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EFFICIENCY ANALYSIS OF PIG PRODUCTION IN SOME COMMUNITIES OF JEMA'A LOCAL GOVERNMENT AREAS IN KADUNA STATE, NIGERIA

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ABSTRACT

This research was conducted to determine the efficiency analysis of pig production in some communities in Jema'a Local Government Area of Kaduna State, Nigeria. Primary data were collected from pig farmers using structured questionnaires. Multi-stage sampling procedure was employed for the study. The first stage involved purposive selection of some communities in the study area based on predominance in pig production. In the second stage, six districts namely Takau, Ungwan Fari, Ungwan Baki, Aduwan, Ugwan Masara, Ungwan Yanshi were purposively selected from the Local Government Area because of intensity in pig production in the area. Finally, a simple random sampling was employed in selecting farmers from each of the villages through balloting system. Thirty percent (30%) of the sample frame (509) was used as the sample size. A total of 152 farmers were randomly selected and interviewed. From the results obtained, the average technical efficiencies of pig farmers were 73%. This implied that on the average, the respondents were able to obtain about 73% of potential output from a given mix of production inputs. Thus, there was possibility of increasing pig production in the study area by 27%. Findings further revealed that none of the sampled pig farms reached the frontier threshold. However, variables included in the model for the efficiency effects were feed, labour, drug and herd size. The parameters of the stochastic frontier production function were estimated simultaneously with those of the model of inefficiency effects. Results indicated that feed, drug and herd size were significant ($p<0.05$). The farm specific technical efficiency distribution concluded that none of the farmers achieved the maximum efficiency level. Thus, output could still be increased by 27% using available inputs and technology. Given that pig is prolific, policies that lead to increased output were bound to affect the economic life of the farmers and the farm families. Pigs would contribute in making animal protein available in the area.

Keywords: *Technical Efficiency, pig, Stochastic Production Frontier, Kaduna state.*

INTRODUCTION

The pig industry can be a very reliable one due to certain attributes of pigs and the Nigerian production system (Oni and Yusuf, 1999). Pigs have a high survival rate and also have the ability to utilize a host of agro-industrial by-products and crop residues with little or no processing fee and at minimal cost (Ikani *at al.*, 2001). Ikani *et al.* (2001) also pointed out that pigs surpass other red meat animals in converting feed to flesh. Pigs have high fecundity, high feed conversion efficiency are early maturing, with a short generation interval and a relatively small space requirement Olukosi *et al.*, 2005). It is produced under a variety of production systems ranging from simple backyard pigs, pigs living on garbage belts, to family operated farms or large scale integrated pig industries with sophisticated bio-safety measures (Shively *et al*, 2010). Pork is the most popular meat consumed in the world today and about 44% of the world meat protein consumption is derived from pork and pork products (Food and Agricultural Organization; FAO, 2009).

According to Holness (2005), traditionally, pig meat provides a wide range of marketable products and the opportunity must be taken to exploit these to the maximum in the developing market situation. In view of the numerous advantages accruable from pig production, this study aimed at bringing out some of the factors affecting pig production in Kaduna State, Nigeria, with a view to making recommendation for improvement where applicable.

In Nigeria, the daily animal protein intake is below the recommended minimum level of 65 gm per caput per day (Madukwe, 2006). It has been observed that only 8.4 gm of the 53.8 gm of protein consumption level of Nigerians is derived from animal sources. Ajala *et al.* (2006) stated that animal products contribute less than 16% protein consumed by Nigerians. This is very poor when compared with countries like United State of America (USA) with about 69% of total protein being derived from animal sources (Holness, 2005). Due to the acute shortage of animal protein in the diet of the average Nigerians, there is the need to increase the production of domestic animals, which are conventional sources of animal protein (Martin, 2011).

MATERIAL AND METHOD

Study Area

The study was conducted in some communities in Jema'a Local Government Area of Kaduna State. It is located between latitude 9^0 10" and 10^0 55" N longitude 6^0 10" and 7^0 34" E in the Northern Guinea Savannah Ecological Zone of Nigeria. Based on NPC (2006), the study area has a projected population of 278,735 at 2012 with an annual growth rate of 3.2%. The mean annual rainfall is 1616 mm. The annual temperature ranges between 21 and 30^0C in the study area. The study area shares boundaries with Jaba Local government Area, Zango Kataf Local Government Area and Kaura Local Government Area to the North, to the East Plateau State, to the South-East Sanga Local Government Area and to the West Federal Capital Territory. The Agricultural activities carried out in the study area include; cultivation of crops like: maize, guinea corn, soya beans, cowpea, yam, potatoes, palm kernel, ginger etc. and rearing of animals like pigs, chickens, goats and cattle (Moreki *et al*., 2011) and (John *et. al*., 2012).

Sampling Procedure

Multi-stage sampling procedure was employed for the study. The first stage involved purposive selection of some communities in Jema'a Local Government Area of Kaduna state based on predominance in pig production. In the second stage, six districts namely Takau, Ungwan Fari, Ungwan Baki, Aduwan, Ugwan Masara and Ungwan Yanshi were purposively selected from the Local Government Area because of intensity in pig production in the area. Finally, a simple random sampling was employed in selecting farmers from each of the villages by identifying the number of pig farmers in each district. Thirty percent (30%) of the sample frame (509) was used as the sample size. In all, 152 farmers were randomly selected and questionnaire was distributed to the farmers, one district at a time by interview method.

Data Collection and Analysis

Primary data were used for this study by administering structured questionnaire to the respondents (pig farmers). The data collected include socio- economic characteristics of pig farmers such as age, household size, educational status, cooperative society, extension and credit obtained in pig farming, input and output of the farmers for both the production and cost function analyses. The input data include labour (man-day), feeds, drugs and herd size.

Model Specification

$\ln Yi = \beta_0 + \beta_1 \ln X_1 i + \beta_2 \ln X_2 i + \beta_3 \ln X_3 i + \beta_4 \ln X_4 i + Vi - Ui$

Where subscript i refer to the observation of ith farmer,

ln = Logarithm to base e,

Y = Output of pig of the ith farmer (kg)

X1= herd size (numbers)

X2 = feed (kg)

X3= medication (mg)

X4= Labour (Man-hour)

The inefficiency effects, Vi is a random error term assumed to be independently and identically distributed as N (0, σ_V^2). U_i represents technical inefficiency and is identically and distributed as a truncated normal with truncations at zero of the normal distribution (14). The U_i is defined as:

$U_i = \delta_0 + \delta_1 \ln Z_1 i + \delta_2 \ln Z_2 i + \delta_3 \ln Z_3 i + \delta_4 \ln Z_4 i + \delta_5 \ln Z_5 i + \delta_6 \ln Z_6 i$

Where:

U_i= Technical inefficiency of the ith farmer

Z_1= Age of the farmer (years)

Z_2= Years of education of the ith farmer

Z_3= Household size of the ith farmer (Number of people)

Z_4 = Cooperative Association of the ith farmer (Years of participation)

Z_5= Extension Contact of the ith farmer (Number of contacts)

Z_6= Credit obtained of the ith farmer (Naira)

RESULT AND DISCUSSION

Costs and returns of pig production

Piglet used by the farmers in the study area were mainly cross breed got from cross breeding exotic and local breed. The average number of piglets used was 3 piglet/10 pigs with an average market price of ₦3781 per piglet was used and this constituted 18.70% of the total cost of production. The quantity of feed was 130kg/10 pigs with an average market price of ₦350 per kg was used and this constitutes 75.02% of the total cost of production while the cost of drugs, disinfectants and vaccines represent 1.00% of the total cost of production. Labour costs consisted of cost of building houses, cost of serving of feed, water or cleaning of the piggery. The family labour was computed on the basis of opportunity cost in man-days. The wage rate varied according to farm operation performed. An average wage rate of ₦200 per man-day was used, giving the average labour cost per 10 pigs to be ₦3,200 and this constituted 5.28% of the total cost of production.

Results presented in Table 1 indicate that the total revenue (TR) was ₦196,612/10 pigs while the total variable cost (TVC) was ₦60,643/10 pigs. The net farm income was therefore ₦185,269/10 pigs. The average rate of returns on investment (return per naira invested) was 3.24, indicating that for every ₦1 invested in pig production in the study area, a profit of ₦2,24 kobo was made. Thus, it could be concluded that pig production in the study area though on a small scale, was economically viable. Also the opportunity cost of capital (interest rate) was 25% that is for every ₦1.00 saved in the bank, 25K is gained as interest. This showed that it is better to invest in pig production than to save in the bank. This finding was similar to that of Ogunniyi and Omoteso (2011) in Economic Analysis of Swine Production in Nigeria: A Case Study of Ibadan Zone of Oyo State observed that pig production was profitable by returning 1.57. This means that for every ₦1.00 invested, 57K is gained in the business.

Table 1: Average costs and returns per hectare of pig production

Variables	Values/10 pigs (₦)	% Contribution
A. Variable cost		
i. feed (kg)	45,500.00	75.02
ii. vaccine (mg)	600.00	1.00
iii. labour (man-days)	3,200.00	5.28
iv. piglet (number)	11,343.00	18.70
Total Variable Cost (TVC) (i + ii + iii + iv)	60,643.00	100.00
B. Total Revenue (TR)	196,612.00	
C. Net Farm Income (NFI)= (B - A)	135,969.00	
D. Return per Naira Invested (B/A)	3.24	

The result in Table 2 revealed income distribution of pig production. The difference in the value of productive goods was large and significant among the farmers. The result revealed that the majority (74.6%) of the farmers had an income greater than ₦60,140 with a minimum of ₦10,000 and maximum of ₦500,000. In terms of medium and high income earners, there were little difference in their income, having low Gini Coefficient of 0.063 and 0.021 for medium and high income earners respectively. However, after estimation, the results showed that difference existed between the incomes of the low-income pig farmers.

The result further shows the analysis of Gini Coefficient (GC) of low, medium and high-income farmers; the spread of income (GC) among the farmers was 0.477, 0.063 and 0.021 respectively. This revealed high level of equalities in income pattern among the pig farmers. Since the values are all tending towards zero, it means that there is greater degree of income equality especially among the medium and high-income farmers. The implication is that, there is little gap between middle- and low-income farmers pig production in their annual income.

Table 2: Income distribution and inequalities (Gini Coefficient) among pig farmers

CLASS	Freq	%	Cumm.	Average income Y	% Y	CUMM	XY	1-N(X)
1-200000	61	39.0	39.0	60140.24	1.7	1.7	65.3831 3	0.610
200001-400000	49	31.2	70.2	100725.6	2.8	4.5	314.801 6	0.298
4000001-600000	11	7.3	77.6	149115.9	4.2	8.6	669.798	0.224
600001-800000	21	13.2	90.7	182934.8	5.1	13.7	1245.93 9	0.093
800001-1000000	5	3.4	94.1	218390.2	6.1	19.8	1865.62 7	0.059
1000001-1200000	3	2.0	96.1	269609.8	7.5	27.3	2626.08 5	0.039
1200001-1400000	2	1.5	97.6	328404.4	9.1	36.5	3558.66 1	0.024
1400001-1600000	1	0.5	98.1	472646.3	13.2	49.6	4867.50 4	0.019
1600001-1800000	0	0	98.0	686487.8	19.1	68.8	6742.66 9	0.019
>18000000	3	2.0	100	1121059	31.2	100	10000	0
Total	157	100		3589514	100			0.139
Low income	117	74.6	74.6	103,327. 3				0.477
Medium income	31	19.5	94.1	223,644. 9				0.063
High income	9	5.9	100	652,149. 3				0.021
Overall income	157	100						

Note: GC= Gini Coefficient

The difference in Gini Coefficient between the three levels of income farmers could have stemmed from differences in their access to ownership and control of physical marketing facilities, trading experience, fund availability and differences in market behaviour and conducts. This result is at variance with studies elsewhere such as the findings of NBS (2012) that obtained GC of 0.43 and 0.45 for entire nation in 2010 and 2011, respectively.

The Lorenz curves (Fig. 1) show the degree of income inequalities which form an arc with the 45^0 lines or equality line. The deviation of these curves from the line of equality indicated the level of inequalities in income distribution in the study area.

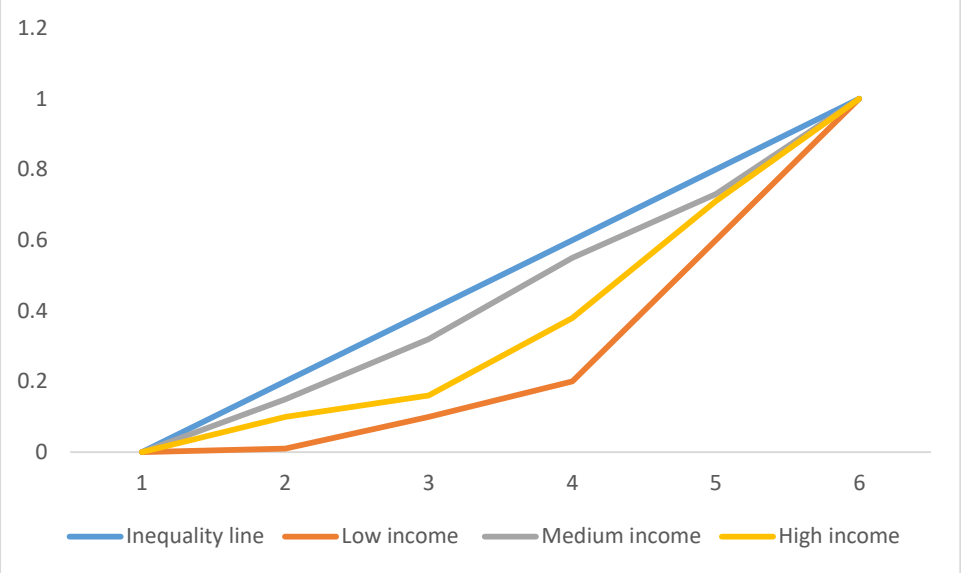


Figure 1: The Lorenz curves

The deviation of these curves from the line of equality indicated the level of inequalities in income distribution in the study area. There was therefore a need for the pig production to engage in activities that will lower the current higher inequalities among the beneficiaries.

Efficiency of Pig Production

The model specified was estimated by the maximum likelihood (ML) method using FRONTIER 4.1 software developed by Coelli (1995). The ML estimates and inefficiency determinants of the specified frontier are presented in Table 3. The study revealed that the generalized log likelihood function was -15.18. The log likelihood function implied that inefficiency existed in the data set. The log likelihood ratio value represents the value that maximizes the joint densities in the estimated model. Thus, the functional form that is, Cobb-Douglas used in this estimation was an adequate representation of the data. The value of gamma (γ) was estimated to be 95% and it was highly significant at $p<0.01$ level of probability. This was consistent with the theory that true γ-value should be greater than zero. This implied that 95% of random variation in the output of the farmers was due to the farmers' inefficiency in their respective sites and not as a result of random variability. Since these factors were under the control of the farmer, reducing the influence of the effect of γ would greatly enhance the technical efficiency of the farmers and improve their output. The value of sigma square (σ^2) was significantly different from zero at 1% level of probability. This indicated a good fit and correctness of the specified distributional assumptions of the composite error terms while the gamma γ indicated the systematic influences that were unexplained by the production function and the dominant sources of random error. This means that the inefficiency effects made significant contribution to the technical inefficiencies of pig farmers.

However, the estimated coefficients of all the parameters of production function (labour, feed, drug and herd size) except labour were positive and significant at 5 and 1% level of probability and hence play a major role in pig production in the study area. The average technical efficiency for the farmers was 0.73 implying that, on the average, the respondents were able to obtain 73% of

potential output from a given mixture of production inputs. Thus, in a short run, there was minimal scope (27%) of increasing the efficiency, by adopting the technology and techniques used by the best pig farmer.

The estimated coefficient for feed was 0.019 which was positive and statistically significant at 1% level. The estimated 0.019 elasticity of feed implied that increasing feed by 1% will increase pig output by less than 1% which means, all things being equal, the output was inelastic to changes in the quantity of feed used. The significance of feed quantity was however, due to the fact that feed determined to a large extent the weight of the output obtained. The output of pig farmers with right quantity of feed were bound to have more output given the same enabling environment for production. Several authors (Ajala *et al*., 2007; FAO, 2012; Montsho *et al*., 2012 and Kelechi *et al.*, 2013) had argued that pig production would serve as an urgent measure to alleviate animal protein difficulty in Nigeria particularly in areas where there was no prohibitions to their production and consumption, of which some selected agrarian communities in Kaduna State, was one of such areas. This finding conformed to that of Hussain, (2012) who reported that feed was positively related to output and was significant at 1% probability level.

Table 3: Maximum Likelihood Estimates Results of Frontier Production Function (Technical Efficiency) of Pig Production

Variables	Parameters	Coefficients	Standard error	T-Value
Production Variable				
Constant	β_0	6.659	0.439	15.17***
Labour	β_1	0.030	0.061	0.49
Feed	β_2	0.019	0.005	3.80**
Drug	β_3	0.057	0.024	2.38*
Herd size	β_4	0.243	0.090	2.70**
Inefficiency Variable				
Constant	Z_0	0.332	0.160	2.08
Age	Z_1	-0.003	0.001	-3.00***
Education	Z_2	-2.387	0.943	-2.531***
Household size	Z_3	0.006	0.004	1.50
Cooperative association	Z_4	-0.015	0.006	-2.50***
Extension contact	Z_5	-0.005	0.335	0.02
Credit	Z_6	0.78E-06	0.91E-05	-0.85E-01
Sigma-square	$(\boldsymbol{\sigma^2})$	0.445	0.017	2.62***
Gamma	**(γ)**	0.947	0.103	9.19***
Log likelihood function	*L/f*	-15.18		
LR test		11.66		
Total Number of Observation		152		
Mean efficiency		0.73		

*** P<0.01 ** P<0.05 and * P<0.1

The production elasticity of output with respect to quantity of drug was 0.057 which was positive and statistically significant at 5% level of probability. This implied that a

1% increase in drug would increase pig output by 5.7%. This was plausible given that the good health status of pigs was a factor for its productive performance. This finding was in line with Adeshinwa *et al*. (2003) and Nganga *et al.* (2010), who in their study found positive relationship between cost of medication and output of pigs.

The estimated coefficient of herd size was positive and statistically significant at 1%. Herd size of the farmers stock being significant at 1% indicates that increase in stock size would result to increase in output and vice versa. This suggested that one percent increase in the number of herd size would increase their output by 17.3 percent *ceteris paribus*. Hence, herd size had an increasing influence on output of the pig farmers. This finding was in line with Hussain *et al*. (2012) who reported that stocking density was positively related to the output of pig farmers in Lagos State but was however not significant. This was in line with a prior expectation. The output of pig farmers with greater number of swine were bound to have more output given the same enabling environment for production (Rekwot *et. al.,* 2003 and Dhuyvetter *et al*., 2014)).

The estimated result of the inefficiency model is contained in Table 3. Generally, a negative sign on a parameter means that the variable reduced technical inefficiency, while a positive sign increased technical inefficiency. The results showed that all the technical inefficiency variable except age and cooperative association were not statistically different from zero.

Age in pig production was negative and significant at 5 % level of probability. This showed that increase in age in pig production would reduce technical inefficiency. Farmers' age could be associated with skill accumulation which could enhance productivity and resource allocations thereby reduce technical inefficiency.

The estimated coefficient of education (-2.387) indicated that the educational status of the pig farmers was negatively related to pig production and statistically significant at 1% probability level. This implied that 1% increase in the education of the pig farmers would increase their output by 23.9%. This is because the more educated the pig farmers, the better will be their managerial ability in handling the operations of their pig farms and also, education enhances their ability to acquire technical knowledge with respect to adoption of technologies geared towards increasing their output. Therefore, the educational level of the pig farmers could be exploited as an important policy variable towards enhancing the reasonable output in the study area. The level of farmers' education was believed to influence the use of improved technology in agriculture and hence, farm productivity (Mutual *et al.*, 2011; Shiferaw *et al*., 2011 and Montsho *et al.*, 2012).

Membership of cooperative was negative and significant at 1% level of probability. The negative coefficient for membership implied that membership of association reduced technical inefficiency in pig production. Membership of association could afford the farmers the opportunity of sharing information on modern farming practices by interacting with other farmers. Ajala *et al*. (2008) and Olukosi *et al* (2005) noted that the reduction of inefficiency effects through farmers belonging to cooperatives was linked to cooperatives being a source of good quality inputs, information and organized marketing of products.

Distribution of pig farmers according to technical efficiency estimates

The frequency distribution of the technical efficiency estimates for pig farmers in the study area as obtained from the stochastic frontier model and presented in Table 4. It was observed from the study that 33% of the farmers had technical efficiency (TE) of 0.81 and above while 67% of the farmers operated at less than 0.8 technical efficiency levels. The farmer with the best and least practice had technical efficiencies of 0.73 and 0.44 respectively. This implied that on the average, output fell by 33% from the

maximum possible level attainable due to inefficiency. The study also suggest that for the average farmer in the study area to achieve technical efficiency of his most efficient counterpart, he could realize about 28% cost savings while on the other hand, the least technically efficient farmers will have about 58% cost savings to become the most efficient farmer. This finding was similar to that of Ajala and Adeshewa (2007).

Table 4: Frequency Distribution of Technical Estimates from the Stochastic Frontier Model for pig production

Technical Efficiency		
Class	**Frequency**	**Percentage**
0.21-0.40	Nil	Nil
0.41-0.60	33	21.7
0.61-0.80	67	45.4
0.81-1.00	50	32.9
Total	**152**	**100**
Mean	0.73	
Minimum	0.44	
Maximum	0.97	

CONCLUSION

The farm specific technical efficiency distribution concluded that none of the farmers achieved the maximum efficiency level. Thus, output could still be increased by 27% using available inputs and technology. Given that the pig is prolific, policies that lead to increased output were bound to affect the economic life of the farmers and the farm families. Pigs would contribute in making animal protein available in the area.

RECOMMENDATIONS

In view of the findings highlighted above, the following recommendations were made: Since majority of the pig farmers (96.7%) do not participate in any cooperative association. It was recommended that pig farmers should form viable cooperative societies, so as to benefit from the government and non-governmental organization through increased credit access, input supply and farm advisory services. Pig production is highly profitable by return of 2.24 in every 1 invested, youth and women should be encouraged by extension agents to go into pig production in order to earn more profit. Researchers should consider studies geared towards discovering least cost combination of feed that will yield the same nutrients equivalent to the pigs' conventional diet.

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