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An Examination of Income Generation Potential of Aquaculture Farms in Alleviating Household Poverty: Estimation and Policy Implications from Nigeria

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Abstract

This study examines income generation potential and resource-use efficiency of 120 aquaculture farms in Oyo state Nigeria. The data collected were analyzed using gross margin and stochastic frontier production (SFP) model. Result of gross margin (GM) shows that the farms were quite profitable with an average GM of ₦207, 000 per annum. The SFP model reveals that, elasticities of all considered inputs were positive and significantly different from zero. Returns to scale of 1.16 computed as sum of the inputs elasticities suggests that, an average farm from the study exhibits increasing returns to scale. Further analyses reveal that, an average technical efficiency estimate of about 81% was obtained from SFP model. This suggests that, about 19% potential yield are forgone due to inefficiency from the study. The result of sources of technical efficiency differential shows that extension; education, stocking density, and credit significantly influenced technical efficiency of the farms. Also, result of simulated marginal effects of these variables on technical efficiency shows that extension has the highest marginal effects on the efficiency estimates followed by credit, education, and stocking density. The study, therefore, suggests that, significant level of profit obtained from the study is synonymous to improve efficiency environment observed among the farms as promotion of aquaculture development has the potential in alleviating household income poverty in the country.

Keywords: income poverty, resource- use, productivity, technical efficiency.

Introduction

Fish is adjudged the cheapest and most affordable source of animal protein to the common man in Nigeria. Recent accounts show that domestic demand (because of progressive increase in the Nigeria population with over 140 million people) for fish in Nigeria could not be met only by dependence on artisanal fisheries, which experts say is fast depleting (Ojo and Fagbenro, 2004).

This observation, contradicts the report of the FAO-World Fish Center workshop on small-scale aquaculture in Sub-Saharan Africa in 2004, which identified Nigeria as one of the country in the region with great potential to attain sustainable fish production, via aquaculture considering extensive mangrove ecosystem available in the country (FAO, 2005).

The annual state of economic report by sector published by Central Bank of Nigeria shows that, Nigeria imports over US$200 million worth of frozen fish per annum. This, however, accounts for over 50% of fish consumed annually to offset the gap in the domestic demand in the country (CBN, 2006).

The country has coastline of about 960km comprising lagoons, estuaries, wetlands and series of interconnecting creeks and coastal zone covering an estimated 1 million hectares, which offers considerable potential for commercial aquaculture in the country. Unfortunately, aquaculture development did not receive due attention in the country until lately. Most of the aquaculture farms in the country in the 80's and earlier 90's are owned by the government with little participation of private individuals in aquaculture production in the country (FAO, 2005).

With implementation of National Economic Empowerment and Development Strategy (NEEDS) in 2001, the good news is that, there is an unprecedented surge in the number of small scale aquaculture farms and few numbers of large farms established across the country in recent years (CBN, 2006). NEEDS is a new policy guideline currently implemented in the country. The implementation of the policy guideline most especially as related to agricultural sector of Nigerian economy ensures that, government at both federal and states level provides needed impetus to ensure sustainable agricultural production in the country to the farmers. These include provision of technical know-how needed through extension, improved credit delivery systems to the farmers among others.

The challenge before us is to investigate the productivity potential of aquaculture farms in alleviating household income poverty in Nigeria. The study proposes to answer the question: Is aquaculture production capable of creating income-earning opportunities through improving the efficiency environment in Nigeria?

We are motivated in part, because the studies have shown that, concept of sustainable income is

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synonymous to poverty alleviation while other findings have shown that the surest way through which mankind can raise itself out of poverty to a condition of relatively material affluence is through the improvement of productivity of his/her production or services (Schubert, 1994; Horrell and Krishnan, 2007). Productivity improvement creates income that can be use to meet present and future needs in terms of investment. This assertion was further stressed by Schubert (1994), who noted a relationship between poverty and productivity and concluded that a push in form of increased productivity may be needed to empower the poor over devastating effect of poverty.

Therefore, this paper examines profitability as well as resource-use efficiency of aquaculture farms in Nigeria. This, however, is to enable us to assess the extent to which aquaculture farms are capable of creating income earning opportunities through improvement of the efficiency in aquaculture production in the country.

Materials and Methods

Study Area

The study was carried out in 2005 in Oyo State Nigeria. Oyo State lies between latitudes 7°N and 9°30'N and longitudes 2°E and 4°E. The state is characterized by two climatic seasons; dry season between november and march and rainy season between april and october. A study of the State showed that, the area is well suited for production of fishery products that is both artisanal and aquacultures considering presence of important rivers in the state.

According to the State Agricultural Development Program (ADP), both indigenous and introduced species are cultivated in ponds, reservoirs, and cages across the state (OYSADEP, 2005), while Tilapias "*Oreochromis*, *Sarotherodon*, *Tilapia* spp.", Clarid catfishes "*Clarias* and *Heterobranchus* spp" and the common/mirror carp "*Cyprinus carpio*" are the most widely cultured fish in the state. This is, these species have fast growth rate, efficient use of natural aquatic foods, omnivorous food habits, resistance to disease and handling, ease of reproduction in captivity and tolerance to wide ranges of environmental conditions.

Data Collection and Sampling Technique

A cross-sectional data from four Local Government Areas (LGAs) of the state were employed for the analysis. The LGAs include: Oluyole, Egbeda, Bodija and Ogbomosho. The LGAs were purposively selected because of prevalence of aquaculture farms in these areas. A random selection of 30 aquaculture farms with aid of a well structured questionnaire from each LGA was carried out using the list of aquaculture farms provided by the fishery unit of the state's Agricultural Development Program (ADP). A total of 120 aquaculture farms were interviewed. Information collected includes cropped fish (kg) per annum and price per kg, pond/ tank size (m^2), feeds (kg), cost of feed per annum, cost of fingerlings, cost of labour, and other costs (cost of transportation and fertilizer). Other information collected includes age of the farmers, years of schooling, years of experience, type of fish produce, number of contacts with extension agents, stocking density, and access to credit.

Method of Data Analysis

Gross margin and stochastic frontier production model were employed for the study. We employed, gross margin to examine profitability of the aquaculture production while stochastic frontier production model to estimate technical efficiencies of the farms.

1. Gross Margin Analysis

A typical gross-margin framework for farm budget can be defined as;

$$\text{Gross margin } (GM_i) = TR_i - TVC_i = P_iQ_i - \sum C_{ij}X_{ij} \quad (1)$$

where, TR represents total value of fish cropped in naira (₦) for i-th aquaculture farm, TVR represents the total variable cost involved in fish production for the period under consideration in naira(₦) for i-th aquaculture farm, P_i represents price per kg of the fish cropped by the i-th aquaculture farm, Q_i represents the quantity of mature fish cropped by the i-th aquaculture farm, C_{ij} represents a unit cost of j-th input used by the i-th aquaculture farm while X_{ij} represents the quantity of j-th variable input used by the i-th aquaculture farm. However, a gross margin greater than zero indicates a profitable enterprise.

2. Stochastic Frontier Production Model

Stochastic frontier model production was proposed independently by Aigner *et al.* (1977) and Meeusen and Van de Broeck (1977). The model had been widely used to study farm level efficiency and sources of inefficiency inherent in the production process (for details see Coelli *et al*., 2005).

The model can be described implicitly as;

$$\mathbf{y}_i = \mathbf{f}\left(\mathbf{x}_{ij};\ \beta_j\right) + \varepsilon_i \quad (2)$$

where, y_i is the output of the i-th aquaculture farm; f is a suitable functional form to represent the fish production frontier such as translog or Cobb-Douglas, x_{ij} is a vector of j-th inputs used by i-th aquaculture farm, β_j is a vector of parameter of j-th input to be estimated, and ε_i is the error term that is composed of two elements defined as;

$$\varepsilon_i = \mathbf{v}_i - \mathbf{u}_i \quad (3)$$

where, v_{is} are random error terms assumed to be independent and identically distributed (iid) with zero mean and constant variance, as $v_i \sim N(0, \sigma^2_v)$, and u_{is} are non-negative random variables associated with the technical inefficiency effects of the farmers which are assumed to be independent and identically distributed (iid) with mean μ_i but truncated as $u_i \sim N^+(\mu_i, \sigma^2_u)$ and independent of v_{is}.

Technical efficiency TE_i of the i-th aquaculture farm is defined in line with the Farrell (1957) definition as the ratio of the observed output to the maximum feasible output in environment characterized by exp (v_i) as

$$\mathbf{TE_i} = \frac{\mathbf{y_i}}{f(X_i;\beta) * \exp(v_i)} = \mathbf{exp(-u_i)} \quad (4)$$

$\mathbf{TE_i}$ takes value on the interval [0, 1]. Where $\mathbf{TE_i}$ equals to one imply a fully efficient aquaculture farm.

The focus of this study is not only to estimate the technical efficiency of the aquaculture farms, but also to examine sources of differences in technical efficiencies of the aquaculture farms. In light of this, the study follows Battese and Coelli (1995) model in which distribution of mean inefficiency (μ_i) is related to the farmers' socio-economic variables. The Battese and Coelli model allows heterogeneity in the mean inefficiency term to investigate sources of differences in technical efficiencies of the farms (inefficiency effect). With this, the farm-specific mean inefficiency (μ_i) is introduced and subsequently truncated at zero, such that non –negative error terms are ensured. The model is defined as:

$$\mu_i = \delta_0 + \delta_{\mathbf{k}} Z_{ik} \quad (5)$$

where, μ_i are as earlier defined, z_{ik} is the matrix of k-th farmer's socio-economic variables for the i-th aquaculture farm to explain determinant of technical inefficiency of the farms and δ_k is a vector of parameters to be estimated.

3. Model Specification

The selected functional form (Cobb-Douglas functional form) employed for the econometric analysis of equation 2 is specify below;

$$\ell n y_i = \beta_0 + \sum_{j=1}^{5} \beta_j \ell n x_{ji} + v_i - u_i \quad (6)$$

where the subscript i = 1, 2 …….. N denotes the observation for i-th aquaculture farm and j=1, 2 … J stands for inputs used. The dependent variable y_i represents the quantity of fish cropped (kg) by the i-th aquaculture farm. The aggregate input included as variables of the production frontier is described in Table 1. β_j are parameters to be estimated while v_i and u_i are as earlier defined. All input variables were in their natural logarithmic form.

The inefficiency model earlier defined by equation 5 can be explicitly specified for this study as:

$$\mu_i = \varphi_0 + \sum_{\mathbf{k}}^{5} \delta_{\mathbf{k}} Z_{ki} + \psi D_i \quad (7)$$

where, Z_{1i} is farmer's age, Z_{2i} is the years of experience; Z_{3i} is years of schooling, Z_{4i} is the number of contacts with extension agents, and Z_{5i} is the stocking density while D_i is dummy variable which represents credit (access =1; otherwise =0). A negative δ_k implies decrease in inefficiency while a positive implies increase in inefficiency.

Marginal effects of Variables Explaining Technical Inefficiency

The estimated parameters (δ_k) in equation 7 only indicate the direction of effects of (Z_k) variables on

Table 1. Summary Statistics of variables of stochastic frontier production model

Variables	Minimum	Maximum	Mean	Std. Deviation
Output (kg)	620	2,871.66	1,361.51	1,896.29
Pond size(m^2)	100	1200	249.28	614.37
Feeds (kg)	70	1600	616.27	375.85
Cost of Fingerlings(₦)	9,000	46,800	13,824.93	56,451.24
Cost of Labour (₦)	1,600	94,000	43,684.12	48,434.29
Other costs	11500	65,700	39,184.12	31,895.59
Stocking density	8	26	18.83	12.37
Years of experience (yrs)	1	13	4.20	2.14
Age (yrs)	26	63	44.51	53.09
Years of schooling (yrs)	6	21	15.71	38.90
No of Contacts with Extension	4	19	12.53	18.67
Credit (access = 1; otherwise = 0)	0	1	0.72	0.032

1 US$ = ₦ 125 (exchange rate as the time of the study)

the estimated technical efficiency estimates. However, marginal effects of (Z_k) variables provide a better measure of long-term effect of (Z_k) on efficiency estimates. Based on this, the computed value of marginal effects of (Z_k) is often interpreted differently from outcome of (7). A positive sign indicatee an increase in TE and *vice versa*.

The quantification of marginal effects as used in Wilson *et al.* (2001) is possible by partial differentiation of technical efficiency predictor with respect to z_k in inefficiency function as presented in equation 8:

$$\frac{\partial TE_i}{\partial Z_k} = \left(\frac{\exp[\{(\gamma-1)Z_k\delta + \gamma e_i\} + 0.5\,\gamma(1-\gamma)\sigma_s^2]\,[(1-\gamma)\{\gamma\,\sigma_s^2 - Z_k\delta\} + \gamma e_i]\,[(1-\gamma)\delta_k]}{[(1-\gamma)\,Z_k\delta - \gamma e_i]} \right) \quad (8)$$

where, γ, σ_s^2, and δ_k represent gamma, sigma-square, and coefficient of the z_k variables in equation 7, respectively. The inefficiency variables (z_k) are evaluated at their mean values while a value of one for dummy variable. Residuals e_i are calculated at the mean value from the estimated equation (6).

The parameters of fish production frontier model (equation 6- β_j), inefficiency model (equation 7- δ), and technical efficiency estimates (equation 4), as well as, variance parameters σ^2_u, σ^2_v, σ^2 and γ were estimated through the maximum likelihood in FRONTIER 4.1 **(**Coelli, 1996).

According to Coelli *et al.* (2005), γ is not equal to the ratio of the variance of inefficiency to total residual variance. The reason is that the variance of *u* equals: $[(\pi\text{-}2)]\ \sigma^2/\ \pi$ and not σ^2. Thus, the relative contribution of variance of *u* (γ*) to total variance σ^2, equals: $\gamma/[\gamma + (1-\gamma)\ \pi/\ (\pi\text{-}2)]$. γ* is derived by substituting everywhere $[(\pi\text{-}2)]\ \sigma^2/\ \pi$ and by using $\gamma = \sigma_u^2/\sigma^2$ and $\sigma^2 = (1\text{-}\gamma)\ \sigma^2$.

Hypotheses Tests

Statistical tests are needed to evaluate suitability and significance of the adopted functional form and model employed in the analysis. Also the test statistics is needed to test for presence of inefficiency effects among the aquaculture farms. Appropriate testing procedure is likelihood ratio (LR). The statistics associated with this test is defined as

$$LR = \left(-2\ell n\left[L(H_0) - L(H_a)\right]\right) \quad (9)$$

where, $L(H_o)$ is log-likelihood value of the restricted model while $L(H_a)$ is the log-likelihood value of unrestricted model. The test statistics LR has an approximately mixed- chi-square distribution with a number of degrees of freedom equal to number of parameter restrictions. When estimated LR is lower than corresponding tabulated chi-square (for a given significance level), null-hypothesis is accepted, vice-versa.

Results and Discussions

Production Performance

The summary statistics of variables of interest is presented in Table 1. We observed that, an average 1,361.51 kg of fish was harvested during the period under investigation. An average, pond size of 249.28 m^2 was also recorded from the analysis. This implies that, an average 5.46 kg of fish was harvested per m^2 of the pond per farm from the study. Further analyses show that an average aquaculture farm from the study, expended approximately ₦13, 824.93, ₦ 43,684.12, and ₦ 39,184.12 on fingerlings, labour, and other costs (this includes cost of fertilizer and transportation), respectively.

Socio-economic variables of the farmers revealed, an average age and years of schooling of 44.51 yrs and 15.71, respectively. Likewise, an average stocking density and number of contacts with extension agents of about 19 and 13 was observed from the study. 73% of the respondents were found to have access to credit.

On the other hands, we observed that 83% of the farms can be considered as monoculture farms while 17% were regarded as polyculture farms. Over 80% of the farms produce tilapias and less than 20% produces catfish.

Most of the farms interviewed rages from homestead concrete pond (31%), earthen ponds (53%), and reservoirs (9%) to cages (7%)

In addition to that we observed that most farms receive supply of fingerlings/seed from both government and private own hatcheries. We also observed that most farms (over 90%) received feed supply from the mills located within the state. Most farms depend on underground water (borehole) as sources of water supply for production.

Profitability Analysis

The breakdown of costs and return analysis revealed a total variable costs and total revenue of ₦ 105,083.25 and ₦ 311,815.59, respectively. The total variable costs when decomposed gave; cost of fingerlings (₦ 13,824.93), cost of feeds (₦ 8,390.08), cost of labour (₦ 43,684.12), and other operating expenses (₦ 39,184.12). The operating expenses include; cost of fertilizer (₦ 5,700) and transportation (₦ 26,684.12).

Using equation 1, we computed gross margin of ₦206,732.34 per annum per farm. This implies that approximately GM /kg of ₦ 151.84 /kg were obtained from the analysis. Further analyses show, that average total revenue per kg of ₦ 229.02 was realized while an average total variable costs per kg of ₦ 77.18 was also obtained from the analysis.

An overview of the distribution of GM across the aquaculture farms is presented in Table 2. The table shows that about 14% of the farms recorded GM less than ₦ 201,000 per annum, about 83% recorded

GM between ₦ 201,000-250,000, while about 3% recorded GM greater than ₦ 250,000. This result suggests that, aquaculture production is a profitable investment considering the size and positive GM obtained from the analysis. Therefore, investment in aquaculture farms will ensure sustainable income generation, capable of helping household to break out of vicious cycle of income poverty.

This finding conforms to findings of Kareem *et al.* (2008a), which reported an average profit of ₦ 204,079 and ₦ 161,789 for concrete and earthen ponds, respectively, for a study conducted on aquaculture farms in Ogun state Nigeria.

Result of the Hypotheses

The results of various proposed hypotheses for the study are presented in Table 3. The first hypothesis of restricting the cross-product in trans-log to zero resulted in LR statistic of 17.3. Given the tabulated chi-square (χ^2) of 24.38 at 5% level with 15 degrees of freedom, the restriction did not result in a significant loss of fit, so the Cobb-Douglas was accepted (first row). Second hypothesis, which specifies that inefficiency effects are absent from the model is strongly rejected. This implies that technical inefficiency cannot be ruled out in the production process of the aquaculture farms under investigation (second row). The third hypothesis specifies that the coefficients of inefficiency model were zero. This hypothesis is strongly rejected (third row). The implication of this is that, included variables explain technical efficiency of the farms as expected.

Result of Productivity Analysis

The estimated parameters of variables included in the regression are presented in Table 3. The estimates, serve as direct measure of input elasticity (a measure of resources productivity of factor inputs). All estimated coefficients were positive and significantly different from zero with exception of cost of labour, which is insignificant at 5%.

Presented in Table 4 is returns to scale (RTS) of 1.16 computed as the sum of the elasticities. The RTS of 1.160 suggests that 1% joint increased in inputs increases the output by 1.16%. This implies that, an average farm from the study area, exhibits increasing returns to scale. This observation is in conformity with the RTS obtained in studies related to aquaculture farms in Nigeria by Fapohunda *et al.* (2005) and Ojo *et al.* (2006).

Technical Efficiency Analysis

To investigate the presence of technical inefficiency among the aquaculture farms, here we first discuss the estimated gamma (γ) in the lower part of Table 5.

From the analysis, we obtained 0.731 of γ, which was found to be significant at 5%. This shows that inefficiency effects are highly significant amongst the farms (a confirmation of the earlier finding under the results of hypotheses).

Further analyses, revealed that about 60% (γ^* in the lower part of Table 5) of deviation of observed output from the frontier can be attributed to the inefficiency effect among the aquaculture farms.

Confirming this observation further is the result of the technical efficiency estimated (for brevity, this is not presented in tabular form). The estimated technical efficiency ranged between 0.815 and 0.968 with an average of 0.806. This value, however, suggests that approximately 19% of the cropped fish for an average farm from the study is forgone due to inefficiency in the production process. Nonetheless, this finding is in conformity with the technical efficiency obtained in the following study related to aquaculture farms in Nigeria; Ojo *et al.* (2006) with an average TE of 0.83 and Kareem *et al.* (2008b) with

Table 2. Distribution of gross margin across the Farms

Gross Margin (₦)	Frequency	Percentage
1000-50,000	5	4.17
51000-100,000	7	5.83
101000-150,000	3	2.50
151000-200,000	2	1.67
201000-250,000	100	83.33
>250,000	3	2.50
Total	120	100

Table 4. Elasticity of production and returns to scale

Variables (x_i)	Elasticities
Pond size	0.120
Feed (kg)	0.034
Cost of fingerlings (₦)	0.589
Cost of labour (₦)	0.387
Other costs (₦)	0.030
RTS	1.16

Table 3. Results of likelihood ratio tests of stochastic production frontier model

Null hypotheses	LL(H_0)	LL(H_a)	LR	χ^2(0.95)	Decision
Production function is Cobb-Douglas :β_{jk}=0	-32.41	-23.72	17.38	24.38	Accept
Absence of inefficiency effects: γ =0	-46.11	-32.41	27.40	14.85*	Reject
$\delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = 0$	-68.15	-32.41	35.74	11.91*	Reject

Table 5. Regression results of the estimated Cobb-Douglas frontier Function

Variables	Parameters	Average OLS	Frontier ML
General Model			
Constant	β_0	2.086*(3.947)	0.194*(3.725)
Pond size(M^2)	β_1	0.126* (8.321)	0.120*(8.751)
Feeds(kg)	β_2	0.029* (2.164)	0.034*(2.943)
Cost of Fingerlings(₦)	β_3	0.289* (3.361)	0.589*(3.521)
Cost of Labour (₦)	β_4	0.039 (1.628)	0.287 (1.132)
Other costs (₦)	β_5	0.146*(2.461)	0.030*(3.987)
Inefficiency Parameters			
Constant	φ_0	0	2.841*(3.94)
Age(yrs)	δ_1	0	1.075 (1.04)
Experience(yrs)	δ_2	0	1.373 (1.25)
Educational level(yrs)	δ_3	0	-0.036*(3.03)
Extension	δ_4	0	-0.012* (6.94)
Stocking density	δ_5	0	-0.842* (2.18)
Credit	ψ	0	-0.272* (2.79)
Variance Parameters			
Sigma-Squared	σ^2	0.351	0.726*(7.617)
Gamma	γ	0	0.731*(19.246)
$\gamma/[\gamma + (1-\gamma)\ \pi/(\pi-2)]$	γ^*	0	0.597*(5.83)
Log likelihood	llf	-46.11	-32.41
Mean TE		0.806	

Figures in parentheses are t-ratio, * Estimate is significant at 5% level of significance

an average TE of 0.88. Meaning that most aquaculture farms across the country have similar pattern of efficiency distribution ranges between 0.80-0.89.

Determinants of Technical Efficiency

Presented in lower part of Table 5 is result of determinants of technical efficiency (TE). The results show that; extension, years of schooling, stocking density, and credit significantly increased TE, while the effect of farmers' age and years of experience decreased TE from the study. The coefficient of years of schooling and age from this study conforms to the findings of Kareem *et al.* (2008b). This suggests that extension contacts, education, stocking density and credit significantly contribute to technical efficiency of the farms under investigation.

Marginal Effects of Inefficiency Variables

Table 6 presents result of marginal effects of inefficiency variables (z_k) on the estimated technical efficiency. While the marginal effect of variables such as education, extensions, stocking density, and credit have positive impact on TE, other variables such as age and years of experience produce negative effects on TE. This suggests that education, extension, stocking density, and credit associate with higher technical efficiency from the study, with extension having the highest marginal effects of 8%. That is, an increase in the present extension contacts will increase technical efficiency of the farms by 8%. In similar way, a unit increase in credit, educational level, and stocking density will increase the technical efficiency of the farms by 5%, 3%, and 1%, respectively.

Conclusions and Policy Implication

This study examines the potential inherent in aquaculture production in alleviating households' income poverty in Nigeria. Gross-margin (GM) to access profitability of the farms as well as stochastic frontier production (SFP) model to measure resources-use efficiency of the farms was employed for the analysis. The empirical results show that, an average GM and technical efficiency of ₦ 206,732 and 0.81, respectively, was obtained from the study. Further analyses shows that, a unit increase in extension contacts, credit, educational level, and stocking density increases level of technical efficiency of the farms by 8%, 5%, 3%, and 1%, respectively.

Based on this, we draw the following conclusions from the study: first, aquaculture production is a profitable investment considering the size GM obtained from the study. Secondly, the farms were fairly efficient in use of their resources considering the size of technical efficiency obtained. Thirdly, it is evident in this study that promotion of aquaculture development has the potential in alleviating household income poverty. Lastly, significant level of profit observed among the farms is synonymous to improve efficiency environment among the farms from the study.

This study, therefore, suggests that policy variables such as extension, education, and credit identified in the study as important determinants of technical efficiency of the farms should strengthen as variable of policy concern for sustainable fish production in the country.

Table 6. Marginal effects of inefficiency variables

Variables (z_k)	Marginal effects
Age	-0.000016
Experience	-0.043
Education	0.030
extension	0.082
Stocking density	0.010
Credit	0.051

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