PERFORMANCE OF SMALL-SCALE FISH FARM OPERATORS IN RESOURCE- USE IN IMO STATE, NIGERIA.

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Abstract: The study estimated the earnings performance and resource-use efficiency of small-holder fish farmers in Imo State, Nigeria. The proportionate and simple random sampling techniques were combined in a multistage sampling in selecting the respondents. Data were collected on output and input use in production and analyzed using descriptive statistics, net income model, the ANOVA and the stochastic translog frontier production function models. . Result showed that fish enterprise is a profitable venture; that the level of profit did not significantly differ between the different agricultural zones in the area. Farmers were found to be inefficient in their use of resources in fish production. The significant factors that positively influenced the economic efficiency of fish production were expenditure on fingerlings, fertilizer, labour, water, feed and capital. The interaction of these variables also significantly influenced the performance of fish output in the area. It was recommended, among others, that financial institutions should be encouraged to improve on the volume and terms of loans extended to the operators to enable them expand their scale of operations and take advantage of the huge profit opportunities in fish production in the are; that the quality of fingerlings and their availability be improved upon in order to reduce their costs and increase their contribution to fish output. [Researcher. 2010; 2(3):56-65]. (ISSN: 1553-9865).

Keywords: earnings performance; economic efficiency; fish production; quality of fingerlings

1.0 Introduction.

Fish production makes immense contribution to Agricultural Development, recognized in Bada (2005); Bene and Heck (2005); WHO (2000). It is consumed in a variety of forms, including smoked, dried, fried or steamed. Although Fish contributes about 40 – 50% of protein intake of the average Nigerian from animal sources Adeniji (1987); Ugwumba and Ugwumba (2003),the average Nigerian was noted to be protein-deficient (Seki and bonzon, 2005); (Oyenuga, 1997); (Ohajianya et al, 2006), with no indication of attaining the recommended daily amount of 1.6Kg (FAO, 2007). The deficiency was attributed to population pressure, inefficient resource-use, decline in output and poverty (Mathew and Hammod (2004). The per capita consumption was postulated to be on the increase over time and the recent suggestion is that the demand is outstripping the supply as explained in Kpadia(2002);;Fabiyi, (1985), creating a deficit which cannot be met from reliance on the coastal waters which are close to depletion(Nwosu et al,2007).Although the deficit could be remedied through measures suggested in Ali and Byerlee (1991), the country had relied on importation of the commodity with adverse consequences explained in FAO, (2007); Although a number of studies had been conducted on fish production, including those of Fabiyi,(1985);;Nwosu et al(2007); Ohajianya et al(2006); Ike and Inomi(2004); Rahman(2002); Wadud and White(2000); non of these adequately addressed the relative earnings performance in the three agricultural zones The crucial information on allocative efficiency in the zones in relation to such critical resources as the land for the pond constructed, labour, capital, water availability, quality of fingerlings, feed and fertilizers have not been adequately reflected in literature. None of these had, in particular, examined the appropriateness of the estimating models adopted and the interaction effect of the variables used in production on fish output. These were captured in this study using the translog stochastic frontier production function approach. The broad objective of the study, therefore, was to ascertain the performance of small-holder fish farm operators in Imo State. The specific objectives were to estimate and compare the returns from fish production in the different agricultural zones in the area, the technical, allocative and economic efficiency in fish production as well as their determinants. It was hypothesized that the fish farmers are allocative inefficient in resource-use, and that there were no significant differences in the output of fish farmers in the three Agricultural zones in the study area.

2.0 Method of Study.

The Study was conducted in Imo State, Nigeria. The area is composed of three Agricultural Zones, namely, Owerri, Orlu and Okigwe. A multistage stratified sampling technique was employed in the study. The area was stratified into three agricultural zones and the list of fish farmers comprising of 60, 70 and 54 from Owerri, Orlu and Okigwe Agricultural zones respectively was compiled with the assistance of the zonal extension agents under the Agricultural Development Programme (ADP) in the area. Using the proportionate sampling technique, 33, 38 and 29 fish farmers were selected from Owerri, Orlu and Okigwe Agricultural Zones respectively. The simple random technique was, thereafter, used to choose the sample size of 100 fish farmers as respondents. Primary data were collected by the use of structured questionnaire and interview schedule administered on the respondents. Secondary data were obtained from relevant texts, journals, bulletins and other relevant documents from the ministry of Agriculture and Natural Resources. Data collection lasted from June 2008 to May 2009. Data were on output and inputs used in production. These were analyzed using relevant statistical tools. The translog stochastic frontier production function was used to determine the technical, allocative and economic efficiency and the determinants of allocative efficiency as well as test hypothesis one. The Analysis of Variance (ANOVA) was used to test for significant difference in the output of fish farmers in the three agricultural zones of the state. The Net Income Model was used to estimate the net return of the fish farmers, specified as:

$$NR = TRi - TCi \quad (1)$$

$$NR = TRi - (TVCi + TFCi) \quad (2)$$

$$NR = \sum_{J=1}^{n} P_J Q_J - \sum_{J=1}^{n} \left(\sum_{k=1}^{m} P_k X_k + \sum_{L=1}^{z} P_L F_L \right) \quad (3)$$

Where,
NRi = Net Return of the ith Fish Farmer (₦)
TR = Total Revenue from Fish Output (₦)
TVC = Total Variable Cost (₦)
Pj = Unit price of the ith Farm Output (₦)
Qj = Quantity of fish produced by the ith Farm (Kg);
P_k = Unit price of $_K^{th}$ variable input used in fish production (₦);
X_k = Quantity of $_k^{th}$ variable input (nos.);
P_L = Unit price of the $_L^{th}$ fixed input used in production(₦);
F_L = Quantity of the $_L^{th}$ Fixed input used in production (nos.);
n = number of farmers;
J = unit farms;
m = number of variable inputs;
k = Variable inputs;
L = Fixed inputs;
Z = number of Fixed inputs.
Technical efficiency was estimated using the translog stochastic frontier production function, specified implicitly as:

$$Yi = F(Xi ; B) \exp (Vi), i = 1, 2,\ldots n \quad (4)$$

For the individual farmer the Technical Efficiency was specified, in line with Aiger et al, 1977; Meeusen, 1977, implicitly, as:

$$TE = Yi / Ki = F(Xi; B) \exp(Vi - Ui) / F (Xi; B) \exp(Vi) = \exp(-Ui) \quad (5)$$

Where,
Yi = Observed output of the i^{th} farm (Kg);
Ki = Frontier Output of the i^{th} farm (Kg)
Xi = Vector of input Quantities used by the ith farm;
B = Vector of unknown Parameters to be estimated;
F(.) = Translog Production function;
Vi = a systematic error term beyond the control of the fish farmer;
Ui = index of inefficiency in production relative to the stochastic frontier (non-negative).

The explicit function, the parameters of which were estimated using the Maximum Likelihood Technique, was specified as:

$$LnYi = b_o+b_1inX_1+b_2lnX_2+b_3lnX_3+b_4lnX_4+b_5lnX_5+b_6lnX_6+b_7lnX_7+_{1/2}b_8lnX_1^2+_{1/2}b_9lnX_2^2$$

$$+_{1/2}b_{10}lnX_3^2+_{1/2}b_{11}lnX_4^2+_{1/2}b_{12}lnX_5^2+_{1/2}b_{13}lnX_6^2+_{1/2}b_{14}lnX_7^2+b_{15}lnX_1lnX_2+b_{16}lnX_1lnX_3+b_{17}lnX_1lnX_4+b_{18}lnX_1lnX_5+b_{19}lnX_1lnX_6+b_{20}lnX_1lnX_7+b_{21}lnX_2lnX_3+b_{22}lnX_2lnX_4+b_{23}lnX_2lnX_5+b_{24}lnX_2lnX_6+b_{25}lnX_2lnX_7+b_{26}lnX_3lnX_4+b_{27}lnX_3lnX_5+b_{28}lnX_3lnX_6+b_{29}lnX_3lnX_7+b_{30}lnX_4lnX_5+b_{31}lnX_4lnX_6+b_{32}lnX_4X_7+b_{33}lnX_5lnX_6+b34lnX_5lnX_7+b_{35}lnX_6lnX_7+Vi-Ui \quad (6)$$

Where,
Yi = Fish output of the i^th farmer (Kg);
X_1 = Pond size (m^2);
X_2 = Quantity of Feed (Kg);
X_3 = Labour Input (Man-days);
X_4 = Water Volume (M^3);
X_5 = Quantity of Fertilizer (Kg);
X_6 = Fingerlings (number);
X_7 = Capital Inputs (depreciated value of implements in Naira);
b_o = intercept ;
$b_1 - b_{35}$ = parameters to be estimated;
Vi and Ui are as defined earlier.

The Economic Efficiency was estimated using a Translog Stochastic Frontier Cost function was specified explicitly as:

$$LnCi = a_o+a_1lnq_1+a_2lnq_2+a_3lnq_3+a_4lnq_4+a_5lna_5+a_6lnq_6+_{1/2}a_7lnq_1^2+_{1/2}a_8lnq_2^2+_{1/2}a_9lnq_3^2+_{1/2}a_{10}lnq_4^2+_{1/2}a_{11}lnq_5^2+_{1/2}a_{12}lnq_6^2+a_{13}lnq_1lnq_2+a_{14}lnq_1lnq_3+a_{15}lnq_1lnq_4+a_{16}lnq_1lnq_5+a_{17}lnq_1lnq_6+a_{18}lnq_2lnq_3+a_{19}ln_2lnq_4+a_{20}lnlnq_2lnq_5+a_{21}lnq_2lnq_6+a_{22}lnq_3lnq_4+a_{23}lnq_3lnq_5+a_{24}lnq_3lnq_6+a_{25}lnq_4lnq_5+a_{26}lnq_4ln_6+a_{27}lnq_5lnq_6+Vi-Ui \quad (7)$$

Where,
Ci = Total cost of the i^th farm (Naira);
q_1 = Expenditure on fingerling (Naira);
q_2 = Expenditure on fertilizer (Naira/Kg);
q_3 = Average wage rate (Naira/man-day);
q_4 =Expenditure on water to fill a pond (Naira);
q_5 = Expenditure on feed (Naira/Kg);
q_6 = Capital (depreciation on implements and fish pond);
a_o = Intercept term;
$a_1 - a_{27}$ = Estimated parameters;
Vi = Error term beyond the control of the farmer;
Ui = Error term under the control of the farmer.
The individual Allocative Efficiency was then estimated as:
AE = EEi / TEi (Rahman and Yakubu, 2005) (8)
Where,
AE = allocative Efficiency of the ith farmer;
EEi = Economic Efficiency of the ith farmer;
TEi = Technical Efficiency of the ith farmer.
If AE = 1, the fish farmer was allocative efficient in resource-use;
If AE <1, the fish farmer was allocative inefficient, over-utilizing the resources;
If AE > 1, the fish farmer was allocative inefficient, underutilizing the resources
The estimated determinants of the allocative efficiency of individual fish farmer were specified, following Kalirajarm (1991; (Coelli, 1996)) as:

$$AEi = b_o+b_1Z_1+b_2Z_2+b_3Z_3+b_4Z_4+b_5Z_5+b_6Z_6+b_7Z_7+b_8Z_8+b_9Z_9+b_{10}Z_{10}+e \quad (9)$$

Where,
AEi = Allocative Efficiency of the ith's farm;
Z_1 = Age of the farmer (years);

Z_2 = Level of education (yrs.);
Z_3 = gender (dummy, 1 = Male; 0 = female);
Z_4 = Farming experience (yrs);
Z_5 = Pond Size (M^2);
Z_6 = Fingerlings (number.);
Z_7 = Extension contact (no. of visits by extension agent);
Z_8 = Credit access (dummy, 1 if farmer has access, zero otherwise);
Z_9 = Membership of cooperative society (dummy, 1 for member, 0 =non-member);
Z_{10} = Household Size (Number of persons);
Z_{11} = Engagement in off-farm employment,(dummy, 1= engagement, zero otherwise);
ei = Error term;
b_o = intercept term;
$b_1 - b_{11}$ estimated parameters;
It was expected, a priori, that

$$b_2, b_3, b_4, b_5, b_6, b_7, b_8, b_9 > 0 ; \quad b1, b10 < 0 \qquad (10)$$

Following Spiegel, Koutsoyiannis, Ohajianya and Onyenweaku (2007), the test for significant difference in output of fish farmers in the three agricultural zones of the state was carried out using the ANOVA model, specified as:

$$F = MSSb / MSSw = \frac{SSb}{SSw} \frac{(n-k)}{(k-1)} \qquad (11)$$

$$SST = SSb + SSw \qquad (12)$$

$$SSb = \sum_{J=1}^{n} nj (X - \bar{X}j)^2 \qquad (13)$$

$$SSw = \sum_{J=1}^{n} nj \sum_{c=1}^{k} (\bar{X}j - \bar{X}j)^2 \qquad (14)$$

$$SST = \sum_{J=1}^{n} nj \sum_{c=1}^{k} (Xj - \bar{X}j)^2 + \sum_{j=1}^{n} nj(X - \bar{X}j)^2 \qquad (15).$$

Where,
F = value by which the statistical significance of the mean differences in fish output was judged;
SSb = Sum-of- squared deviations between the sample means;
SSw = Sum-of squared deviations within sample means;
n = number of fish farmers;
k = number of samples;
nj = sample size from agricultural zone j

$\bar{X}j$= mean fish output from agricultural zone j

$\bar{X}$ = grand mean output of fish;

$\bar{X}ij$ = ith mean output from agricultural zone "j";
k-1= Between samples' degrees of freedom;
n-k = within Sample's degrees of freedom;
X = Output of fish farmers.
The null hypothesis was to be rejected if the calculated F-value was greater than the tabulated F-value and accepted if otherwise.

3.0 RESULTS AND DISCUSSION.

The estimated returns to fish farmers are as presented in Table 1. The table 1 shows that, in Owerri Agricultural Zone, the sum of ₦596910/tonne/year was earned per farmer as average total revenue and, with an average total cost of production of ₦160279.30, the sum of ₦436630.70 was earned as net return with a return on investment of 2.72.

In Okigwe Agricultural zone, average total revenue of ₦ 621440/tonne/year was earned per farmer with an average total cost of production of ₦186414.51, giving a net return of ₦435025.49 and 2.35 as return on investment. In Orlu Agricultural Zones average total revenue of ₦ 650560/tonne/year was earned per farmer with a total cost of production of ₦ 188155.80 per tonne, giving estimated net revenue of ₦ 462404. Although this result shows fish production to be profitable in the state, it suggests that they are most profitable in Orlu Agricultural Zone, followed by Owerri Agricultural Zone and, then Okigwe Agricultural zone.

Table 1: Distribution of Returns to Fish Farmers in the Study Area.

Item	**Costs and Returns to Fish Farmers (Naira / tonne / farmer/ annum).**			
	Owerri Agric. Zone	**OkigweAgric zone**	**Orlu Agric. zone**	**Total**
Total Revenue (₦)	596910	621440	650560	1868910
Variable Cost(₦)	-	-	-	-
Feed	28507.56	39765.71	36972.66	35081.98
Medication	1352	1531	1317	1400
Fertilizer	1032.8	1735	1107	1291.6
Fingerling	19242	21512	20880	20544.67
Electricity	1092.86	1820.2	1336.04	1416.37
Water	38980	36760	40050	38596.67
Transportation	3869.6	3276	3650.1	3598.57
Labour	8016	11000	10210	9742
Other costs	3388	2076	3572	3012
Total Variable Cost(₦)	105480.82	119475.91	119094.8	114683.86
Fixed Cost(₦)	-	-	-	-
Depreciation	28742.48	21216	39911	36409.16
Repairs and Maintenance	3924	4011	4904	4279.67
Interest	13404	13000	13472	13292
Overhead	8728	8720	8582	8676.67
Total Fixed Cost(₦)	54798.48	66938.60	69061	63599.37
Total Cost(₦)	160279.30	186414.51	188155.80	178283.23
Net Returns / Tonne	436630.70	438025.49	462404.20	1690626.67
Returns on Investment (%)	2.72	2.35	2.46	9.48

Source: Field Survey Data, 2009.

3.1 Estimated Production Function.

The double-log estimates of the parameters of the Translog Stochastic Frontier Production function for fish are as shown in (equation 16).

$$LnYi = 10.37+0.20inX_1+0.08lnX_2+0.02lnX_3+0.10lnX_4+0.07lnX_5+0.04lnX_6+0.07lnX_7+$$
(6.40)* (4.11)* (3.82)* (3.12)* (3.90)* (4.17)* (3.85)* (4.01)*

$$0.02lnX_1^2+0.08lnX_2^2+0.05lnX_3^2+0.06lnX_4^2+0.08lnX_5^2+0.05lnX_6^2+0.07lnX_7^2+0.09lnX_1ln$$
(3.85)* (4.00)* (1.53)* (3.18)* (1.61)* (3.89)* (4.10)* (3.87)*

$$X_2+0.07lnX_1lnX_3+0.04lnX_1lnX_4+0.10lnX_1lnX_5+0.04lnX_1lnX_6+0.09lnX_1lnX_7+0.05lnX_2ln$$
(1.70)* (3.94)* (1.46)* (3.89) (4.10)* (4.37)*

$$X_3+0.08lnX_2lnX_4+0.09lnX_2lnX_5+0.08lnX_2lnX_6+0.04lnX_2lnX_7+0.07lnX_3lnX_4+0.05lnX_3ln$$
(3.71) (1.33)* (3.96)* (3.87)* (1.56) (1.39)*

$$X_5+0.09lnX_3lnX_6+0.03lnX_3lnX_7+0.04lnX_4lnX_5+0.06lnX_4lnX_6+0.07lnX_4X_7+0.02lnX_5lnX$$
(1.66)* (1.33)* (1.67)* (4.09)* (3.61)* (1.50)*

$$_6+0.03lnX_5lnX_7+0.07lnX_6lnX_7+Vi - Ui \qquad \text{(eqn. 16)}$$
(4.10) (4.37)*

The function shows that, at 5% probability level, the coefficients for pond size, feed, water, fertilizer, fingerlings, capital and labour were positively related to fish output (the figures in parentheses are t-ratios of estimates).
Among the second order terms, the coefficient of pond size ($_{1/2}\ln X_1^2$), feed ($_{1/2}\ln X_2^2$), water ($_{1/2}\ln X_4^2$), fingerlings ($_{1/2}\ln X_6^2$) and Capital ($_{1/2}\ln X_7^2$) were significant and positively related to fish output. The coefficients of all other second order terms were not significant, indicating that they did not influence fish output in the study area.
As regards the interaction terms, pond size and feed ($\ln X_1 \ln X_2$), pond size and water ($\ln X_1 \ln X_4$), pond size and fingerlings ($\ln X_1 \ln X_6$), pond size and capital ($\ln X_1 \ln X_7$), feed and water ($\ln X_2 \ln X_4$), feed and fingerlings ($\ln X_2 \ln X_6$), feed and capital ($\ln X_2 \ln X_7$), water and fingerlings ($\ln X_4 \ln X_6$), water and capital ($\ln X_4 \ln X_7$), fertilizer and capital ($\ln X_5 \ln X_7$), fingerlings and capital ($\ln X_6 \ln X_7$) were also significant and positively related to fish output. The coefficients of all the second order terms were not zero, suggesting that the translog function was a more appropriate model than the Cobb-Douglas function for the estimation. The estimated Gamma (Y), derived as ($\lambda^2 / 1+ \lambda^2$), was 0.7463 and significant at 5% level, indicating that 74.63% of the total variation in fish output is due to technical inefficiency. The variance ratio estimate ($\lambda^2 u / \lambda^2 v$) was 1.7153 and significant at 5% level, implying that variation in actual fish output from maximum fish output between fish farms mainly arose from differences in farmer practices rather than random variability.

3.2 Estimated Economic Efficiency.
The estimated economic efficiency using a Trans-log Stochastic Frontier Cost function is as shown in equation (17).

$LnCi= 9.82+0.03\ln q_1+0.09\ln q_2+0.07\ln q_3+0.07\ln q_4+0.06\ln a_5+0.09\ln q_6+0.07\ln q_1^2+0.03\ln$
(7.11)* (4.29)* (3.74) (3.00)* (4.81)* (4.51)* (4.67)* (1.39)* (3.10)*

$q_2^2+0.05\ln q_3^2+0.03\ln q_4^2+0.05\ln q_5^2+0.08\ln q_6^2+0.03\ln q_1\ln q_2+0.06\ln q_1\ln q_3+0.08\ln q_1\ln q_4+0$
(1.52)* (3.61)* (3.11)* (3.83)* (1.44)* (1.50)* (3.12)*
.
$06\ln q_1\ln q_5+0.07\ln q_1\ln q_6+0.01\ln q_2\ln q_3+0.03\ln_2\ln q_4+0.05\ln q_2\ln q_5+0.05\ln q_2\ln q_6+0.04\ln$
(3.83)* (1.44)* (1.50)* (3.12)* (3.83)* (1.44)* (1.40)*

$q_3\ln q_4+0.08\ln q_3\ln q_5+0.03\ln q_3\ln q_6+0.08\ln q_4\ln q_5+0.06\ln q_4\ln_6+0.05\ln q_5\ln q_6+Vi - Ui$
(1.70)* (1.30)* (3.84)* (4.13)* (3.71)* (Eqn. 17).

(Sigma Square (δ) = 7.1088; Lambda (λ) = 1.4892; Gamma (γ) = 0.6892)
(6.1341*); (5.0613*); (4.1026*)

The sum of the coefficients of all the second order term was not equal to zero, indicating that the translog model was more suitable than the Cobb-Douglas for the data and model specification. The estimated Sigma square (δ) was 7.1088 and, with a t-ratio of 6.1341, the variable was significant at 5% level, indicating a good fit and the correctness of the specified distributional assumption of the composite error term. The Gamma estimate was 0.6892(with t-ratio of 4.1026), implying that 68.92% of the variations in total cost of fish production resulted from economic inefficiency. The estimated variance ratio, Lambda (λ), was 1.4892 (with a t-ratio of 5.0613), and significant at 5% level, implying that the variation in actual total cost of fish production from maximum total cost of fish production between fish farms mainly arose from differences in farmer practices rather than random variability. The estimated function shows that the coefficients of expenditure on fingerlings ($\ln q_1$), fertilizer ($\ln q_2$), labour ($\ln q_3$), water ($\ln q_4$), feed ($\ln q_5$) and capital ($\ln q_6$) were positively signed and significant at 5% probability level. These indicate that the production cost of fish production increases with increases in the quantities of these variables. Among the second order terms, the coefficients of the square for expenditure on fertilizer ($_{1/2}\ln q^2{}_2$), expenditure on water ($_{1/2}\ln q^2{}_4$), expenditure on feed ($_{1/2}\ln q^2{}_{5)}$ and expenditure on Capital $_{1/2}\ln q^2{}_6$), and those of the interaction of fingerlings and expenditure on water ($\ln q_1\ln q_4$), fingerlings and feed($\ln q_1\ln q_3$), fingerlings and capital ($\ln q_1\ln q_6$), fertilizer and water ($\ln q_2\ln q_4$), fertilizer and feed ($\ln q_2\ln q_5$), fertilizer and capital ($\ln q_2\ln q_6$), water and feed ($\ln q_4\ln q_5$), water and capital ($\ln q_4\ln q_6$), feed and capital ($\ln q_5\ln q_6$) are positive and statistically significant at 5% level showing direct relationship with total cost of fish production. The coefficients of all other second order terms were statistically insignificant at 5% level indicating no significant relationship with total cost of fish production.

3.3 Technical, Allocative and Economic Efficiency of Indivdual Famers.
The estimated Technical, Economic and Allocative Efficiency of individual farmers are as presented in Table 3.

Table: 3 Distribution of the Efficiency Indices of Individual Farmers.

Range of Efficiency	Technical Efficiency		Allocative Efficiency		Economic Efficiency	
	Frequency	%	Frequency	%	Frequency	%
< 50	3	2.50	2	1.70	5	4.20
51 – 60	14	11.70	3	2.50	26	21.70
61 – 70	28	23.30	9	7.50	52	43.30
71 – 80	13	10.80	19	15.80	12	10.00
81 – 90	53	44.20	26	21.70	18	15.00
91 – 100	9	7.50	61	50.80	7	5.80
Total	120	100.00	120	100.00	120	100.00
Mean Value	75.49%			85.74%	67.39%	
Maximum Value	96.13%			99.97%	98.33%	
Minimum Value	48.37%			46.28%	38.21%	

Source: Field Survey Data, 2009.

Results on Table 3 show that about 97.52% of the farmers had a technical efficiency index of above 50.0%, with an individual technical efficiency ranging between 48.37% and 96.13% and a mean of 75.49%.This compares favourably with the 64% obtained in other settings by Kalirajan (1981) and Rahman and Yakubu, but at variance with that of Onyenweaku and Nwaru (2005); Onyenweaku and Okoye (2006) . Table 3 also shows that about 95.8% of the farmers had economic efficiency indices above 50%, with a range of individual economic efficiency indices between 38.21% and 98.33% and a mean of 67.39%, which was an indication of efficiency in resource use. The table also shows that about 98.3% of the farmers had an allocative efficiency index above 50%. The individual allocative efficiency indices range between 46.28% and 99.97% with a mean of 85.74%. This means that the overall allocative efficiency index was less than 1.00 or 100%.The hypothesis that the fish farmers are allocative inefficient in resource use is, therefore, accepted This suggests that the potentials exist for increasing the farmers' gross revenue through a better resource allocation, in line with the findings of Rahman and Yakubu (2005);Sarker et al (1999). The average best farmer from the sample would require a cost reduction of 33.67 % (1 – 0. 67 / 0.98 x 100) to become the best economically efficient farmer while the worst farmer in the sample would require a cost reduction of 63.27% (1 – 0.38 / 0.98 x 100) to become the best economically efficient farmer in the sample. These are in agreement with Ohajianya et al (2006); Effiong and Idiong (2008).

3.4 Determinants of Allocative Efficiency.

The estimated linear functional form for the determinants of allocative efficiency among the farmers is shown as equation (18).The figures in parentheses are t-ratios of the estimates.

$$AEi = 9.11 - 2.17Z_1 + 0.31Z_2 + 0.02Z_3 + 2.17Z_4 + 1.82Z_5 + 0.71Z_6 + 0.08Z_7 + 0.05Z_8 + 0.07Z_9 -$$

(8.91)* (-4.09)* ((3.58)* (1.43) (3.17)* (4.02)* (3.15) * (4.21)* (3.94)* (1.46)

$$0.81Z_{10} - 3.73Z11 + e \qquad \text{eqn(18)}$$

(-4.09)* (3.73)*

When evaluated at 5% probability level the function shows that the coefficient of Farming experience (Z_4),Pond size(Z_5),Fingerlings(Z_6),Extension Contact(Z_7) and household size(Z_{11}) were positive and significant in influencing the allocative efficiency of fish farming in the area. The Coefficient of age (Z_1) was significant but negative suggesting that allocative efficiency decreases with advances in age. The coefficient of education (Z_2) was positive and significant, implying that higher education leads to improvements in allocative efficiency of fish farmers. The coefficient of farming experience (Z_4) was positive and significant, implying that increase in farming experience leads to improvement in allocative efficiency in fish farming. The coefficient of pond size (Z_5) was positive and significant, indicating that large pond sizes result in increase allocative efficiency in fish farming. The coefficient of fingerlings (Z_6) was positive and significant, implying that increases in the number of fingerlings stocked leads to improvement in the allocative efficiency of the fish farmers. The coefficient of Extension contact (Z_7) was positive and significant, indicating that increase in the number of extension visits leads to the improvement of allocative efficiency of fish farming. The coefficient of Credit access(Z_8) was positive and significant, indicating that access to production credit leads to improvement of allocative efficiency if fish production. The coefficient of household size (Z_{10}) was negative and significant, implying that increase in household size leads to reduction in allocative efficiency of fish farming. The coefficient of off-farm employment (Z_{11}) was negative and significant, suggesting that engagement in off-farm employment decreases allocative efficiency of fish farmers. The coefficients of Gender (Z_3) and cooperative (Z_9) were not significant at 5% level, suggesting that they have no influence in allocative efficiency in fish farming.

3.5 Test of Significant Difference in Output of Fish Farmers in the Three Agricultural Zones of the State.

The result of the ANOVA test is as shown in Table 6.

Table 6: Distribution of ANOVA Results on Differenses in Fish Output in the State.

Source of Variation	Sum-of Square	df	Mean Sum-of Square	F-ratio
Between Zones	47820935	2	23910467.5	2.38(NS)
Within Zones	6670824939	117	57015597.5	
Total	6718645874	119		
$F_{05}(V_1 = 2; V_2 = 117) = 3.04$				
NS = Not Significant at 5% level				

Source: Field Survey Data, 2009.

The result shows a mean-sum-of-squares of 23910467.5 between zones and a mean sum-of-squares of 57015597.5 within zones, with an F-ratio of 2.38 which, when compared with the critical F-value (V_1 = 2; V_2 =117) of 3.04, led to the acceptance of the null hypothesis that there are no significant differences in the fish output of the farmers in the three agricultural zones.

4.0 Summary.

The study analyzed the efficiency of fish farming in Imo State, Nigeria, using the translog stochastic frontier production approach, estimated with the Maximum Likelihood Method. Results showed that an estimated net return of ₦436630.70, ₦ 435025.49 and ₦ 462404 were earned as net revenue in Owerri, Okigwe and Orlu Agricultural Zones respectively. The corresponding returns on investment were 2.72, 2.35 and 2.46 respectively. This result tends to suggest that fish production, although profitable in the state, is most profitable in Orlu Agricultural Zone, followed by Owerri Agricultural Zone and, then Okigwe Agricultural zone. However, a statistical test established that there is no significant difference in the fish output of the farmers in the three agricultural zones.

Result further shows that, at 5% probability level, the coefficients for pond size, feed, water, fertilizer, fingerlings, capital and labour were positively related to fish output. The interactions between pond size and feed, pond size and water , pond size and fingerlings , pond size and capital, feed and water , feed and fingerlings , feed and capital , water and fingerlings , water and capital, fertilizer and capital, fingerlings and capital were also significant and positively related to fish output.

The significant factors that positively influenced the economic efficiency of fish production were expenditure on fingerlings, fertilizer, labour, water, feed and capital. The interactions between number of fingerlings purchased and expenditure on water, number of fingerlings purchased and feed, number of fingerlings purchased and capital, fertilizer and water, fertilizer and feed, fertilizer and capital, water and feed, water and capital, feed and capital were positive and statistically significant at 5% level showing direct relationship with total cost of fish production.

Results further showed that about 97.52% of the farmers had a technical efficiency index of above 50.0%, with an individual technical efficiency ranging between 48.37% and 96.13% and a mean of 75.49%. About 95.8% of the farmers had economic efficiency indices above 50%, with a range of individual economic efficiency indices between 38.21% and 98.33% and a mean of 67.39%. About 98.3% of the farmers had an allocative efficiency index above 50%. The individual allocative efficiency indices range between 46.28% and 99.97% with a mean of 85.74%. This means that the overall allocative efficiency index was less than 1.00 or 100%.The hypothesis that the fish farmers are allocative inefficient in resource use was, therefore, accepted This suggests that the potentials exist for increasing the farmers’ gross revenue through a better resource allocation,

5.0 Conclusion.

Fish production is a profitable venture in the state, and the profit level is similar across the three Agricultural zones. The operators are inefficient in their uses of resources. There is, however, room for increased profit among the farmers through reduced level of existing resource-use inefficiency

6.0 Recommendations

(1).The operators require a well designed education that would expose them to better resource management techniques, particularly feeds, fingerlings and pond management. The average best farmer would require a cost reduction of 33.67 %to become the best economically efficient farmer while the worst farmer would require a cost reduction of saving of 63.27% to become the best economically efficient farmer in the sample (2). The profit opportunities in fish farming in the area require that financial institutions should be encouraged to improve on the volume and terms of loans extended to the operators to enable them expand their scale of operations and take advantage of these profit opportunities.(3). The quality of fingerlings and their availability needs to be improved upon in order to reduce their costs and increase their contribution to fish output. This requires partnership between government and private breeders in renewed efforts to establish new hatcheries and the reactivation of the dysfunctional ones and the introduction of a workable breeding programme that will ensure year-round available and affordable fingerlings in the state. This partnership should also extend to the provision of better infrastructural facilities like roads, steady power supply, pipe-borne water to enhance the efficiency of fish production in the area (4)Private feed millers should be exposed to more effective ways of producing quality and low-cost feed to alleviate the problem of high cost of feed being experienced by the farmers.

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