Profit Efficiency of Pig Producers in Kaduna State, Nigeria

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Abstract: **- The study analysed the profit efficiency among pig producers in Kaduna State, Nigeria. A multi-stage sampling technique was used to collect data from one hundred pig producers. Primary data were generated using structured questionnaires and personal observations for 2015 production year. Data were analysed using gross margin, Cobb Douglas Stochastic profit frontier function, maximum likelihood estimates and factor analysis. Pig production was profitable with a return per naira invested of 69% and gross margin of ₦8,426.30 per pig. The result of profit efficiency showed that feeds and labour coefficients were 0.13 and 0.19 respectively and were significant at 1% level. The study found out that profit efficiency varied from 0.01 to 0.99 with a mean profit efficiency of 52.35%. On the other hand, profit inefficiency increased with the use of the following variables, education, farming experience, household size, gender, pen age and conflict while age and co-operative membership decreased profit inefficiency. The result of the chi- square (x) confirmed that farm and farm-specific characteristics significantly affected profit inefficiency at 5% level. It is recommended that all the variables responsible for profit inefficiency should be adequately addressed through good and experienced management.**

Key Words: **pig, producer, profit efficiency, gross margin**

I. INTRODUCTION

In Nigeria, the indigenous pigs have been recommended as a good alternative source of cheap and high quality animal protein that suits the escalating human population. They have relatively low cost of production and their growth rate is fast, (Osaro, 1995; Onwujiariri and Okoronkwo, 2007). In addition, they are a source of income to many rural and urban dwellers. Their anal droppings are also used to fertilize backyard farms and vegetable gardening in fadama (Holmes, 1991 and Osaro, 1995). Nigeria is yet to become self-sufficient in animal protein intake. The intake of protein of livestock origin is estimated at 3.3g – 3.5g/head/day as against the recommended Food and Agriculture Organization (FAO) figure of 27.2g/head/day (Tewe 1999; Aromolaran and Bamgbose, 1999).

According to Balogun, et al. (1990), pigs are omnivorous and in some respect, compete with man for food, but are also very useful utilizers of by-products and waste from human feeding. In the last few years, the growth of the swine industry has witnessed serious setbacks, largely attributable to escalating feed and labour costs. Feed cost accounts for 80% of the total cost of producing pigs (Godwin, 1994; Ka'ankuka, 2012) and with the scarcity of feed grain in this country, the cost of producing pigs continues to increase (Santiago and Tegbe, 1987). The size of the pig population of any given region also, of course, depends upon other factors. For example, the climate, only small numbers of pigs are found in the arid areas of the world and the social and religious beliefs of the indigenous people. Hence, there are few pigs in countries with predominantly Muslim population, (Madubuike, 1992; Ogunniyi and Omotoso, 2011).

Nigeria is the second largest pig producer in Africa after South Africa, but pork contributes only about 4.5% of meat consumed. (Ter meulen Udo and E-Harinth, 1985; Tewe and Adesehinwa, 1995;Adesehinwa et al, 2003; Dafwang et al. 2011and Ka'ankuka, 2012).

World pig population is estimated to be 923 million. The estimates of individual countries, indicate that the population of pigs is 454 million in China, 59 million in USA, 20 million in Vietnam, 17 million in India, 10 million in Japan, 5 million in Nigeria, and 0.5 million in Tanzania (FAOSTAT,2002).

Statement of the Problem

Nigeria is one of the developing Countries that is affected by hunger, deprivation and abject poverty by its citizenry inspite of its enormous natural and human resources (Alamu, et. al; 2004).With the prevailing economic situation in the country, there is need for farmers to engage in result oriented farming systems that would guarantee and sustain adequate food security, create employment and raise incomes.

In Kaduna State, pigs are reared for both social and economic purposes. It improves the income sources of the families that engage in its production. However, as a result of lack of records, illiteracy or refusal to keep them, it becomes difficult to work towards maximizing profit and maintaining efficiency. Furthermore, most small scale farmers use only family labour to produce (Adegeye and Dittoh, 1995). Therefore, it becomes difficult to assign costs in the production process to enable them know exactly the amount expended. For instance, matured pigs may not be sold when they have reached market size and the farmers would continue to spend on feeding and medication, thereby increasing cost. Scholars like Ajala and Adesehinwa, (2008), Ogunniyi and

Omotoso, 2011), Adesehinwa et al, (2003) and Duniya, et al. (2013) have come up with findings that pig production is profitable. There are lack of records to justify the efficiency of this profit. This is what this study sets out to establish. The following questions would help accomplish this work. Is pig production profitable? What are the farmer' and farm-specific characteristics that affect profit efficiency of pig production?

Objective of the study

The broad objective of the study is to analyse the profit efficiency of pig producers in Kaduna State, Nigeria. The specific objectives are to:

i. determine the costs and returns in pig production in the study area and

ii determine the farmer's and farm-specific characteristics influencing profit efficiency in pig production.

Hypotheses

Ho: pig production is not profitable

Ho: Farmer' and farm-specific characteristics do not significantly influence profit efficiency of pig producers in the study area.

Concepts of Profit Efficiency

Profit efficiency is defined as the ability of a farm to achieve highest possible profit given the prices and levels of fixed factors of that farm and profit inefficiency in this context is defined as the loss of profit from not operating on the frontier (Ali and Flinn, 1989).

Lau and Yotopoulos (1971) and Yotopolous and Lau (1973) therefore popularized the use of the profit function approach, in which farm- specific prices and levels of fixed factors are incorporated in the analysis of efficiency. The advantage of using this approach is that input and output prices are treated as exogenous to farm household decision making, and they can be used to explain input use. Adesina and Djato (1996) defined profit efficiency as the ability of a firm to achieve potential maximum profit, given the level of fixed factors and prices faced by the firm. Aigner, *et al.* (1977), however, showed that profit function models do not provide a numerical, measurable firm-specific efficiency and popularised the use of the translog production frontier approach. The stochastic frontier approach has gained popularity in firm- specific efficiency studies. Example of recent application includes (Ali and Flinn, 1989; Kumbhakar and Bhattacharyya, 1992; Ali, *et al*. 1994). The stochastic profit frontier function is an extension of incorporating farm level prices and input use in the frontier production function. The incorporation of the farm-specific level prices leads to the profit function approach formulation (Ali and Flinn, 1989; Wang *et al.* 1996). A production approach to measure efficiency may not be appropriate when farmers face different prices and have different factor endowment (Ali and Flinn, 1989). Hence the use of stochastic profit functions to estimate farm-specific efficiency directly (Ali and Flinn, 1989; Ali, *et al*, 1994; Wang, *et al*. 1996). The profit function approach combines the concepts of technical, allocative and scale inefficiency in the profit relationships and any errors in the production decision translate into lower profits or revenue for the producer (Rahman, 2003).

II. MATERIALS AND METHODS

Study Area

The study area was Kaduna State. The state lies between latitude 11^{o} 32' and 09 ^{o} 02' north of the Equator and longitude 80 ^{o} 50' and 06 ^{o} 15' east of the Greenwich meridian (Kaduna State Statistics Year Book, 1996). It is made up of twenty-three Local Government Areas. The state had a population of about 6.6 million people in 2006 (NPC, 2006) and 4,000 farm families (KADP, 1999). Based on these figures, the current population is projected at about 6,667,787 people comprising of 644,013 farm families.

Sampling Technique

A multi-stage sampling procedure was adopted. The first stage was the purposive selection of four Local Government Areas (LGAs) known for their prominence in pig production. namely: Jema'a, Zango-Kataf Kaura and Kachia. The second stage was the purposive selection of five villages in each of these LGAs. The third stage involved the proportional random selection of 10% producers from each village obtained from the extension list of Samaru Zone of the Kaduna State Agricultural Development Project. A total of one hundred (100) pig producers were selected from the sampled villages

Primary data were collected for the study through the use of a structured questionnaire and administered through oral interviews. The primary data for the study were collected based on the 2015 production season.

Data was analysed using gross margin model to achieve Objectives i while Maximum likelihood Estimates (MLE) of the Cobb-Douglas Frontier Profit function model was used to achieve objective ii. Factor analysis was employed to analyse objective iii. Hypotheses i and ii were tested using t-test and Chi-square respectively.

Model specification

Models used to analyse the data to achieve the specific objectives are specified below:

Gross Margin Model

The model was used to compute the gross margin for both pig producers The model is expressed algebraically as:

$$GM = \sum GFI - \sum TVC \qquad - 1$$

$$GM = \sum_{t=1}^{n} PiQi - \sum_{t=m}^{m} PjQj \qquad - 2$$

Where: $\sum$ = Summation sign

Pi = Price of unit of ith output

Qi = Quantity of ith output

Pj = Price of unit of jth input

Qj = Quantity of jth input

n = Number of output

m = Number of inputs

Stochastic Profit Frontier Function

The Stochastic Profit Frontier Function was used to analyse the profit efficiency and the farmer and farm-specific characteristics affecting pig producers. The profit function approach combines the concepts of technical and allocative efficiencies in the profit relationship, and any errors in the production decision are assumed for to be translated into lower profit or revenue for the producer Ojo (2003).This study utilizes the Battese and Coelli (1995) model by postulating a profit function, which is assumed to behave in a manner consistent with the stochastic frontier concept Rahman (2002), Kolawale (2006), Tijani, et al. (2006), Ogundari et al. (2006) , Adeleke (2008) and Tsue, et al (2012). The stochastic profit function is defined as:

$\pi i = f(Pij, Zkj)Exp, ei$ -- 3

Where:

π = normalized profit of the jth farm and it is computed as gross revenue less variable cost divided by the farm specific output price,

Pij = price of jth variable input faced by the ith farm divided by output price

Zik = level of the kth fixed factor on the ith farm

ei = an error term

I = 1,…….., n, is the number of farms in the sample.

The error term ei is assumed to behave in a manner consistent with the frontier concept Rahman (2002) that is,

$ei = Vi - Ui$ --4

Vi is the symmetric error term and it is assumed that it is an independently and identically distributed two-sided error term representing the random effects, measurement errors, omitted explanatory variables and statistical noise, i U is the one-sided error term, representing the inefficiency of the farm.

The inefficiency effects Ui in equation 2 is expressed as:

$Ui = \delta O + \sum \partial i\ Zdi$ --5

Where:

Zi= (I x m) vector of farm specific variables, which varies across respondents and not over time. ∂= (m x I) vector of unknown coefficients of the farm specific inefficiency variables. The Ui is a non-negative one-sided error term representing the inefficiency of the farm. Thus, it represents the profit shortfall from its maximum possible value that will be given by the stochastic frontier.

The estimated frontier function provides an estimate of industry's 'best practice' profit for any given level of price and fixed factors (Adeleke, 2008).

The method of maximum likelihood was used to estimate the unknown parameters, with the stochastic frontier and the inefficiency models estimated simultaneously. The likelihood function is expressed in terms of the variance parameters,

$\sigma^2 = \sigma^2 v + \sigma^2 \mu$ --6

and

$\gamma = \sigma^2 \mu / \sigma^2 \mu + \sigma^2 v$ --7

The presence of technical inefficiency effects were tested using the generalized likelihood ratio test (λ), which is defined by

$\lambda = -2(LR - Lu)$ --8

where LR=log likelihood of the restricted model (Model 1)

Lu=log likelihood of the unrestricted model (Model 2)

λ has a chi-square distribution with degree of freedom equal to the number of parameters excluded in the unrestricted model. The null hypothesis was that the restricted Cobb-Douglas profit frontier model is the same as the unrestricted Cobb-Douglas Stochastic profit model.
The Ui are the profit inefficiency effects and for this study, they are defined as

$Ui = \partial o + \partial_1 Z_1 + \partial_2 Z_2 + \partial_3 Z_3 + \partial_4 Z_4 + \partial_5 Z_5 + \partial_6 Z_6 + \partial_7 Z_7 + \partial_8 Z_8$ --9

Where: Z_1 = age of pig producers in years (expected sign -)

Z_2 = years of educational attainment of pig producers (expected sign -)

Z_3 = farming experience of pig producers in years (expected sign -)

Z_4 = household size (expected sign +)

Z_5= gender (dummy: Male=1; Female=0) (expected sign -)

Z_6 =membership of co-operative society (dummy: yes=1, no=0) (expected sign -)

Z_7 = Pen age in years (expected sign -)

Z_8 = conflict (dummy: yes=1; no=0) (expected sign -)

$\partial_0, \partial_1, \partial_2, \partial_3, \partial_4, \partial_5, \partial_6, \partial_7, \partial_8$ = parameters to be estimated.

The Maximum Likelihood Estimates (MLE) of the parameters in the Cobb-Douglas stochastic frontier profit model defined equation 8, given the specification for profit inefficiency effects defined by equation 8 were obtained using a computer programme, Frontier 4.1, developed by Coelli

(1994).The unknown parameters of the models β's and ∂'s and the variance parameter, $\sigma^2=\sigma^2\mu+\sigma^2 v$

$\gamma= \sigma^2\mu /(\sigma^2\mu + \sigma^2 v)$ were simultaneously estimated.

The value of γ above indicates the relative magnitude of the variance, associated with the distribution of the inefficiency effects, Ui. If Ui in the stochastic frontiers are not present or alternatively, if the variance parameter, γ, associated with the distribution of Ui has value zero, then $\sigma^2 u$ in the frontier model defined by equation 8 is zero and the models reduce to the traditional response model in which the variables age, years of schooling, years of experience, household sizes, gender, co-operative membership, pen age and conflict explanatory variables in the frontier function (the inefficiency effects are not stochastic).

III. RESULTS AND DISCUSSION

Cost and Returns of Pig Producers

The result of the gross margin analysis for the respondents in the study area is presented in Table 1. The gross margin obtained per pig raised and sold was ₦ 8, 426.30. The rate of return (ROR) on investment was 0.69kobo.This means that for every naira invested in pig production, ₦ 0.69 kobo was received as profit by the producers. However, this profit level was lower than findings by Ogunniyi and Omoteso, (2011) and Duniya, et al. (2015), who recorded ROR for pig production of ₦ 1.57 and ₦ 1.38 respectively. These differences could be attributed to a number of factors like inflationary trends, distance to the market and the time the data were collected. Between the months of August and October, there is usually scarcity of pigs in the markets due to the bad state of rural roads making such areas inaccessibility, thereby affecting supply and creating demand to be greater than supply while during other months, the prices used to drop due to increased pigs supply, thereby affecting the margin.

Table 1: Determination of Costs and Returns of Pig Production in the Study Area

Cost/Return ₦	Mean ₦	Std. Dev.
A Costs		
Feed Cost	29,533.50	14,256.37
Piglet Cost	16,808.00	6,573.72
Stock Transport Cost	860.20	927.44
Labour Cost	11,618.30	4,380.74
Clipping and Castrating	1,243.00	786.81
Drugs Cost	3,254.00	1,273.70
Breeding/Mating Cost	3,885.02	4,649.22
Veterinary Service	1,467.00	643.08
Disease	950.00	8,512.77
Transport to Market	2,950.10	10,185.64
Total Variable Cost (TVC)	26,718.74	67,916.60
Total Fixed Cost (TFC)	4,746.40	1,962.98
Total Cost (TC)	72,663.10	27,184.99
Cost per Pig	13,627.41	8,377.77
B Returns		
Total Returns	110,247.00	40,171.94
Total Return/Pig	22,053.67	14,296.95
Gross Margin (GM)	42,330.40	27,984.58
Gross Margin/Pig	8,426.30	7,888.59
Rate of Return/Pig	0.69	0.42

Maximum Likelihood Estimates of Parameters in Profit Function

The result showed that majority (46%) of the producers operated within a profit efficiency range between 0.31-0.60, while 26% producers operated at 0.61- 0.90, with 20% at 0.30 or less and a few (8%) at 0.91 or more. It was deduced that 0.34 or 34% had a profit efficiency 0.61 and above. This implies that 34% of pig producers had 39% profit inefficiency or less and this is the value that would be required to attain its frontier. The minimum profit efficiency was 0.01 while the maximum profit efficiency was 0.99. The mean profit efficiency of producers was 0.5235 or 52.35% (Table 2). This implies that in order to raise the profit efficiency in the study area to maximum, there should be an increase of 47.65% of technical and allocative efficiency. The result is similar with findings by Abu, et al. (2012) and Tsue, et al. (2012) who reported that there is a scope for increasing sesame and catfish output by 33.3% and 16% respectively in the short – run with improved technology.

The Maximum Likelihood Estimates (MLE) of the Cobb - Douglas Stochastic Frontier Profit Function Model of pig producers is presented in Table 3. The first order coefficients with respect to gross profit of pig producers showed that all the regressors included in the stochastic profit model were statistically significant at 1% level. The coefficients of feeds (0.13), labour (0.19) and medication (0.63) were found to be positive. This implies that increasing the quantity of feeds, labour and medication by 100%, would lead to increase in gross profit of pig producers by 13%, 19% and 63% respectively in the study area. On the other hand, piglet number and number of breeding were negative and significant at 1% levels. This means that an increase in the use of these variables would decrease the gross profit of pig producers too. This implies that if each input was increased in the short- run by one, gross profit would decrease by the same proportions of the elasticities. The result is similar to results obtained by Ogah, et al. (2015) in their work on profitability and technical efficiency of palm oil processing, found out that the coefficients of firewood (-3.24) was negative and statistically significant at 1% probability level, an implication that excessive use of this variable will decrease the yield of palm oil.

Table 2: Profit Efficiency Estimates from Cobb-Douglas Stochastic Frontier Model of Pig Producers in Kaduna State

Efficiency Range	Frequency	Percentage (%)
0.01≤ 0.30	20	20.0
0.31−0.60	46	46.0
0.61−0.90	26	26.0
≥0.91	8	8.0
TOTAL	**100**	**100.0**
Mean Efficiency	0.5235	
Minimum	0.01	
Maximum	0.99	

Determinants of Profit Efficiency Model

The result showed the performance of the model in terms of Gamma (γ**)** and squared variance (α).These were large and significant at 5% and 10% respectively. This was confirmed by a test of hypothesis for the presence of inefficiency effects using generalized Likelihood Ratio (LR) test. The result of the LR rejected the hypothesis that the restricted Cobb Douglas profit function model 1 is the same as the unrestricted Cobb Douglas stochastic profit function, model 2.This is based on the fact that lamda value 231.12 was more than the critical value of chi-square (3.94) at 5% level of significance with 10 degrees of freedom. This means that the unrestricted Cobb Douglas stochastic model which has inefficiency effects fits this data better. The significance of α showed the correctness of the estimated stochastic profit frontier model that is estimated with inefficiency effects fits the data better than the ordinary least square. The model showed that there were profit inefficiency effects in pig production. This is confirmed by the high and significant Gamma (γ**)** 0.999 at 5% level. The estimated Gamma 0.999 implies that 99.9% of the variation in the actual profit from maximum profit among pig producers was due to the differences in farmers' cultural practices rather than random variable. This conforms to Tsue, et al. (2012) and Umeh, et al. (2015) in their findings in profit efficiency in catfish production and technical analysis of pig production respectively found that about 99 percent of the variation in the actual profit from maximum profit obtainable (profit frontier) among catfish farms was due to the differences in the farmers' practices rather than random variability.

The signs and significance of the estimated coefficients in the inefficiency model in table 8, have important implications on the profit efficiency of pig marketing. Education and farming experience were negative and significant at 1% while age and membership of co-operative variables were negative and significance at 5% levels. This implies that increase in these variables would increase the profit efficiency or reduce profit inefficiency in the study area. The negative coefficient for education implies that farmers with greater years of education tend to be less profit inefficient. This agrees with Battese and Coelli (1995), Ozkan *et al*. (2009) and Biam *et al*. (2015) who found in their studies that an increase in any if the negative variables would reduce technical inefficiency among farmers thereby increasing technical efficiency and ultimately profit efficiency. . Also, the negative estimate for farming experience implies that over the years they had gained specialisation with increased productivity and subsequent increased profit efficiency. This also agrees with studies by Bamiro (2008), Orkan *et al*. (2009) and Iordekighir *et al*. (2016) and contrary to studies by Abu *et al.* (2012). Age was expected to increase efficiency because most of the farmers were young and agile to carry out production activities. This was found to agree with and Tsue *et al.* (2012) who found age to increase profit efficiency in catfish production, while it was at variance with Abu *et al.* (2012). In the same vain, as members of co-operatives, this would afford them the opportunity of access to extension agents that would avail them with improved technology and techniques of production, thereby raising efficiency in production and subsequently, profit maximisation.

The result also revealed that household size, gender, pen age and conflict were found to be positive and significant, tended to increase profit inefficiency. This was contrary to a priori expectations about the roles of these variables except conflict (Table 3).

Table 3: Maximum Likelihood Estimate of Parameters in Cobb-Douglas Stochastic Frontier Profit Function Model for Pig Producers

Variable	Parameter	Coefficient	t-ratio
Stochastic Frontie Profit Model 1			
	β_0	3.054	4.79***
Cost of feeds (₦)	β_1	0.132	6.11***
Cost of Labour (₦)	β_2	0.19	2.62***
Cost of Piglet (₦)	β_3	-0.02	3.90***
Cost of Breeding (₦)	β_4	-0.01	2.51***
Cost of Medication (₦)	β_5	0.63	4.09***
Inefficiency Model 2			
Constant	∂_0	4.82	1.66
Age (years)	∂_1	-1.30	2.39**
Education	∂_2	-0.23	3.27***
Farming Experience (years)	∂_3	-0.04	5.80***
Household Size	∂_4	1.47	1.90*
Gender	∂_5	9.18	1.64*
Cooperative Membership	∂_6	-15.08	-2.01**
Pen-age (years)	∂_7	1.06	9.04***
Conflict	∂_8	14.48	2.16**
Variance Parameter			
Sigma Squared	σ^2	35.85	18.78***

Gamma	γ	0.99	693787.16***
Log Likelihood Function	LLF		-129.98
Likelihood Ratio	LR		231.12

*, **, *** = t-ratio significant at 10%, 5% and 1% respectively

₦ = Naira (Nigerian Currency)

IV. CONCLUSION AND RECOMMENDATION

The gross margin analysis revealed that pig production is profitable with a 69% rate of return to capital invested. The study also showed that the mean level of 52.35% of producers were profit efficient, while 47.65% were inefficient. This implies that there is the need to improve in our technical and allocative efficiency. Age, education and membership of co-operative societies increased profit efficiency while farming experience, household size, gender, pen age and conflict were found to increase profit inefficiency. It is recommended that all the variables responsible for profit inefficiency should be adequately addressed through good and experienced management.

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