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TECHNICAL EFFICIENCY ESTIMATES AND THE ROLE OF FORMAL EDUCATION: EVIDENCE FROM CATFISH FIRMS IN IJUMU LOCAL GOVERNMENT AREA OF KOGI STATE, NORTH CENTRAL, NIGERIA.

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ABSTRACT

This study was conducted to estimate the technical efficiency and understand the influence of education on technical inefficiency of fish farmers in Ijumu local government area of Kogi state. Multistage random sampling was employed in the selection of 100 fish farmers for questionnaire administration. The Cobb-Douglas stochastic frontier production function was applied to the data. Findings show that all Fish farmers in Ijumu local government area are educated and have moderate level of farming experience. The number of fingerling stocked and labour have significant positive effects on the volume of production but the return to scale of 0.88 was estimated. Technical efficiency estimates for fish farmers in the area range from 0.47 to 0.97 and averaged 0.88%. This means that increase in output by about 12% may be achieved through more efficient use of the existing input and technology. Contrary to general notion, formal education was found to increase technical inefficiency. Age and training were however negatively related to technical inefficiency. Therefore, in order to achieveproduction at the isoquant frontier in Ijumu, policy attention needs to focus on variables other than education. Thus we recommend mentoring relationships between younger fish farmers need and older ones; as well as Improvement in quality and numbers of training opportunities.

Keywords: Technical efficiency, Frontier, Fish farmers, Ijumu

INTRODUCTION

Declining productivity in artisanal fisheries has drawn attention to aquaculture. Aquaculture in Nigeria has been growing at an average of 20% for over a decade. Its average contribution to total fish supply in the country since the early 1970s is about 6.6% as against 88.2% from the artisanal subsector (Onuche, 2015). The subsector has the potential of meeting over 90% of local fish demand if resources are optimally harnessed. Estimates by (Onuche, 2015) indicate that at the prevailing growth rate, supply from the subsector will overtake the artisanal subsector supply in

2023. The estimates further revealed that from 2025, aquaculture will begin to contribute 50% or more to total local fish supply. This potential can however be hampered by the level of efficiency in production.

Inefficiency has been the bane of Nigerian agriculture (Onuche *et al.*, 2014, Awoyemi and Adekanye, 2005). Inefficiency in resource allocation and production leads to wastage and low production levels. Types of efficiencies include allocative efficiency and technical efficiency. The product of these efficiency measures defines economic efficiency. While allocative efficiency is associated with the costs of inputs, technical efficiency is associated with the ability of a firm to produce on the isoquant frontier. It describes the ability to produce the maximum level of output with a given quantity of inputs at a particular level of technology. Farrell (1957) introduced the term technical efficiency although according to Ali (2014), efficiency analysis dates back to Knight (1933). The level of technical efficiency of a firm is characterized by the relationship between observed production level and some ideal level of production. The measurement of firm specific technical efficiency is based on the deviation of observed output from efficient production frontier (Battese and Coelli, 1995). There are two basic methods of measuring efficiency and productivity: the classical method and econometric (frontier) method.

The advantages and disadvantages of these methods have been provided by Battesse (1992) and Coelli and Perelman (1999). The econometric method is stochastic and separates the effect of the random noise from the inefficiency effect. But the non parametric method is non stochastic and lumps noise and inefficiency effect. Also econometric approach is parametric and restricts the effects of misspecification of functional form (of both technology and inefficiency) with inefficiency. The non parametric method is however not susceptible to this error of misspecification. The econometric method is most widely used. The advantage of separating noise from inefficiency effect makes it useful in isolating sources of technical inefficiency.

One factor which has been extensively studied and known to influence technical inefficiency is education. Consensus in literature indicates that Education is known to increase production efficiency (Tsue, 2010; Ekunwe and Emokaro, 2009; Opaluwa, 2013; Shahid Ali, 2014; Onuche *et al.*, 2014; Nosiru, Rahji, Ikpi and Adenegan, 2014). This is mainly because education instills a sense of discipline and organization in the farmer. It is an important factor in innovation adoption (Adejoh, Onuche and Edoka, 2010; Nwaru, 2004; Abolusoro, Ogunjimi and Abulosoro, 2014). An educated farmer is more likely to access more useful information related to his production process and more rationally apply resources, hence the consensus of studies on the impact of education on agricultural production efficiency. It is however not in all cases that education has been found to decrease technical inefficiency (Iheke and Nwaru, 2015). Thus, to avoid blanket policy application, specific production areas need specific attention in research. This work was designed to investigate the level of technical efficiency and the sources of technical inefficiency with special focus on education. To the best of our knowledge, no work of this kind has been reported on fish farming in the area.

Reliable estimates of technical efficiency and it sources are important in policy engendering. Findings from this study will provide information on the level of technical efficiency of fish farmers in the area. The study enriches the existing pool of literature by providing information on the peculiarities of fish farming in Ijumu local government especially as it affects the role of education. This will enable policy makers identify specific intervention avenues.

MATERIAL AND METHODS

The study was carried out in Ijumu local government area of Kogi State, Nigeria. Geographically, Ijumu Local Government Area is located on the latitudes 7°51N and 5° 58 E and longitudes 7.850°N and 5.967° E, and has a population of 139,790. Ijumu Local Government Area has a warm humid climate with annual rainfall of between 1,016mm and 1,524mm and two main seasons, which are: dry season, which lasts from November to February and raining season which lasts from March to October (Special History, 2009).

The sampling frame was obtained from the secretariat of fish farmers association in the state headquarters. Simple random sampling procedure was employed in the selection of 100 respondents from a list of all the fish farmers operating in the area. The study relied on primary data which were collected using structured questionnaire. Data collected include production information on inputs used in catfish farming production such quantities of fingerlings, feed quantity (kg), expenses of drugs (Naira), labour used (man-days) and pond size (m^2) as well as output. The stochastic frontier production function was used for data analysis. It was hypothesized that the stochastic frontier can be fitted to the fish production data in the area.

The Stochastic Frontier Production function

The Stochastic Frontier Analysis (SFA) was used to analyze the technical efficiency of catfish farmers in the area. The model was cast in the double log framework. This has been used by many empirical studies, particularly those relating to developing countries' agriculture. Other advantage of the method lies in the fact that the functional form meets the requirement of being self-dual i.e. it allows an examination of economic efficiency. The Cobb- Douglass functional form of the model is represented as follows:

$LnY_i = \beta_0 + \beta_1 lnX_1 + \beta_2 lnX_2 + \beta_3 lnX_3 + \beta_4 lnX_4 + \beta_5 lnX_5 + (V_i - U_i)$ …………1

Where:

In = represents the natural logarithm

Y_i= Quantity of catfish harvested in (kg)

X_1 = pond size as a proxy for farm size ($cm^{2)}$

X_2 = total quantity of labour use (in man days)

X_3 =total feed used (kg)

X_4= fingerlings quantity

X_5= drugs expenses (₦)

The β_is are the regression parameters, V_i is a random variable which is assumed to be independent of $U_{i,}$ identical and normally distributed with zero mean and constant variance N (0, σ2); and, U_i is non-negative random variables which are assumed to account for technical inefficiency in production and are often assumed to be independent of Vi such that U is the non-negative truncated (at zero) U of half normal distribution with |N (0, σ_2 v))|. Furthermore, the inefficiency in production, $U_i$was modeled in terms of the factors that are assumed to affect the efficiency of production of the fish farmers. Such factors were considered to be socioeconomic and management factors. The inefficiency model is described as:

$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4$……………………………..2

Where:

$U_i$is technical inefficiency value for the *ith* fish farmer

Z_1= years of formal education

Z_2= Years of experience

Z_3= Age of farmers

Z_4= training on catfish farming (measured by number of fish farming training attended), and the δ_is are inefficiency parameters.

These variables are assumed to influence technical efficiency of the catfish farmers. The gamma ($\gamma = \sigma_2 u / (\sigma_2 u + \sigma_2 v)$ which is the ratio of the variance of *U* ($\sigma_2 u$) to the Sigma squared ($\sigma 2$) which is a summation of variances of *U* and V ($\sigma 2 = \sigma 2u + \sigma 2v$) were also determined.

The technical efficiency (TE) of an individual farm is defined in terms of the observed output (Y_i) to the corresponding frontier output (Yi*) given available technology, that is:

$TE_i = Y_i/Y^*$ ………………………………………………………………….. 3

Where Y_i is the observed output and Y* is the frontier output.

Equation 3 can also be expressed as;

$TE_i = Y_i/Y^* f(X_i; \beta_i) \exp(V_i - U_i) / f(X_i; \beta i) \exp(V)$……………………………….4

$TE_i = \exp(-U_i)$

So that, $0 \leq TE \leq 1$. If TE = 1, the farm is said to be technically efficient and its output is on the frontier. Otherwise, the firm is technically inefficient because it could have produced more outputs with the given level of inputs. The estimates for all the parameters of the stochastic frontier production function and the inefficiency model were simultaneously obtained using the computer programme Frontier 4.1 (Coelli, 1994).

RESULTS AND DISCUSSION

The distribution of respondents according to years of formal education relayed in Table 1 shows that 96% of the farmers have attained some level of formal education. Table 2 provides the summary of the variables considered in the work.

Table 1: Years of formal education by Fish famers in Ijumu

Years of formal education	Frequency	%
0	4	4.0
6-12	60	60.0
Above 12	36	36.0

Source: Computed From Field Survey, 2015

The level of input and outputs presented in Table 2 indicate the small holder nature of aquacultural production in the study area. Table 2 also shows that the fish farmers are generally well educated but do not have much experience in the venture. The level of education is similar to the finding of Ekunwe and Emokaro (2009) but far higher than was obtained by Shahid-Ali (2104).

Table 2: Descriptive statistics of key variables in Ijumu local government area

Variable	Mean	Std.Dev.	Minimum	Maximum
Output in (kg)	2206.4	933.47	650	5000
Pond size (cm^2)	807.8	348.71	225	1575
Fingerlings (number)	2303	966.43	799	5000
Feed (kg)	1044.4	601.45	300	3400
Labour (man days)	124.54	62.2	31.75	281
Drugs (expenses in Naira)	1330	835.33	100	4000
Age (years)	52.4	7.60	34	67
Education(years of schooling)	14.28	3.42	4	24
Experience (years)	5.66	2.040	2	14

Source: Computed from field survey, 2015

The results presented in Table 3 indicate that the production variable of pond size, fingerlings, feed, and labour were positively signed. The coefficient for pond size and labour were however insignificant. The elasticities of fingerlings and feed indicate that 100% increase in fingerling and feed will yield 60% and 19% increases in output respectively. Total elasticity of production was found to be 0.88, implying that fish farmers in the area operate in the second stage of production which exhibits a decreasing return to scale for fish farmers in the area. Explicitly, this implies that a 100% increase in the factors of production will lead to only 88% increase in the total fish output. The coefficient for drugs (-0.06) is negative. This may be due to the overuse of the variable and indicates the fish farmers are operating in stage III in the production function as regards the application of drugs.

Diagnostic parameters of the maximum likelihood estimates presented in Table 3 are appropriately signed and have the right magnitude needed to conclude that the technical efficiency model is appropriate in estimating the technical efficiency of the fish farmers in Ijumu area. The calculated LR statistic of 28.9 is greater than the critical value of 12.59 hence the null hypothesis as regards the appropriateness of fitting a technical efficiency model is rejected.

Age was negatively signed and significant. This indicates that technical inefficiency decreases with age. This agrees with Onuche *et al*. (2014) and Ekunwe and Emokaro (2009). Age also encourages farmers to stick to their profession thereby minimizing the amount of time and attention they may have for other ventures (Osondu, 2014).

The result on education disagrees with the general notion that it increases agricultural efficiency in agricultural production (Tsue, 2010; Ekunwe and Emokaro, 2009; Opaluwa, 2013; Shahid Ali, 2014; Onuche *et al*., 2014; Nosiru *et al* 2014) but is in tandem with the findings of Iheke and Nwaru, (2015). It is possible that the highly educated fish farmers combine their ventures with their jobs as civil servant in which case they may not have enough time to monitor the farm operations. Such a situation may lead to negligence on the part of the labourers or family members saddled with the responsibilities for farm operations. It is also possible that adequate attention may also be lacking due to the fact that fish production may not be the sole source of income for some of the highly educated operators. Results also revealed that training on fish farming reduces technical inefficiency in the area. It thus suggests that aquaculture related training might be more responsive to the goal of efficiency improvement than formal education.

Table 3: Stochastic frontier estimates for catfish production in Ijumu LGA

Variables	Parameter	Coefficient	t-ratio
Constant	β_0	1.36	2.42**
Pond size	β_1	0.11	0.88
Fingerlings	β_2	0.60	4.26***
Feed	β_3	0.19	2.62**
Labour	β_4	0.04	0.89
Drugs	β_5	-0.06	-1.85*
Inefficiency Model			
Constant	δ_0	3.38	2.64**
Age	δ_1	1.16	-2.91**
Education	δ_2	0.99	3.09***
Experience	δ_3	0.07	0.49
Training	δ_4	-0.18	-1.79*
Variance Parameter			
Sigma square	δ^2	0.069	4.9***
Gamma	Γ	0.71	7.1***
Logliklehood Ratio	28.9		
Mean technical efficiency	0.88		
Minimum technical efficiency	0.47		
Maximum technical efficiency	0.97		

***, **, * = Significant at 1%, 5%, 10%
Source: Computed From Field Survey, 2015

Technical efficiency estimates

The estimated values of the specific firm level technical efficiency as grouped in Table 4 show that the efficiency of the fish farmers in Ijumu Local government area ranges from 0.47 to 0.97. This indicates that the least efficient farmer need to increase output by 53% to reach the frontier while the most efficient fish farmer in the area need to increase his output by only 3%. The mean efficiency (0.88) shows a generally high level of technical efficiency in the area. The finding is similar to those found in Ekunwe and Emokaro (2009) who reported a range of 47% -0.971% and average efficiency of 0.854 for catfish farmers in Kaduna state, but higher than those reported by Ihieke (2015) Ali (2014) , Ahmad *et al.* (2005), Ogundari (2008), Kolawole and Ojo (2007), who reported mean efficiency of 57.8%, 66%, 68%, 75%, 79%, but lower than the estimate by Onuche et al (2013) who reported a mean of 94% for women cassava farmers in Kogi state. In this study, the average fish farmer need about 9.3% i.e. [1-$\frac{0.88}{0.97}$*100] increase in his total production to be at par with the most technically efficient farmer. The least efficient fish farmer needs 51.6% i.e. [1-$\frac{0.47}{0.97}$ *100] to attain the efficiency level of the most technically efficient fish farmer. In all, for the average fish farmer to attain the frontier, an average of 12% increase in output is required.

Table 4: Summary of technical efficiency estimates in Ijumu local government area

Class	Frequency	%	Cum.%
0.31-0.5	2	2.00	2.0
0.51-0.7	4	4.00	6.0
0.71-0.9	38	38.00	44.0
Above 0.9	56	56.00	100
Total	100	100.00	

Source: Computed From Field Survey, 2015

CONCLUSION AND RECOMMENDATIONS

The fish farmers in Ijumu local government area are educated and have moderate level of farming experience. The number of fingerling stocked and labour have significant positive effects on the volume of production but the return to scale suggests that doubling the input will lead to less than double the output. Technical efficiency estimates for fish farmers in the area averaged 88%, implying that the farmers are operating at 12% below the isoquant frontier. This means that increase in output by about 12% may be achieved through better use of the existing input and technology. Contrary to the volume of literature in support of education as having the ability to decrease technical efficiency, the study found that level of education increases technical inefficiency. Age and training were however negatively related to technical efficiency. Thus rather than focus on education as is with the case of recommendations from majority of literature, attention should be focused on mentoring relationships and training in Ijumu. Hence, we recommend that in order to achieve production at the isoquant frontier, younger fish farmers need to interact with older ones. Improvement in quality and numbers of training opportunity is also canvassed. Adjustment in the use of production resource to achieve higher efficiency is another area to focus attention. For instance the use of drugs which is negatively related to output should be reduced.

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