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Economic analysis of pig production towards protein sufficiency and food security in the Niger Delta area, Nigeria

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Abstract

The study was carried out to evaluate profitability and efficiency of pig production in the Niger Delta Area, Nigeria. A multi-stage random sampling technique was used in the selection of respondents for the study. Primary data were obtained with the aid of a well-structured questionnaire and were analyzed using descriptive and inferential statistics, cost and return analysis, and stochastic production frontier. The result showed that most of the pig farmers (51.9%) fell within age range 41-60years with Male farmers accounted for 69.4%. majority of Pig farmers 81.5% had formal education. The total variable cost incurred by the farmers amounted to the sum of N46629353.63 (73%) of total cost at N63721684.63 while total fixed cost was N17092331.00. Finding indicated that feeds cost accounted for about 85.2% which is the greatest variable cost. The result also showed that the Benefit/Cost Ratio of 1.5 with rate of return at N32114088.09 indicated that pig production is a profitable business enterprise. The stochastic frontier production function with Sigma square parameter (0.930) reflects variability in inefficiency levels across farms and the Gamma parameter (0.778), highlights the nature of inefficiency. The study recommended diversification of capital sources with capacity building on technical information for optimum profitability.

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Introduction

The growing population of humans and reports of a large number of people, who are been undernourished or starving especially in developing countries have prompted the need for an increase in food production a major worldwide issue of concern. The lingering economic quagmire, coupled with increasing population growth, low food production, and continuously rising food demand in Nigeria have led to increasing cases of mal-nutritional diseases nationwide, Onah (2015). This ugly development has necessitated a national consciousness and outcry for a tremendous improvement in animal protein production, availability, accessibility, and affordability in the country. Therefore, food supply must be improved by all the concerned sectors, including the different value chains both in quantity, quality, and proportionally distribution to enhance food security.

Pig (*Sus scrofa*), a monogastric animal, with huge potential and profitability, remains a very lucrative livestock venture with the capacity to ameliorate the hunger problem and safeguard the future of the nation's food supplies as well as a veritable tool for curbing the increasing unemployment occasioned by the current economic downturn. The breeding and rearing of pigs for domestic and commercial purposes have gained more attention in recent times due to the rising demand, especially for dietary purposes; thus, creating more markets for those in the piggery enterprise, National Agricultural Sample Survey (2011). However, pigs are been neglected in some parts of the country like in Northern Nigeria due to their religious and social factors while in the Southern part, people refuse to participate in pig production due to its dirty nature without realizing that piggery production can generate income. Its meat (pork) is nutritive which is a good source of protein due to its composition of essential amino acids and slightly low content of water which yields energy maintenance.

The pig industry in Nigeria is an important arm of the livestock sub-sector in the overall agricultural sector, Ezeibe (2010). This assertion derives from the fact that porcine production, among other species, has a high potential to contribute to high economic gain in three ways. First, the pigs have high fecundity, high feed conversion efficiency, early maturity, short generation interval, and relatively small space requirements, Cameron (2000). Secondly, they are multipurpose animals providing about 40% of meat in the world market, cooking fats and bristles. Pig is equally important for agro-based industries like feed mills for the provision of bone and blood which are used for the production of bone meal and blood meal respectively, which are good source of calcium in animal nutrition, Oguniyi *et al.* (2011). In addition, pig's manure is an excellent fertilizer for enriching poor soils and providing biofuel for cooking. Its skin is also useful for light leather production, Babatunde *et al.* (1990). Thirdly, it is produced under a variety of production systems ranging from simple backyard piggery, and pigs living on garbage belts to family-operated farms or large-scale integrated pig industries with sophisticated biosafety measures, Cameron (2000).

Nigeria like many other developing countries is facing the problem of shortage of dietary protein. The gravity of this problem is with a growing population. Pork represents one of the fastest ways of increasing animal protein since pigs grow at a faster rate than cattle, goats, and sheep, Ajala *et al.* (2007). Despite these attributes, the production of pigs in Nigeria has remained low. Nigeria has a large population of Muslims who constitute the majority of most States of the Northwest and Northeast zones as well as other zones in Nigeria, so opposition to pig production is very significant and may not favor profitable pig production due to their religious belief, Umeh *et al.* (2015). Other factors that have militated against pig production in Nigeria include disease outbreaks, inadequate technical assistance in the form of extension services, inaccessibility of pig farmers to credit facilities, lack of adequate supply of genetically sound breeders, high cost of feed, poor infrastructure facilities, the fear of inadequate market for piggery products, the absence of pig product processing industry in Nigeria, and the belief that pigs are dirty

and constitute a health hazard. This is untrue for pigs that are produced under modern intensive production techniques since under suitable modern husbandry pigs can be very clean animals, Ajala *et al.* (2007). However the production of pork to satisfy the protein needs of Nigeria is far from being achieved.

The broad objective of the study was to analyze the profitability and efficiency of pig production in the Niger Delta Area, in Nigeria.

The specific objectives are to:

1. Describe the socioeconomic characteristics of pig producers in the study area;
2. Estimate the cost and return of pig production;
3. To determine the technical efficiencies of pig production;
4. To identify the production constraints faced by pig producers in the study area.

The following hypotheses were tested to guide the study:

H_{o1}: Pig production is not profitable in the study area.

H_{o2}: There are no technical inefficiency effects in pig production.

Materials and methods

Area of study and sampling technique

The study was carried out in the Niger Delta Area, Nigeria. A multi-stage random sampling technique was used in the study. Stage 1, involved a random selection of five (5) states from the nine states. In stage 2, a simple random technique was used to select five (5) local government areas each from the states to give a total of twenty five (25) local government areas for the study. Stage 3, involved a random selection of seven communities each from the local government areas to give a total of one hundred and seventy-five (175) communities. Stage 4, involved a purposive sample of four (4) pig farms/ farming households from the communities to give a total of seven hundred (700) pig farms and farming households for the study.

Method of data collection and analysis

Both primary and secondary data were used for the study. Primary data were obtained with the aid of a well-structured questionnaire on socioeconomic characteristics of the respondents, production systems, input and output cost, efficiency techniques, constraints faced by the farmers, etc., while secondary data were obtained from both published and unpublished relevant materials. Descriptive statistics and inferential statistics were used in the study such as frequency, percentage, mean, cost and return analysis and the stochastic production frontier function.

Model specification

Stochastic production frontier analysis

The stochastic frontier function used by Onu *et al.* (2000) and Bandyopadhyay (2004) as derived from the error model of Aigner *et al.* (1997) will be employed to achieve objective iii of the study. The Cobb-Douglas production function will be fitted to the frontier model of pig production. The result will be estimated using the maximum likelihood method. The stochastic frontier production function is written as:

$$Yi=f(X: \beta) +e \quad \text{.....(2)}$$

$$e_i = V_i-U_i \quad \text{.....(3)}$$

Where:

Yi = Output of the ith farm

Xi = Vector of inputs used by the ITH farm

B = A vector of the parameters estimated

e_i = Composite error term

V_i = Random error outside farmers' control

U_i = Technical inefficiency effects

The empirical stochastic frontier model that will be employed is specified as follows:

$$\text{In } Y_1=\beta_0+\beta_1 InX_1I + \beta_2 InX_2I + \beta_3 InX_3i + \beta_4 InX_4I + \beta_5 InX_5I + \beta_6 InX_6I + V_i-U_i \quad \text{.....(4)}$$

Where;

Subscripts ij refer to the j^{th} observation of i^{th} farmer,

In = Logarithm to base e,

Y = Output of pig (kg)

β_0 = Constant

β_1 -β_6 = Parameters estimated
X_1 = piglets (Number)
X_2 = Pig feed (Kg)
X_3 = Labour (Man-days)
X_4 = Drugs (₦)
X_5 = Fuel (Litres)
X_6 = Pen size (m^2)
V_i = Random noise (white noise)
U_i = Inefficiency effect which is non-negative with half-normal distribution.

It is assumed that inefficiency effects are independently distributed and Uij arises by truncation (at zero) of the normal distribution with mean Uij and variance δU^2 where Uij is specified as;

$U_i = \delta_0 + \delta_1 InZ_1i + \delta_2 InZ_2i + \delta_3 InZ_3i + \delta_4 InZ_4i + \delta_5 InZ_5i + \delta_6 InZ_6I$ .....(5)

Where;
U_i = Inefficiency effect of pig production
δ_0 = Constant
δ_1-δ_6 = Parameters to be estimated
Z_1 = Farmers age (years)
Z_2 = Household size of farmer (number)
Z_3 = Years of formal education of the farmer (years)
Z_4 = Years of farming experience of the farmer in pig production (years)
Z_5 = Number of years in cooperative society (years)
Z_6 = Number of contacts with extension agents (measured as number of contacts in a year)

Results and discussion

Distribution of respondents according to their socio-economic characteristics

Table 1, indicates that 69.4% of pig farmers in the area are male, while only 30.6% are female. This gender disparity suggests a significant imbalance in the representation of male and female farmers in pig production. The majority of respondents (51.9%) fall within the age range of 41-60 years, while only 1.9% is aged 1-20 years. This age distribution points to a potential generational gap in pig farming, with younger individuals less actively involved in the industry. The survey reveals that 32.4% of pig farmers have completed secondary education, and 21.3% have tertiary education. This suggests that a significant portion of farmers has attained at least a secondary level of education, which can positively impact their adoption of modern farming practices and technical knowledge.

Table 1. Distribution of respondents according to their socio-economic characteristics

Parameter	F	(%)	Mean
Gender			
Male	486	69.4	
Female	214	30.6	
Age			
1-20	13	1.9	
21-40	285	40.7	42.7
41-60	363	51.9	
>61	39	5.6	
Educational level			
No formal education	130	18.5	
Primary	195	27.8	
Secondary	227	32.4	
Tertiary	149	21.3	
Marital status			
Single	162	23.1	
Married	389	55.6	
Divorced	65	9.3	
Widowed	84	12.0	
Household size			
1.00-3.0	305	43.5	3.9
4.00-6.00	337	48.1	
7.00-9.00	58	8.3	
Main occupation			
Farming	616	88.0	
Trading	32	4.6	
Formal Employment	26	3.7	
Casual Work	26	3.7	
How long in pig farming			
0-10 years	97	13.9	
11-20 years	408	58.3	16.5
21+ years	195	27.8	
Purpose of pig farming			
Commercial Purposes	97	13.9	
Domestic Purposes	130	18.5	
Both Commercial and Domestic	473	67.6	
Religion			
Christianity	616	88.0	
ATR	85	12.1	
Flock Size			
1- 50 pig	246	35.2	
51-100	350	50.0	65.3
Above 101	104	14.8	
Technical information			
Yes	616	88.0	
No	84	12.0	
Monthly income			
0.00 – 200000.00	545	77.8	
201000.00-400000.00	123	17.6	153815.2
401000.00-600000.00	32	4.6	
Where do you buy pigs from?			
From other farms	434	62.0	
House supplies	246	35.2	
Breeders	20	2.8	

F=Frequency, %=Percentage, Source: Field Survey, (2023)

The majority of the respondents (55.6%) are married, and the average household size is approximately 3.9 members. This implies that pig farming is often a family-based enterprise in the area. While family involvement can positively impact labor availability, it can also pose challenges in terms of resource allocation and management. The primary occupation of 88.0% of respondents is farming, indicating that pig production is a significant agricultural activity in the region. This finding emphasizes the economic importance of pig farming and its potential contribution to rural livelihoods and food security. It also highlights the need to prioritize agricultural development initiatives to enhance the productivity and profitability of pig farming. The majority of pig farmers (58.3%) have been engaged in pig farming for 11-20 years, indicating that many respondents have considerable experience in the industry. This experience can be beneficial in terms of knowledge and expertise. The majority of pig farmers (67.6%) engage in both commercial and domestic purposes for pig farming. This suggests that pig production serves not only as a source of income but also provides food for household consumption. The dual-purpose nature of pig farming can enhance the overall resilience of farm households, contributing to food security and income diversification. The average monthly income of the respondents is approximately 153,815.2 Naira. This income level may vary across different households and could be influenced by various factors such as flock size, market demand, and production efficiency. A majority of pig farmers (62.0%) purchase their pigs from other farms, while 35.2% source from house supplies. Only 2.8% obtain pigs from breeders. This result indicates the existence of a market for pig trade in the region. However, the reliance on external sources may pose risks in terms of disease transmission and the quality of breeding stock. The flock size refers to the number of pigs a farmer keeps. According to the survey, 50.0% of respondents have a flock size ranging from 51 to 100 pigs, while 42.6% have a flock size above 101 pigs. Only 7.4% of respondents have a flock size of less than 50 pigs. The flock size has significant implications for the scale and profitability of pig farming operations. A larger flock size indicates a potentially more commercial and profitable enterprise, while a smaller flock size might indicate small-scale or subsistence farming. The survey reveals that 88.0% of respondents identify as Christians, and 12.1% African Traditional Religion (ATR). Religion can play a role in shaping farming practices, cultural norms, and dietary preferences. The survey indicates that 88.0% of respondents have access to technical information related to pig farming, while 12.0% do not have access. Access to technical information is crucial for the adoption of improved farming practices, disease prevention, feed management, and overall productivity enhancement.

Production system used in a pig farm

Table 2 present the distribution of respondents based on the production systems used in pig farms. The extensive (free range) system is used by 33.0% of respondents, involves allowing pigs to roam freely over a large area, enabling them to forage for food and exhibit natural behaviors. This result implies that farmers using the extensive system may have lower infrastructure and feeding costs since pigs rely on natural resources. However, this system may lead to slower growth rates and lower productivity due to limited control over pig feeding and exposure to diseases from the environment. Ogunyi *et al.* (2011) reported that Pig production in Nigeria has not yet developed like ruminant and poultry production. The semi-intensive system by 76.1%, the intensive system by 40.7%, and a combination of semi-intensive and extensive systems by 10.2%. The intensive system, utilized by 90.0% of respondents, involves keeping pigs in a confined space with controlled environmental conditions and a carefully regulated diet. This result implies that farmers using the intensive system may achieve higher growth rates and productivity due to optimized feeding and disease management. However, this system requires significant investment in infrastructure and inputs, and there may be concerns regarding animal welfare and environmental impact, while 42.2 of the respondents used both extensive and intensive system.

Table 2. Production system used in a pig farm

Production system used	F	(%)
Extensive (free range) system	231	33.0
Semi-intensive system	533	76.1
Intensive system	630	90.0
Semi-intensive and extensive system	295	42.2
Total	700	100

F=Frequency, %=Percentage

Source: Field survey, 2023. (Multiple choice responses recorded)

Average cost of production

The economic analysis of pig production in the Niger Delta States reveals important insights into the cost structure and profitability of the venture. The production process involves several crucial components, each contributing to the overall expenses and outcomes (Table 3).

The expenditure result showed that a boar amounts to N4137481 .48. Sows, incur a higher cost of N7263657 .41 Piglets represent another substantial expense at N5170680.56. Ensuring the health of the pigs is paramount, as reflected in the expenses for drugs and medication amounting to N2363098.15, and veterinary services, which account for N1219484.18. These costs emphasize the essential investments required for maintaining the well-being of the animals and preventing potential diseases. The provision of adequate feed is a major ongoing expense in pig farming, with a total cost of N20182562.96. This highlights the need for consistent and high-quality nutrition to ensure optimal growth and productivity of the pigs. Labor is a substantial component of the cost structure, with a significant expense of N3952261.11. This underscores the labor-intensive nature of pig farming, from daily care to managing various aspects of the operation. Transportation costs, amounting to N2340127.78 indicate the logistical requirements involved in moving pigs and related resources, which can impact both the welfare of the animals and the overall efficiency of the production process.

Table 3. Average cost of production

Items	Total cost (₦)
Boar	4137481.48
Sow	7263657.41
Piglets	5170680.56
Drugs and medication	2363098.15
Veterinary service	1219484.18
Feed	20182562.96
Labor	3952261.11
Transport	2340127.78
Total variable cost (TVC)	46629353 .63
Building	12743598.00
Equipment	4348733.00
Total fixed cost	17092331.00
Total cost	63721684.63

Source: Computed from field data, 2023

The Total Variable Cost (TVC) amounted to N46629353.78 reflecting the cumulative expenses associated with the pigs, their care, and the resources needed for their growth and maintenance. The expenditure on building facilities is N12743589.00 while equipment costs amount to N4348733.00. These costs represent investments in infrastructure that contribute to the long-term sustainability and efficiency of the operation. The Total Fixed Cost (TFC) amounted to N17092331.00 indicating the consistent financial outlay required for maintaining the physical assets and equipment. The Total Cost (TC) structure of pig production amounts to N63721684.63. This figure encapsulates the sum of variable and fixed costs, representing the comprehensive financial commitment involved in running a pig farming enterprise.

Profitability of pig production

The Profitability analysis indicated that the Total Revenue (TR) generated from the venture is N95835742.72, while the Total Variable Cost (TVC) and Total Fixed Cost (TFC) sum up N46629323.63 and N17092331.00, respectively. The Gross Margin (GM) is N49206419.09, signifying the earnings remaining after deducting variable costs from revenue. Despite the significant costs involved, the venture showcases profitability as indicated by the positive Gross Margin, Net Return, and the favorable Benefit-Cost Ratio (Table 4).

Table 4. Profitability of pig production

	Amount (₦)
Total Revenue (TR)	95835742.72
Total variable cost (TVC)	46629323.63
Total fixed cost	17092331.00
Total cost	63721684.63
Gross Margin (MG) = TR- TVC	49206419.09
Net Return(NR) GM-TFC	32114088.09
Benefit-Cost-Ratio = TR/TC	1.504

Source: Field Survey data, 2023

Stochastic frontier production function for pig production

Table 5 indicates the factors influencing production efficiency and inefficiency within the pig farming sector. The stochastic frontier production function offers insights into how various variables contribute to the overall output of pig production. The constant term in the production function, 45463.3, indicates a baseline level of output. The result indicates that the factors: flock size, feed, income, labor, and drugs all show positive coefficients, indicating their positive impact on pig production. Larger flock sizes, increased feed inputs, higher income, more labor, and greater use of drugs are associated with higher levels of production.

Table 5. Maximum likelihood estimates for the parameters of the stochastic frontier production function for pig production

Variables	Coefficients	T-ratio
Constant	45463.3	8.73***
Flock size	0.023	3.09***
Feed	0.452	3.17***
Income	0.065	2.99***
Labor	0.603	2.43**
Drugs	0.084	1.448
Inefficiency Model		
Constant	0.318	1.961*
Farmers Age	−0.254	−1.934*
Sex	0.103	0.174
Educational level	−0.076	−4.472***
Household size	−0.162	−2.591**
Farming experience (years)	−0.181	−3.186***
Cooperative society	−0.022	−0.046
Technical information	−0.197	−1.729*
Extension contact	0.038	0.054
Sigma-squared	0.930	4.46***
Gamma	0.778	4.587***
Log-likelihood function		−43.62

Source: Computation from Field Survey data, 2023

The inefficiency model showed that the Farmer's age exhibits a negative coefficient of -0.254, indicating that as the farmer's age increases, inefficiency tends to decrease. This could be attributed to experience and knowledge gained over time. Educational level, on the other hand, is associated with reduced inefficiency, reaffirming that better-educated farmers tend to adopt more efficient practices. Household size has a negative coefficient of -0.162, suggesting that larger households might provide more labor resources, thus decreasing inefficiency. Additionally, farming experience (-0.181) and technical information (-0.197) both have negative coefficients, implying that experienced farmers and those with access to technical knowledge tend to operate with lower inefficiency. This is confirmed by Ezeibe (2010), and Umeh *et al.* (5015).

It's worth noting that the sigma-squared parameter (0.930) reflects variability in inefficiency levels across farms, indicating diversity in farmers' abilities to manage their operations efficiently. Similarly, the gamma parameter (0.778) highlights the stochastic nature of inefficiency as illustrated by Perkins (2003).

Constraints in pig production

Table 6 presents the distribution of constraints in pig production, along with their corresponding frequencies and rank orders. The top constraint, reported by 90.7% of respondents was inadequate capital. The second-ranked constraint, reported by 88.9% of respondents, is the inaccessibility to credit. The third-ranked constraint, reported by 85.2% of respondents, is the cost of feeding. The fourth-ranked constraint, reported by 82.4% of respondents, is housing.

Table 6. Constraints in pig production

Constraints	Frequency (%)	Rank order
High cost of labor	81(75.0)	7th
Inadequate capital	98(90.7)	1st
Inaccessibility to credit	96(88.9)	2nd
Housing	89(82.4)	4th
Feeding cost	92(85.2)	3rd
Veterinary services	73(67.6)	8th
Drugs and medication	63(58.3)	9th
Marketing	61(56.5)	10th
Pollution	83(76.9)	6th
Religion	88(81.5)	5th
Diseases outbreak	81(75.0)	7th

Source: Computed from field survey data, 2023

***Significant at 1% ** 5% *10%

Proper pig housing is essential for ensuring animal health, well-being, and productivity. The fifth-ranked constraint, reported by 81.5% of respondents, is religion. The sixth-ranked constraint, reported by 76.9% of respondents, is pollution. High Cost of Labor and Diseases Outbreak ranked seventh, reported by 75.0% of respondents. Veterinary services ranked eighth, reported by 67.6% of respondents. Access to reliable veterinary services is essential for disease prevention, diagnosis, and treatment. Drugs and medication ranked ninth, reported by 58.3% of respondents. Marketing ranked tenth, reported by 56.5% of respondents. Effective marketing strategies and access to appropriate markets are essential for selling pig products and generating income. The implication is that improving market linkages and marketing efforts can boost farmers' profitability and market reach. Lapar (2003) reported the management problem of disease outbreaks, feed efficiency, and high cost of feedstuffs, which stems from a lack of swine production knowledge Omage (2004). These problems contribute to low technical efficiency in pig production, Uddin *et al.* (2017).

Conclusion

The study provides valuable insights into the socio-economic characteristics, production systems, constraints, and production efficiency of pig farming in the area. It highlights gender disparities, generational gaps, and educational levels among farmers. The dual-purpose nature of pig farming for income and consumption is significant, and the constraints identified call for targeted interventions. The choice of production system carries implications for costs and productivity, while the factors influencing production efficiency emphasize the importance of proper resource management and knowledge.

Based on the findings, the following recommendations are proposed to enhance pig farming in the area: Address the gender imbalance by promoting gender-specific training and support programs to ensure equal opportunities for male and female farmers., Provide ongoing training and capacity-building programs to enhance farmers' technical knowledge and modern farming practices., Facilitate better access to credit and alternative sources of capital to address the constraints of inadequate capital and high feeding costs., Strengthen extension services, training, and knowledge-sharing platforms to ensure widespread access to technical information and modern farming practices, Promote environmentally sustainable practices to address concerns about pollution and waste management associated with pig farming and Provide training and support to improve production efficiency, taking into consideration factors like flock size, feed management, and disease prevention.

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