was planted, it will perform well relative to other months in Anambra State. Out of the 225 valid responses on this issue, 64 farmers or 28% planted rice in the month of July; 56 farmers or 25% planted rice in the month of May; 46 farmers or 20% planted rice in the month of April; 33 farmers or 15% planted rice in the month of June while 15 farmers or 7 percent planted rice in the month of August. The details are in table 3.

Table 3: Month Rice was planted

Month	Frequency	Percent
April	46	20%
August	15	7%
July	64	28%
June	33	15%
March	10	4%
May	56	25%
November	1	0%
Total	225	100%

Source: Study data analysis

Descriptive Statistics of variables

The study used the SPSS to analyze the descriptive statistics of the continuous variables in the study. The variables included: age; household size; farming experience in years; number of extension contacts; loan amount; quantity of rice seeds in kg; price of rice seeds in naira; quantity of fertilizers (50- kg-bag); price of fertilizer per bag; quantity of agro-chemicals in litres; price of agrochemical per litre; land area in hectare; labour in man-days; wage of labour in naira per man-day; farm yield in Mt.; quantity of produce sold in Mt.; price of produce sold in naira; value of packaging in naira; value of transportation and value of home consumed produce in naira. The results were presented in table 4.

The mean, maximum, minimum and standard deviations of the variables applied in the Gross Margin analysis and Simulation were presented in table 4. In table 4, the range and the estimated standard deviations of the variable were wide indicating wide spread of the values. This was not unexpected of survey data; however, it was hoped that the estimates were unbiased. From table 4 the age of the average sample respondent was 46 years. This was not unexpected; it corroborated the findings of Nwalieji, H.U, et.al. (2015) and Keghter V.S. et.al. (2023) which indicated that the rice farmers were old and that the youths were not taking farming as a means of livelihood. The farmers were in their middle active and productive ages with very long years of rice farming experience. The average size of a typical household in the sample rice farmers was 7 persons with a standard deviation of 2 persons.

Table 4: Descriptive Statistics of selected Variables

	Min	Max	Mean	Std. Dev
Age	19	70	46.3	10.3
Household size	2	11	6.6	2.1
Experience in Years	2	50	20.1	9.1
No. of Extension contacts	1	38	7.5	6.9
Loan amount	0	1000000	325000.0	276666.1
Quantity Rice Seed kg	20.0	125.0	55.5	28.3
Price Rice Seed/Kg	700	2500	1213.7	572.6
Qty Fertilizers 50kgbag	3.0	20.0	9.0	6.0
Price Fertilizer per bag	15000	43000	34845.1	9033.2
Quantity Agro-Chem Lt	3.0	18.0	6.8	3.9
Price Agrochemical/Lt	3500	7500	5105.8	1313.8
Land Area Ha	.50	3.00	1.1	0.7
Labour man-day	3	45	20.6	13.8
Wage Labour/man-day	3500	10000	7175.7	1812.6
Farm Yield MT	2.0	12.0	5.8	3.0
Quantity produce sold MT	2.0	10.0	5.1	2.8
Price produce sold/MT	105000	1050000	739734.5	285479.7
Value Packaging	10000.00	50000.00	25573.0	14133.4
Value Transportation	4000.00	20000.00	10229.2	5653.4
Value Home Consumed	0.00	525000.00	30348.9	102818.6

Source: Study data Analysis

This value was in agreement with the estimates of the authors in the literature reviewed. The farming experience of a typical rice farmer in Anambra State was estimated at 20 years with a standard deviation of 9 years. This finding reinforced the opinion that the youths were not taking up rice farming as a means of livelihood. Policies need to be formulated to attract youths into rice farming in Anambra State. The number of extension visits had by a typical rice producer was 8 visits with a standard deviation of 7 visits. The size of loan accessed by a typical farmer was ₦325,000.0 with a standard deviation of ₦ 276,666.0.

Only 18 rice farmers accessed loan and the standard deviation about the mean loan was very high. It was apparent from literature review that the value of rice used at home for consumption and gifts, value of packaging of rice for sale; and cost of transportation to and from the farm were very important in estimating the gross margin, this study had to impute them from the existing variables. Rice production in the State was constrained by: (1) advanced age of the farmers; (2) the limited number of extension visits; (3) very exorbitant cost of fertilizers, agrochemicals and labour; and

(4) non- accessibility of farming loans. See details in table 4.

Estimation of the Gross Margin

Following the procedures from literature review and the theoretical framework, the gross margin was estimated as the difference between total revenue and total variable cost. The estimated value was ₦ 3,201,954.16 and the details were presented in table 5.

Table 5: The Estimation of the Gross Margin

	Unit	price ₦	Quantity	Amount
Sales	MT	739734.5	5.1	3,772,646.02
Home Use	MT			30348.9
Total Revenue	Naira			**3,802,994.91**
Variable Cost				
Rice seeds	Kg	1213.7	55.5	67,312.95
Fertilizer applied	50kgbag	34845.1	9.0	315,302.20
Agrochemical	**Liters**	5105.8	6.8	34,633.27
Labour Aggregated	**Manday**	7175.7	20.6	147,990.13
Packaging	**Naira**			25573.0
Transport	**Naira**			10229.2
Value VariableInputs	**Naira**			**601,040.75**
Gross Margin				3,201,954.16

Source: Study data Analysis

In farm planning, gross margin is usually expressed in the terms of gross margin per hectare for easy comparison between farms or enterprises (Upton M., 2005). The average size of rice farm in this study was 1.1 Ha. This could be approximated to 1 Ha. The magnitude of the estimated gross margins indicate that rice farming in Anambra state was profitable. Rice consumed at home or given out as gift was imputed as 50 percent of the difference between the naira value of the total rice produced in the farm and the naira value of the quantity of rice sold.

The imputed value was ₦ 30,348.9. The cost of packaging was imputed as one percent of the value of rice sold while the cost of transportation of inputs and outputs to and from the farm was imputed as 0.03 percent of the value of rice sold. In the literature reviewed, the estimated gross margins for Anambra state ranged from ₦ 59,105 as estimated by Nwalieji H, U. et.al., which was published in 2015 to ₦301,233 as estimated by Obiekwe N, et.al. who collected the data for the study in 2022 and published the study in 2024. In this study the data used was collected in 2024 rain- fed

cropping season and the estimated deterministic Gross Margin was ₦ 3,201,954.16. There was a wide difference in the levels of the estimates. This is not surprising because after the presidential broadcast on 1st of October 2023, all prices spiked-up about ten folds or more. Given that gross margin, GM = TR – TVC Alternatively, $GM = P_1Q_1 - P_2Q_2$ Where,

P_1 = vector prices of Outputs

Q_1 = vector of Outputs

P_2 = vector price of inputs

Q_2 = vector of inputs

Let k be an exogenous spontaneous increase in price level, Then $GM = kP_1Q_1 - kP_2Q_2$

This could be rearranged by bringing k before the bracket as:

$GM = k(P_1Q_1 - P_2Q_2)$

The exponent of k determines the degree of homogeneity, since $k = k^1$, then, gross margin is homogeneous to degree 1. This implies that an equal proportionate increase in all prices of both inputs and outputs will increase the gross margin by the same equal proportion. Since the prices of outputs and inputs were equally affected, the spike in the estimated Gross Margin was not unexpected. The gross margin estimated in table 5 was purely deterministic: it did not take into consideration the fluctuations of yield and prices which was inevitable in traditional agriculture in Anambra State. Being realistic, this study took into consideration the fluctuations of yield and prices consequently, it applied Monte Carlo simulation technique to estimate a more reliable expected gross margin and the associated distribution.

Applying Monte Carlo Simulation To Estimate the Gross Margin

This study employed the mean and standard deviation of the variables which were estimated from the descriptive analysis to specify probability distribution of the quantities and prices of rice sold, rice seeds, fertilizers applied, agro-chemicals applied, and aggregate labour which were applied in the computation of the gross margin. The resultant expected gross margin was estimated at ₦ 3236890 only. The average of the expected gross margin was ₦3,206,500; the expected minimum was ₦ 767,194; and the expected maximum was ₦ 5,748,844; and the expected class interval was estimated at ₦498,165; the details are presented in table 6.

Table 6: Monte Carlo Simulation for Rice Gross Margin

	Unit	price N	Quantity	Amount
Sales	MT	739736.28	4.9119745	3633565.7
Home Use	MT			30350.607
Total Revenue	Naira			3663916.3
Variable Cost				
Rice seeds	Kg	1213.7168	45.020965	54642.702
Fertilizer applied	50kg bag	38485.367	4.631706	178252.9
Agrochemical	Liters	4109.5555	6.5400843	26876.839
Labour Aggregated	Manday	8351.6952	16.027607	133857.69
Packaging	Naira			22713.545
Transport	Naira			10682.532
Value Variable Inputs	Naira			427026.21
Gross Margin				3236890.1

Source: Study Data Analysis

In what follows the percentage frequency of each individual mid-point value, was listed against the mid-point of

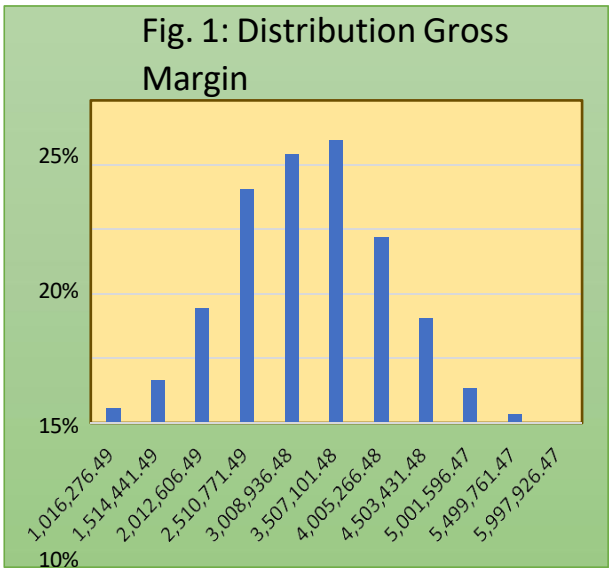
Table 7: Distribution Gross Margin

S/No	Mid-point	Frequency
0	1,016,276.49	1%
1	1,514,441.49	3%
2	2,012,606.49	9%
3	2,510,771.49	18%
4	3,008,936.48	21%
5	3,507,101.48	22%
6	4,005,266.48	14%
7	4,503,431.48	8%
8	5,001,596.47	3%
9	5,499,761.47	1%
10	5,997,926.47	0%

Source: Study Data Analysis

the interval to aid visual perception of the distribution of the expected gross margin in table 7 and figure 1. The range between the maximum and the minimum values of the expected gross margin was distributed into 10 classes and the percentage frequency of each class was presented in table 7 to provide a clear visual representation of how the gross margin was distributed. Locating a number in the frequency distribution of the gross margin shows the number's position or significance within gross margin's pattern of occurrence. Suppose the minimum wage in the state was ₦ 70,000 per month. If this amount is multiplied by 12 months, the product will amount to ₦ 840,000 and this falls within the first class of the frequency distribution of the gross margin.

The implication is that the established minimum wage in the state was covered by the first-class interval of the expected gross margin. The simulation of the gross margin enabled four important decisions namely; (1) Notwithstanding the fluctuations in yield and prices, the expected gross margin showed that the variable cost was adequately covered in the 2024 cropping enterprise. (2) Since the average expected gross margin was ₦3,206,500, it indicated that rice production enterprise was profitable in Anambra state in 2024 rain-fed cropping season. (3) Estimation of the expected minimum and the maximum values of the gross margin enabled visual presentation of the distribution of the expected gross margin. (4) It enabled comparison of any amount with the classes in the distribution of the expected gross margin.



Summary and Conclusions

Rice is a staple food crop in Anambra State of Nigeria. The rice farmers in Anambra state in 2024 rain-fed cropping season were aged and have been in the farming business for more than 19 years while the youth were not willing to take up rice production as a means of livelihood probably because they consider it an unprofitable enterprise.

This study carried out a gross margin analysis of rice production enterprise in Anambra State in the 2024 rain-fed cropping season as a second-best approach to determine the profit level of the enterprise and it applied Monte Carlo Simulation techniques to estimate the expected average gross margin and the distribution in the state.

This study used secondary cross-sectional data. The data was primarily collected VCDP from eight LGAs in the state during the 2024 rain-fed cropping season. The survey design was a multistage stratified sampling design.

The sample size of 543 was apportioned to the selected LGAs with proportionality to their sizes. In the selected LGA systematic sampling was used to select the desired

number of farmers from the sampling frame which was an updated listing of all VCDP beneficiary farmers in the LGA. The rice producers in the sample were 226 farmers.

The data was collated and managed with Microsoft excel spread sheet and statistical analysis was carried out using the SPSS. Based on the literature review and the theoretical framework, the gross margin was estimated as the difference between total revenue and total variable cost. The estimated deterministic value was ₦ 3,201,954.16. On simulating with the Monte Carlo technique, after 2000 iterations the resultant expected gross margin was estimated at ₦ 3,236,890 only. The average of the expected gross margin was ₦3,206,500; the expected minimum was ₦ 767,194; and the expected maximum was ₦ 5,748,844; and the expected class interval was estimated at ₦ 498,165.

The constraints identified in this study were: insufficient funds, scarcity and high cost of labour, scarcity and high cost of improved seeds, difficulty in obtaining credit, high cost of fertilizers, poor extension services to farmers and small farm size, Recommendations made by this study included: (i) Government should subsidize farming inputs like fertilizers and herbicides to reduce the cost burden on farmers and financial institutions should make credit facilities available and affordable to the farmers. (ii) Government should increase the ratio of the number of extension agents to farmers. (iii) Subsidy should be provided inform of inputs used for rice production such as fertilizer, agro-chemicals like herbicides and pesticides to prevent under-utilization. (iv) Simulation analysis should be applied in the analysis of farm production especially in estimating the profitability to take into consideration the fluctuations in outputs and prices and estimate reliable expected values and their distribution.

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