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Original Article

Economic analysis of allocative efficiency of resources use for pig production in Southeastern Nigeria

OPEN ACCESS

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ABSTRACT

This study was conducted to analyze the allocative efficiency of resource use for pig production in southeastern Nigeria. Four hundred respondents were selected using a random sampling technique. Primary data for the study were collected using a structured questionnaire and interview schedules. Frequency distribution table, percentage responses, principal component analysis, and an allocative efficiency model were used to analyse the data collected. The results showed that the majority of the respondents were aged (mean=47 years), educated (mean=9 years of formal education), had moderate household sizes (mean=6 people), were experienced in piggery (21-40 years), belonged to cooperative societies, and had limited access to credit. The result of the allocative efficiency showed that none of the sampled farmers achieved absolute efficiency of resource use as they either underutilized or overutilized the resources. The under-utilized resources were farm size (33.25), feed (0.88), medication (0.47), and labour (3.02), while capital (-2.69) was over-utilized. The limiting factors to pig production were poor access to credit (3.5472), high cost of feeds (3.3075), poor access to improved breeds of piglet (2.2822), poor access to information (2.0339), and water scarcity (2.1567) at (P<0.01). Conclusively, the allocative efficiency results show that none of the respondents were able to use resources as efficiently as possible since they either overused or underutilized them. Thus, there is a need to enhance pig farmers' access to credit at a low interest rate, feed materials at a subsidized cost, and improved breeds of piglets at a moderate cost to enable them to attain absolute efficiency in their piggery endeavour.

KEYWORDS: *Constraints, Maximization, Piggery, Resources, Utilization*

INTRODUCTION

It is often known that pig production is crucial to economic growth. Pig is an essential source of animal nutrition, money, jobs, labor, manure, and foreign exchange earnings. Pigskin and bristles are used to make light leather and brushes, and the manure is utilized to make cooking gas (Oni, 2014; FAO, 2018;). Because of the inherent qualities of the animal, pig breeding is becoming a profitable industry worldwide, especially in non-Islamic societies (Anukwu & Ebong, 2011). These intrinsic qualities include thriving in marginal conditions, having high fecundity, high feed conversion efficiency, early maturity, short generation interval, and a comparatively modest area requirement, according to studies (Ona, 2015; Ibitoye *et al*., 2016). China produced the most pigs worldwide in 2022, with 450 million heads, followed by the US and the EU, with 140 and 74 million heads, respectively (FAO, 2023). There were 44 million people in Africa that year, and Nigeria was the

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continent's biggest producer with 302,976 thousand tonnes. The production of pigs in Nigeria is rapidly decreasing (Ume *et al*., 2018). Nigeria's pig meat output, for example, increased significantly between 1971 and 2020, from 29,190 to 302,976 thousand tonnes, at an increasing yearly rate that peaked in 1984 at 29.41% and then fell to 0.84% in 2020 (FAO, 2023).

Potential causes of the production decline include poor quality feeds, limited access to veterinary care, farmers' illiteracy, pests and diseases attack as well as lack of credit. Other are poor housing, poor quality breeds, high feed prices, inadequate infrastructure, a weak market for pig products and the absence of a pig product processing industry in the nation. (Ibitoye *et al*., 2016; Ume *et al*., 2018). Low productivity is the result, and this could be fixed by using resources efficiently. Efficiency in pig production is the degree to which productive resources such as land, labour, feed, vaccines, and drugs are employed to produce output without wastage (Ume *et al*., 2018).

According to Esheya (2025), a key component of raising production is efficiency, especially in a nation with limited resources and a lack of innovative technological trend. Low stocking rates and inefficient use of productive inputs by pig farmers have been identified as the main reasons for the low productivity of Nigeria's piggery subsector (Bamiro, 2008). Economic efficiency is the result of combining technical and allocative efficiency (Abunyuwah & Ahiale, 2019). The degree to which farmers use inputs efficiently up until their marginal contribution to output value equals the marginal factor cost is known as allocative efficiency (Ume *et al*., 2016). This concept is the focus of discussion in this study.

The management of available finite resources and technical know-how to achieve the largest likely economic gain within given resources is known as allocative efficiency Esheya (2022). The capacity to select the best input levels for a given factor price is also known as allocative efficiency. The ability of farmers to attain the ideal mix: that is, the appropriate and effective combination of inputs, is what produces the best results (Abunyuwah & Ahiale, 2019). Thus, achieving a high degree of allocative efficiency is essential for enhancing nutrition, food security, career options, and labor usage efficiency in pig production. To the researcher's knowledge, a paucity of research exists in this area, thereby necessitating this investigation.

This study aims at: characterize the socioeconomic traits of the pig farmers; ascertain the farmers' allocative efficiency of the farm resources at their disposal; and pinpoint the obstacles to productive pig farming in the research region.

METHODOLOGY

The study was carried out in the southeast part of Nigeria, which covers five states that comprise of Abia, Anambra, Ebonyi, Enugu, and Imo (Esheya, 2023). Southeast Nigeria lies between latitudes 4º20′and 7º25′North of the Equator and longitudes 6º37′ and 8º28′ East of the Greenwich Meridian (NPC, 2006; Okonkwo & Eyisi, 2014). For this investigation, a multi-stage random sampling technique was employed. Four (4) states: Abia, Anambra, Ebonyi, and Enugu were purposively chosen for the first stage, and five (5) Local Government Areas were purposefully chosen from each of these four states according to the level of pig production. Five (5) communities were selected randomly from each of the identified LGAs for the second stage. Finally, from each of the one hundred (100) localities that were selected, four (4) registered pig producers were chosen at random. This increased the number of respondents for the detailed study to four hundred (400). Data for the study was gathered through oral interviews and a standardized questionnaire. Allocative efficiency score and principal component analysis (PCA) were used to analyze data.

Model Specification

Efficiency Ratio

Efficiency ratio was used to determine the efficiency of resources use in pig production enterprise. The estimated coefficients of the relevant independent variables were used to compute the Marginal Value Products (MVP) and their corresponding Marginal Factor Costs (MFC).

The equation is r = MVP (1)

Where r = efficiency ratio, MVP = Marginal Value Product of variable input, MFC = Marginal Factor Cost

The value of MVP was computed using the regression coefficient of each input and the price of the output was expressed as stated below:

$$MVPx = bi \times Py \quad (2)$$

Where; Py = price per unit of output, bi = regression coefficient of input i (i = 1, 2, ...n), MVPxi = Marginal Value Product of input xi

The prevailing market price of inputs was used as the Marginal Factor Cost (MFC).

b. Ordinary Least Squares Multiple Regression Model (bi coefficient)

Ordinary Least squares multiple regression model was used to determine the bi coefficient.

The general form of an OLS regression equation is:

$$Y = \beta0 + \beta1X1 + \beta2X2 + \ldots + \beta nXn + e \quad (3)$$

In this study, the implicit form of the model is specified as follows:

$$Y = f(X_1, X_2,X_3,X_4,X_5,X_6,X_7,X_8,X_9) +e \quad (4)$$

Where, Y = allocative efficiency of respondents, X_1 = Gender (male =1, female =0), X_2 = Age (Years)

X_3 = Educational level of respondents (Number of years spent in school), X_4 = Access to credit (Dummy variable; access =1, no access = 0), X_5 = Experience (Years), X_6 = Membership of Organisation (Dummy), X_7 = Household size (Number of persons in the household), X_8 = fixed inputs cost (rent, interest, annual depreciation), X_9 =Labour (Manday), e = stochastic error term

c. Principal Component Analysis (PCA).

The Model of Principal Component (PCA) is stated thus:

$$\propto_k = \propto_{1k1}, \propto_2 K, \propto_3 k, \dots, \propto pk \quad (5)$$

$$x = x^{1,2}, x^3, \dots, xp \quad (6)$$

$$\propto_K^T x = \sum_{j=1}^{p} \propto_{Kj} x_j \quad (7)$$

$$Var = [\propto_K^T X] \text{ is maximum} \quad (8)$$

Maximise subject to

$$\propto_K^T \propto_K = 1 \quad (9)$$

$$\text{Cov} = [\propto_1^t \propto - \propto_2^t \propto] = 0 \quad (10)$$

The Variance of each of the Principal Component:

$$Var[\propto_k X] = \lambda_k \quad (11)$$

$$S = \frac{1}{n-1}(X - \bar{X})(X - \bar{X})^T \quad (12)$$

$$S_i = \frac{1}{n-1}\sum_{i=1}^{n}(X_i - \bar{X}_i)(X_I - \bar{X}_i) \quad (13)$$

Where, X = vector of 'P' Random Variables;

$\propto k$ = Vector of 'P' Constraints; λk = Eigen Value;

RESULTS AND DISCUSSION

Socio-economic Characteristics

The result in Table 1 shows 47.25% of the respondents were between the ages of 41 and 50, and 33.75 percent were under 40. According to Adetunji &AAdeyemo (2012), the remaining 20% of those over 50 were risk averse to modern advancements and could prefer the status quo out of concern that they would lose their hard-earned money. Furthermore, 36.25 percent of the farmers lacked access to financing, whereas 63.75 percent had it. According to Ume *et al*. (2019), farmers that use loans more frequently attempt to use it more effectively in order to increase their earnings. The majority of farmers in the sample (63.50%) had households with seven to twelve people, while the smallest (10.00%) had households with one to six people. When members of a large household are recruited by the head of the household to purchase material inputs for technology, this could be interpreted as a proxy for family labor and income access (John, 2011). Additionally, 46.25% of the respondents did not belong to any organizations, whereas 53.75% did. In terms of allocative type specifically, this result was in line with Ume *et al*. (2018), who proposed that cooperative members are more efficient because they have greater access to training, credit, production inputs, and agricultural knowledge. Additionally, 85.00% of the respondents had a formal education, whilst

Four functional forms of ordinary least square regression model were fitted. These included: linear, semi-log, Cobb Douglas (double log) and exponential functions. The choice of the best functional form was based on the magnitude of the R^2 value, number of the significant, size and the signs of regression coefficient as they relate to a priori expectation (Omogo *et al*., 2023).

15.00% did not. A higher level of education enables farmers to use their natural talents and adventurous nature to produce pigs in the most efficient way possible, resulting in high yield (Ume *et al*., 2018). Furthermore, 56.25% of the respondents had between 21 and 40 years of experience raising children, and the smallest percentage (16.00%) had between 41 and 60 years. Skilled farmers possess the ability to combine resources creatively in order to maximize their agricultural output (Abiola *et al*., 2004). Table 1 demonstrates that while 42.25 percent of farmers lacked access to extension services, the majority (57.75 percent) did. It is implied that the study's farmers experienced inadequate extension outreach. Low productivity results from most farmers being denied access to technical assistants of technology function by change agents (Ituma & Esheya, 2024; Amusa *et al*., 2017; FAO, 2018). The aforementioned claim is not supported by the findings of Abonyi *et al*. (2012). They said that in the majority of developing nations, extension services are a key channel for informing farmers about technologies that can increase their allocative efficiency (Esheya, 2024).

Multiple Regression Production Function Analysis

The multiple regression production function analysis was used in determining the bi-coefficients of allocative indices of the pig farmers and was concise and presented in Table 2. Table 2 shows the statistical and econometric criteria, the double log multiple regression analysis was selected as the lead equation. The coefficient of multiple determination, or R^2, was 0.789, indicating that the independent variables in the model were responsible for 78.89% of the variation in the dependent variable, with the error term accounting for the remaining 21.11%. According to apriori expectations, the farm size coefficient was positive and significant at the 1.0% probability level. This suggested that a 0.1224% increase in pig production would result from a 1% increase in farm size. According to Adetunji & Adeyemo (2012), farm size is a reliable indicator of both managerial skill and financial standing. Furthermore, at the 5% probability alpha level, the feed coefficient (0.1239) was positive and statistically significant. This is in line with John (2011), who confirmed that animal feed is a crucial component of animal agriculture and frequently the primary expense of animal rearing. Farmer's supplement expensive feeds with alternatives, such as food wastes like leftover grains from beer making, to reduce the cost of these feeds (Abiola *et al*., 2015). Additionally, the authors claimed that home food scraps and the leftovers from food processing companies like milling and brewing are traditional sources of animal feed. At the 5.0% probability level, the labour input coefficient was significant. Its positive sign suggests that allocative inefficiency would decline as labor input increased.

Table 1: Socio-economic Characteristics of the Respondents

Socio-economic variables	Category	Frequency (N=160)	Percentage (%)
Age	30-40	135	33.75
	41-50	189	47.25
	51-60	56	14.00
	Above 60	20	5.00
	Mean	**47**	
Access to credit	Access	255	63.75
	No. access	145	36.25
Household size	1-6	40	10.00
	7-12	254	63.50
	13 and above	106	26.50
	Mean	**6**	
Education level	No. formal	60	15.00
	Primary	138	34.50
	Secondary	102	25.50
	Tertiary	100	25.00
Membership of Organization	Yes	215	53.75
	No.	185	46.25
Rearing Experience	1-20	111	27.75
	21-40	225	56.25
	41-60	64	16.00
Access to extension services	Yes	231	57.75
	No.	169	42.25

This result ran counter to the findings of Abonyi *et al*., (2012) and Omeh & Machebe (2012), who claimed that a lack of availability makes many workers afraid to work in pig barns for fear of getting bitten. Pig production in the study area is less profitable, though, because the few who dare that demand high prices (Uneze & Onugu, 2012). The dependent variable had a negative correlation with the medication coefficient, which was significant at the 10% risk level. Due to inadequate auditing of medications and related substances imported into developing nations, the majority of drugs that are available in most marketplaces are expensive, subpar, and tainted (Ubokudom *et al.,* 2021). Additionally, most livestock farmers are able to use quacks due to the inadequate location of veterinary clinics in rural areas, which results in massive animal losses (Machebe *et al*., 2009). Onyekuru *et al.* (2020) found that the variable's coefficient had a sign identity. Machebe *et al.* (2009) *and Onyejuru et al* (2020) believed that believed that the majority of vaccines used to cure their cattle lacked effectiveness since they were not kept in cold chains and were instead promoted by some unhappy elements. This was especially true in rural areas where there is no power supply or epileptic power (Ume *et al*. 2018). Farmers face significant losses as a result, which frequently causes these firms to fail and close.

The Allocative Efficiency Indices Measurement

The allocative efficiency indices were summarized and presented in Table 3.

Table 3 shows that none of the variables taken into account had effective resource use. This is due to the fact that none of the variables had an efficiency ratio of one. Furthermore, the marginal factor cost and marginal value production (MVP) ratios for labor and farm size were 3.02 and 33.25, respectively, and both were higher than 1. This indicated that the farmers were not making the most of the resources available to them for raising pigs. The high costs that workers in the company charge could be the reason for the underutilization of labor. This result was in agreement with Onah (2015). He reported that the piggery industry requires a lot of labour and that labour costs rise as young people with the physical capacity move into cities. Besides, raising pigs requires a lot of cash, which many farmers: especially those with limited resources, may not be able to pay, which could result in underuse of the resource. The underutilization of these resources suggested that their use exceeded the levels required to maximize profits. The result of underutilizing resources is that farming typically stays at rudimentary and traditional levels (Onubuogu *et al*., 2012). Likewise, feed's (0.88) and medicine's (0.47) allocative efficiency indices were underutilized. Some farmers may supplement with poor nutrients from household trash due to underutilization caused by the high cost of feed.

Due to the exorbitant expense and poor quality of medications and vaccines, many farmers have abandoned them in favor of using local physicians, who are frequently less effective (Ajayi, 2005). Again, the marginal factor cost for capital and marginal value production (MVP) ratio was -2.69, which is below unitary. This showed that the resource is being used excessively. The overuse of the resource suggested that less of its profit-maximizing potential was used. The overuse of the fact that raising pigs requires a lot of money is one of the potential causes (Agada *et al*., 2006).

Therefore, labour, feed, and medication should be decreased from their current levels by 97%, 66.9%, -13.64, and -112.7%, and capital should be increased from their existing levels by -137.2%, in order to maximize profit in pig production in the research area. Table 4 summarizes and displays the production and return to scale elasticities.

Table 2: Estimated Multiple Regression Production Function for Pig Production

Variable	Linear	Exponential	+Double Log	Semi Log
Constant	5.024 (4.006)***	3.675 (4.167)***	6.380 (3.557)***	3.133 (3.445)***
Farm size	2.423 (2.911)**	0.335 (0.311)	0.122 (1.309)*	0.002 (0.399)
Feed	0.093 (0.022)	0.289 (0.556)	0.123 (2.098)**	1.721 (-0.165)
Medication	0.527 (-1.005)	0.451 (1.490)**	0.027 (-3.119)***	-2.654 (2.001)**
Labour	0.3877 (3.434)***	0.0018 (4.032)***	0.360 (1.096)*	-0.221 (0.1701)
Capital	-0.372 (-2.091)	-0.051 (-1.411)	0.3441 (0.674)	0.0134(0.112)
R^2	0.5623	0.0268	0.7889	0.6442
F Value	3.0991***	6.4401***	9.0074***	4.5541***

****, **, * significant at 1.0%, 5.0% and 10.0% levels of probability respectively*
The figure in parenthesis is the t-ratio

Table 3: Allocative Efficiency Indices of Pig Production in the Study Area

Variable	$\overline{Y}$	$\overline{X}$	Bi	MPP	MVP	MFC	R	(D)%
Farm size	940	580	0.12	114.67	66,508.60	2000	33.25	97
Feed	68.40	12.57	0.12	8.42	105.83	120	0.88	-13.64
Medication	0.64	0.36	0.03	0.23	28	60	0.47	-112.70
Labour	0.54	0.48	0.36	504	241.92	80	3.02	66.90
Capital	880	-14.80	0.34	363.72	-5,383.10	2000	-2.69	-137.20

Elasticity of Production and Return to Scale

The change in output in relation to a unit change in input is shown by the elasticity of production. Cobb Douglas coefficients were used to directly measure the elasticity of pig production. Each of the individual input resources used has a production elasticity of less than one, as shown in Table 4. This indicated over-utilization of these inputs because they showed an inelastic relationship between all of the factor inputs and the output of pig production. Nevertheless, the return to scale- the total elasticity of all inputs employed in pig production was higher than 1, indicating that the plan for pig production was elastic. The farmers were in the third stage of their producing process. This indicated that the responsiveness of pig production output to a 1% change in all factor inputs would be 1.0880%. The results are similar to those of Onubuogu *et al*. (2012) and Ume *et al*. (2018), who found that the farmers in their studies were in stage 3 of the production function.

Table 4. Elasticity of Production and Return to Scale in Pig Production

Variable	Elasticity of Production
Farm size	0.122
Feed	0.579
Medication	0.027
Labour	0.360
Capital	0.344
Return to Scale	1.088

Constraints to Pig Production

The result in Table 5 shows that the number of principal components retained using the Kaiser Meyer criterion were four in line with Eigen-values greater than 1. Of the disparities between the components integrated in the model, 0.7925% were explained by the components that were kept. A value of 0.7925 was supplied by the Kaiser-Meyer-Olkin (KMO) test, which gauges sample adequacy, and a Bartlett test of sphericity of 3.01357*** was declared significant at the 1% probability level. This indicates the importance of using the data set for factor analysis. According to the sampled farmers, the credit access problem was ranked first in terms of importance and had an Eigen-value of 3.5472. Poor credit availability may be linked to respondents' ignorance about the bank's credit facility and the lending agencies' loan repayment policies (Onyekuru *et al*. 2020). The high cost of feed, with an Eigen value -value of 3.3075, comes next. The high cost of feeding materials such palm kernel cake, discarded grains, etc., may be linked to the high cost of feed (Anukwu & Abonyi, 2011). Poor piglet breeds came in third place with an Eigen-value of 2.2822. Limited access to better breeds and their expensive cost may also be contributing factors to the inferior piglet breed (Onah, 2015). Bad roads were the least important of the characteristics taken into consideration, ranking eighth with Eigen-values of 0.0667. The lack of tar on the roads leading to the majority of the study's pig farms may be the cause of this.

Table 5: Results of the Principal Component Analysis on Constraints for pig production

Constraints	Eigen-Value	Difference	Proportion	Cumulative
Credit access problem	3.5472	0.22674	0.1007	0.2882
High cost of feed	3.3075	1.2673	0.3019	0.3473
Poor breeds of piglet	2.2822	0.3556	0.2017	0.4002
Water Scarcity	2.1567	0.3066	0.0121	0.4643
Poor access to information	2.0339	0.2699	0.2601	0.8332
High cost of Labour	2.0192	0.2617	0.2423	0.4469
High cost of building material	1.0344	0.2543	0.1647	0.8022
Bad Road	0.0667	0.2215	0.0488	0.8113
KMO	0.7925			
Chi-Square	3.2271***			
Rho	1.00000			
Bartlett Test of Sphericity	3.01357***			

CONCLUSION AND RECOMMENDATION

Based on the study, it was concluded that none of the respondents were able to use resources as efficiently as possible since they either overused or underutilized them. Capital was the resource that was overused, but farm size, labor, feed, and medication were the resources that were underutilized. Poor loan availability, high labor costs, water scarcity, high feed costs, and issues with enhanced piglets were the main obstacles to pig production in the research area. Based on the findings, the following recommendations were proffered:

i. Improved piglets should be bred by the government in partnership with suitable research institutions and made reasonably priced for farmers.
ii. The government must incentivize financial institutions to offer farmers credit facilities at the appropriate time, location, and with appropriate collateral.
iii. To achieve complete efficiency in the study region, pig producers should increase the underutilized resources (farm size, labor, feed, and medication) and decrease the overutilized resource (capital).

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Authors' Contributions

The lead author initiated the research, went to field for data collection and collation while the co-author worked on the data coding, analysis and interpretation of results. Both authors read and approved the final manuscript as a product of a harmonious positive academic collaboration.

Ethical Statement

The authors hereby declare that this study does not require ethical statement.

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