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COST-RETURNS STRUCTURE AND TECHNICAL EFFICIENCY OF PIG PRODUCTION IN IJEBU DIVISION OF OGUN STATE, NIGERIA

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Abstract
The quantity of animal products in Nigeria shows a serious shortage of animal protein intake while production of pig meat has been slowed down by many constraints. This study examined the profitability and technical efficiency of pig production. Purposive sampling technique was used to select and interview 107 respondents through structured questionnaire. Data were analysed using descriptive statistics, budgetary technique, Double-log function and Stochastic Production Function (SPF). Descriptive result shows that male (74.8%) dominated pig farming, 88.8% was<60 years old, 69.1% was married, average household size was 6 persons. About 51.4% had>10 years' experience with average herd size of 33 pigs, 73.8% disposed waste into bush with chemical treatment. Gross income was ₦282,128.29 per annum while rate of return was 1.58. Most expensive input was feed (65.9%). Major challenges were inadequate fund (74.8%) and high mortality (58.9%). Age (1%), experience (1%), herd size (1%) and credit (10%) significantly increased gross margin while feed (1%) and labour (1%) increased production efficiency. In Conclusion, pig production was profitable with technical efficiency slightly above average level. Therefore, agricultural stakeholders should ensure that extension training, agricultural credit and modern production technologies are promoted to resolve the challenges in pig production.

Key Words: *Pig production, Profitability, Technical efficiency, Challenge*

Introduction

Animal husbandry plays important roles in provision of employment in Nigeria. The livestock sub-sector is the main supplier of essential animal protein as it provides 53% of the daily protein intake in the country (Adetunji and Adeyemo, 2012). There is assurance of optimal output and high profit in pig production given an access to adequate capital, farm structures and modern inputs (Abiola *et al.,* 2015). Population growth, low food production and continuous rise in food demand contribute to increasing case of malnutrition and diseases in the nation (Onah, 2015). The country imported 30% of animals slaughtered for consumption annually while about 7 grams of animal

protein are consumed daily against the required 35 grams (Sese *et al.,* 2014).

There is need to produce a prolific and fast growing animals such as pig (Susscrofa), which has the ability to utilize a host of agro-industrial by-products including crop residues (Igwe *et al.,* 2014). Pig production increases the availability of animal protein; minerals and vitamins thereby contributing to balanced diet of human being. There is a greater output of meat from pigs than from cattle, buffalo, sheep or goat. Therefore, the rate of investment in pig production should increase to speed up meat production in the country (Dennis and Lutwama, 2012).

Economically, pig is regarded as an asset or a store of wealth or safety net for a time of economic crisis. Culturally, traditional ceremonies and beliefs are centred on pig as an asset to belief system in some places. According to Phiri (2012), pig production enhances households' income and food security among resource poor small-holder households. Globally, there is increasing population of pigs in developed countries like United States of America where more than ten million pigs are slaughtered each year (Machete and Chabo, 2020). Nigeria is the second largest pig producer in Africa following South Africa. In spite of this, the quantity of animal products produced is below the recommended level of animal protein intake thereby resulting in protein malnutrition (Inyang *et al*., 2014; Obayelu *et al.,* 2017). Meanwhile, production of pig meat has been slowed down by many constraints including social factors, religion, diseases, inadequate extension services, lack of credit and fear of inadequate market demand (Umeh *et al.,* 2015). The main social constraint is the belief that pigs are dirty and could lead to health hazard if consumed. Meanwhile, this assertion is not true because, pigs that are reared under intensive production systems and modern farm practice are clean and hygienic for consumption (Duniya *et al.,* 2013; Aminu and Akhigbe-Ahonkhai, 2017). There is need for extension services to educate the public about consumable qualities of pork and its high rate of returns to investment (Osondu *et al.,* 2014).

This study aims to describe the socioeconomic characteristics of the pig farmers, their farming systems, estimate the cost-returns and examine the factors affecting technical efficiency among the pig farmers in Ijebu Division of Ogun State. The study area is a predominant area for pig production with high level of pork consumption mainly among Christians and traditional worshippers who are prominent with their annual festivals and occasions.

Literature Review

The modern practice of intensive system of pig production involving restriction of the animal in an area and provision of feeds, water and healthcare ensures hygienic pig meat (Duniya, *et al.,* 2013; Osondu *et al.,* 2014). Pig is highly prolific with a short production cycle and is capable to produce twice or more in a year. Therefore, different types of pen must be used to reduce overcrowding and competition for food (Irekhore *et al.,* 2016). The level of pilferage in piggery is low due to their noise and other social reasons. Thus, a farmer can regain the cost of production within a short period of time (Onyekuru *et al*., 2020; Nwachukwu and Udegbunam, 2020). The limiting factors against pig production in Nigeria include inadequate disease prevention and control, inadequate healthcare and management

practices which result in high mortality rates (Uddin and Osasogie, 2017).

The main diseases of pig are helminthoses, diarrhoea, cough, mange, mastitis and ascaris, which can be controlled through hygiene, routine medication, timely intervention of medical practitioners and proper waste management (Ume *et al.,* 2018; Dorh *et al*., 2019). According to Adetunji and Adeyemo (2012), pig production is a lucrative enterprise with a mean Cost-Benefit Ratio of 2.82. Osondu *et al.* (2014) affirmed that access to credit, age of the farmers, farming experience, herd size and educational level significantly influenced pig production and majority (78.3%) of the farmers had no access to institutional credit. Umeh *et al.* (2015) found that the enterprise was dominated by male (68.3%), pork output had positive and significant relationship with feed and labour while education had a significant reduction effect on technical inefficiency.

Uddin and Osasogie (2017) categorized 1- 50 pigs as small scale, 51-100 pigs as medium scale and large scale (above 100 pigs) which was 58.4%, 15.0% and 26.6% respectively. The major pig production challenges were difficulties in securing institutional loans (61.0%) and high cost of feed (46.3%). Obayelu *et al.* (2017) found that an average pig farmer was young and active at 36.6 years, but 68.3% had no access to credit. Abiyong *et al.* (2019) estimated that the gross margin was an average of ₦8,426.30 per pig with mean profit efficiency of 52.35%. Maduka *et al.* (2020) revealed that pig farmers (100%) were aware of both vaccination and de-worming while 91.2% could control ecto-parasites. There was a positive and significant correlation (0.483) between level of knowledge and utilization of the technologies. These literatures provided a useful guide in identifying relevant variables and analytical model used in this study.

Study Area

The study area is Ijebu Division which is one of the four Divisions in Ogun State, Nigeria. Ogun state is bounded in the West by Republic of Benin, in the South by Lagos State and shares boundary with Oyo State in the North and Ondo State in the East. The State has an estimated land of about 16.409.26 square kilometers. The estimated total population of Ogun State is 6,379,500 (NPC, 2022). The study area is located in the lowland, semi deciduous forest belt with undulating topography while the overall altitude ranges between 122m-152m above sea level.

The main ethnic groups are the Yoruba people with Igbo and Hausa. The main economic activities are farming, saw milling and transportation services. The wet season is characterized by high annual rainfall between 1,200mm and 1,500mm between March and October of every year. The mean temperature ranges between - 23°C - 32°C. These climatic conditions favour production of arable, permanent crops and pig production among other livestock.

Materials and Methods

Sampling Technique

A multi-stage sampling technique was used in selecting the respondents for the study. In the first stage, three Local Government Areas (LGAs) namely Ijebu-ode, Ijebu North and Ijebu East LGAs were selected from Ijebu Division being the predominant area of pig production due to concentration of Christians and traditional worshippers that consume pork. The second stage involved a purposive

selection of the pig farmers through a snow-ball sampling technique. A total of 130 questionnaires were administered out of which complete responses from 107 respondents were subsequently used in data analyses.

Method of Data Analysis

The socioeconomic characteristics of the farmers, their farming systems and production constraints were analysed using descriptive statistics, i.e. frequency distribution, percentages and measure of central tendency. Budgetary technique was used to estimate costs and returns while Stochastic Production Frontier (SPF) model was used to examine the technical efficiency of the pig farms.

Cost and Return Structure of the Pig Farms

The budget of the farms was estimated as follows;

GI = TR – TVC

π = TR-TC

TC = TVC + TFC

Where:

GI = Gross Income

π = Net income

TR= total revenue

TC = Total cost

TVC = Total variable cost

TFC = Total fixed cost (Depreciation value of fixed assets)

Determinants of Profitability in Pig Production

The Cobb-Douglas (double-log) production function was adapted to examine the determinants of profitability in pig farming according to Dahal and Rijal (2019) as follows;

$$\ln Y = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \ldots + \beta_{13} \ln X_{13} + \mu_i$$

Where:

Y =Gross margin (₦aira)

X_1= Age of the farmers (years)

X_2 = Pig farming experience (years)

X_3 = Household size (number)

X_4= Formal education (years)

X_5 = Herd size (number of pigs)

X_6 = Access to credit (1, if yes; 0, otherwise)

X_7 = Extension agent (Number of visit)

X_8 = Distance from market (km)

X_9 = Medication (in Naira)

X_{10} = Quantity of feed consumed (kg)

X_{11} = Farm labour (man-days)

X_{12} = Religion (1, if Christianity; 0, if otherwise)

X_{13} = Sex (1, if male; 0, if otherwise)

β is parameter to be estimated

μi is error term

The Efficiency Model

The stochastic frontier production function adapted to analyze the production efficiency of the pig farms is given as;

$$Y_i = f(x_{ij}\beta)\exp(V_i - U_j) \quad (1)$$

Technical efficiency is specified as;

$Y_i/Y_i^+ = f(x_i\beta)\exp(V_i - U_i)/f(x_i\beta)\exp(V_i) = (\exp)(-U_i)$ (2)

i = 1, 2. …..n

The pig production technology is specified by the Cobb Douglas production frontier following Ume *et al* (2018) and Oyebanjo *et al* (2020). Y_i^+ is frontier output; Y_i is observed farm output while x_i is vector of input quantities used by the farms. The parameters of the stochastic production frontier are estimated using the maximum likelihood method. The estimating equation is specified as;

$InQ = \beta_0 + \beta_1 InX_1 + \beta_2 InX_2 + \beta_3 InX_3 + \beta_4 InX_4 + \ldots. + \beta nInXn + vi\text{-}\mu i$ (3)

Where:

Q= Herd size (Number of pigs per farm)

X_1= Initial number of piglets (Number)

X_2= Quantity of feeds/ feed supplements (kg)

X_3= Labour input (man-days)

X_4= Chemical/drugs (litre)

v_i= Random error

μ_i= Technical inefficiency

The inefficiency model μi is defined as

$$\mu_i = \alpha_0 + \alpha_1 Z_1 + \alpha_2 Z_2 + \alpha_3 Z_3 + \alpha_4 Z_4 + \alpha_5 Z_5 + \alpha_6 Z_6 + \alpha_7 Z_7 + \alpha_8 Z_8$$

Where:

Z_1= Age of farmers (years)

Z_2= Educational level (years)

Z_3= Sex (1, if male; 0 if otherwise)

Z_4= Marital status (1, if married; 0, if otherwise)

Z_5 = Household size (number)

Z_6= Membership of farmers association/cooperatives (1, if yes; 0, if otherwise)

Z_7= Rearing experience (years)

Z_8= Amount of credit obtained (₦)

α is the parameter to be estimated.

Results and Discussion

The Socioeconomic Characteristics of the Pig Farmers

The results of the descriptive statistics in Table 1 shows that pig farming was dominated by male (74.8%) probably because they were energetic than female (25.2%). Majority (88.8%) was below 60 years old while the mean age was 48 years. Thus, the pig farmers were young and active to handle the farm practices like mating, birth delivery, weaning, ear tagging, among others. Majority (69.1%) were married while 30.9% was single, widowed or divorced. Being married implies possible assistance from family labour. Literarily, 58.9% had maximum of secondary education, 29.0% had tertiary education while 12.1% was illiterate. Thus, majority of the farmers could keep farm records.

About 79.4% were Christians, Muslims (10.3%), traditionalist (8.4%) and non-religious (1.9%). The involvement of the few Muslims could be due to training in livestock husbandry in higher institution

since religion faithful are not exempted. However, 65.4% of the respondents had at most 5 members, 34.6% had up to 8 members while the average household size was 6 persons. Larger farm family implies access to cheap family labour but could exert high consumption needs on farm output which will reduce marketable surplus and farm income. Participants of cooperative society were 47.7%.

These findings were corroborated by Obayelu *et al.* (2017) who reported that an average pig farmer was young and active at 36.6 years, but 68.3% had no access to credit which significantly influenced pig production.

Table 1: Distribution of Pig Farmers by Socioeconomic characteristics (n = 107)

Variables	**Frequency**	**Percentage (%)**	**Mean**
Sex			
Male	80	74.8	
Female	27	25.2	
Age			
< 40	30	28.0	
40 -< 50	32	29.9	48.05
50 - < 60	33	30.9	
≥ 60	12	11.2	
Marital Status			
Single	19	17.8	
Married	74	69.1	
Divorced	8	7.5	
Widowed	6	5.6	
Level of Education			
No formal education	13	12.1	
Primary	25	23.4	
Secondary	38	35.5	
Tertiary	31	29.0	
Religion			
No religion	2	1.9	
Christianity	85	79.4	
Islam	11	10.3	
Traditional	9	8.4	
Household Size			
1 – 2	14	13.1	
3 – 5	56	52.3	
6 – 8	34	31.8	5.6
Cooperative membership			
None	56	52.3	
Member	51	47.7	

The Pig Farming System

The result in Table 2 shows that 58.9% have been rearing pig for more than 10 years while an average years of experience was 7.7 years implying that majority had enough practical knowledge. About 72.9% reared less than 50 pigs while average herd size was 33 pigs meaning that majority

were small-scale pig farmers. Majority (58.0%) constructed/ purchased the farm, 11.2% inherited while 30.8% leased or rented. The acquisition by personal construction indicates that more people are venturing into pig farming business. The pig farms (48.8%) engaged, at most, 2 workers, 51.4% employed about 5 workers while average quantity of worker was 2.36 indicating small-farm holding.

Majority (62.6%) sold live pigs, 2.8% sold pork while 34.6% sold both pork and live pigs possibly to increase farm income. Majority (73.8%) disposed their farm waste into bush with chemical treatment/ deodorant, 24.3% of them disposed waste into pit while 1.9% sold certain quantity of the waste for organic farming.

Table 2: Distribution of respondents by the farming system

Variables	**Frequency**	**%**	**Mean**
Pig farming experience			
< 10	44	41.1	
10 - <20	37	34.6	7.7
20 - <30	17	15.9	
≥ 30	9	8.4	
Herd size of pigs			
< 25	51	47.7	
25 - < 50	27	25.2	33.21
50 - < 75	23	21.5	
≥ 75	6	5.6	
Mode of pen acquisition			
Constructed/ purchased	62	58. 0	
Lease/rented	33	30.8	
Inherited	12	11.2	
Farm labour (Man-day)			
1 – 2	52	48.6	
3 – 4	46	43.0	2.36
≥ 5	9	8.4	
Form of farm output			
Slaughtered/ pork	3	2.8	
Live pig	67	62.6	
Sale of pork and live pig	37	34.6	
Method of waste management			
Disposal into pit	26	24.3	
Use as organic manure/ sale	2	1.9	
Bush disposal/ chemical treatment	79	73.8	
Total	**107**	**100**	

Cost and Returns of Pig Production in the Area

The budget of the farms was estimated based on the average costs and returns of pig production in the area. The result in Table 3 shows that an average farmer earned total revenue of ₦549,285.05 while total cost was ₦167,128.29 with a gross margin of ₦203,845.65 per annum. Thus, pig production was a profitable farm enterprise in the area. Feed and labour were the most expensive inputs at 65.9% and 12.7% of total cost respectively. These findings were corroborated by Abiyong *et al.* (2019) who claimed that pig farming is profitable at average gross margin of ₦8,426.30 per pig.

Table 3: Estimate of Cost and Returns of Pig Production

Cost of item	**Mean**	**% of TC**
Total Revenue (TR)	549,285.05	
Variable cost		
Cost of feed	110,065.19	65.9
Cost of water	1,886.57	1.1
Cost of medication and veterinary services	11,396.99	6.8
Cost of farm labour	21,302.03	12.7
Cost of fumigation/ disinfectant	2,541.12	1.5
Cost of vitamins	1,349.07	0.8
Cost of de-ticking	232.78	0.1
Total Variable Cost (TVC)	148,773.75	89.0
Depreciation value or Total Fixed Cost (TFC)	18,354.54	11.0
Total Cost (TC)	167,128.29	100.0
Gross Farm Income (GM) = TR – TVC	203,845.65	
Net Farm Income (NFI) = GM – TFC	185,354.54	
Return on investment (ROI) = NFI / TC	1.11	

Factors Influencing Profitability among the Pig Farms

The estimates of the factors affecting profitability in pig production were presented in Table 4. F-statistics (17.776) is significant at 1% with Adjusted R^2 (0.754) indicating that the determinants explained 75.4% of the variation in profitability of pig production in the area. Age (0.039) significantly affected profitability level at 1% probably because the farmers were relatively young.

Farming experience (0.030) increased profitability significantly at 1% possibly due to practical knowledge that enhanced resource utilization. Herd size (0.370) and access to credit (0.111) had positive and significant relationship with profitability at 1% and 10% respectively. This implies that credit beneficiaries earned higher farm income than their counterpart.

Table 4: Determinants of Profitability Estimated by Double-log Production Function

Variables	Coefficients	Standard Error	t-value
(Constant)	11.619***	0.172	67.381
Age	0.039***	0.005	7.526
Experience	0.030***	0.005	6.300
House hold size	-0.015	0.020	-0.760
Years of formal education	0.003	0.007	0.464
Herd size	0.370***	0.080	4.754
Access to credit	0.111*	0.058	1.903
Extension contact	0.019	0.123	0.156
Distance from market	-0.010	0.030	-0.412
Medication	0.020	0.023	0.898
Quantity of feed consumed	0.006	0.006	0.896
Farm labour	0.006	0.023	0.265
Religion	-0.003	0.012	-0.166
Sex	-0.014	0.010	-1.326
R –Square	0.799		
Adjusted R-Square	0.754		
F value	17.776***		

Technical Efficiency of Pig Production in the Area

The estimates of the Stochastic Production Frontier in Table 5 shows that sigma square (0.654) was positive and significant indicating a good fit with Log-likelihood function of -124.6497. The variance (0.531) indicates that the variables in the model accounted for 53.1% of the variation in technical efficiency of pig production. Labour input had the largest output elasticity, followed by feeds (0.370) and initial number of piglets (0.035) while chemical/drugs (0.023) had the least. Thus, labour (0.916) contributed the largest output elasticity which was significant at 1% followed by feeds (0.370) at 10% possibly due to efficient utilization.

Education (-0.325) and access to credit (-0.047) significantly reduce inefficiency in pig production at 10% and 1% respectively, meaning that farmers with higher education achieved higher levels of technical efficiency as a result of knowledge and skills to use available technology. These results were in line with Osondu *et al.* (2014) who reported that credit, farmer's age, farming experience, herd size and education significantly influenced pig production. Umeh *et al.* (2015) also found that pork output had positive and significant relationship with feed and labour.

Table 5: Estimate of Stochastic Production Frontier for Pig Farming in the Study Area

Variables	**Parameters**	**Coefficient**	**Standard error**	**t-ratio**
Constant	β_0	-1.771*	0.978	-1.811
Initial number of piglets	β_1	-0.035	0.154	-0.225
Quantity of feeds/feed supplements	β_2	0.370***	0.050	7.415
Labour input	β_3	0.916***	0.283	3.234
Chemical/drugs	β_4	-0.023	0.028	-0.833
Inefficiency model				
Constant	α_0	0.308	0.975	0.316
Age of farmers	α_1	0.078	0.293	0.267
Formal education	α_2	-0.325*	0.182	-1.782
Sex	α_3	-0.038	0.183	-0.205
Marital status	α_4	0.072	0.245	0.293
Household size	α_5	0.338	0.269	1.256
Membership of farmers association	α_6	0.351	0.220	1.598
Rearing experience	α_7	-0.031	0.108	-0.286
Access to credit	α_8	-0.047***	0.013	-3.619
Sigma-squared	δ^2	0.654***	0.136	4.804
Gamma	γ	0.531***	0.113	4.704
Log likelihood function		-124.6497		

Efficiency Levels of the Pig Farms

The distribution of farm efficiency levels is shown in Table 6. The range of technical efficiency of the farms was between 0.19-0.95. About 24.3% of them were below technical efficiency (TE) of 0.40, only 34.6% operated between 0.41-0.60 while 41.1% was above TE of 0.60. Thus, majority of the farmers performed below mean technical efficiency of 0.56 in the area. This result suggests that the pig production efficiency could still be increased by 44.0% through better use of modern technology.

Table 6: Distribution of Respondents by Farm Efficiency Level

Efficiency level	Frequency	Percentage	Minimum	Mean	Maximum
≤ 0.20	3	2.8	19.39		
0.21 - 0.40	23	21.5			
0.41 - 0.60	37	34.6		56.33	
0.61 - 0.80	27	25.2			
> 0.80	17	15.9			95.19
Total	107	100			

The Challenges Confronted by Pig Farmers

The challenges in pig farming as presented in Table 7 shows that majority of the farmers were confronted with high input prices (92.5%), pest and disease (79.4%), inadequate fund (74.8%), high mortality (58.9%) and low output price or low market demand (52.3%). These problems possibly contributed to low technical efficiency in pig production. Uddin and Osasogie (2017) also reported that the major pig production challenges were difficulties in securing institutional loans (61.0%) and high cost of feed (46.3%).

Table 8: Problems Encountered on the Sampled Farms (n=107)

Challenges	Frequency	%
High input prices	99	92.5
Inadequate fund	80	74.8
Low output prices/demand	56	52.3
Theft	40	37.4
Pest and disease	85	79.4
Poor access to medicine	27	25.2
Cannibalism	43	40.2
Inadequate housing	21	19.6
Mortality	63	58.9
Pollution/disposal of waste	29	27.1

Conclusion

The findings revealed that majority (72.9%) were small-scale famers with average of 33 pigs. The average gross income was ₦282,128.29 per annum confirming that pig farming is lucrative. Feed (65.9%) was the most expensive input while high input prices (92.5%), pest and disease (79.4%) and inadequate fund (74.8%) were the major production challenges. Profitability was significantly influenced by farming experience, herd size and access to credit while education significantly reduced inefficiency in pig production. Mean technical efficiency was 0.56 showing that pig production efficiency in the area was slightly above average. Therefore, government should promote extension training to enhance education of pig farmers. Access to credit should be promoted at affordable interest rate while farmers should participate actively in cooperatives in order to have access to additional fund. Effective distribution of modern production technology should be ensured to encourage expansion of pig enterprises beyond small-scale level. The relationship between farmers, extension agents and research institutes should be intensified to resolve major challenge in pig farming for the purpose of increasing protein production and consumption in the area.

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