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Analysis of Technical Efficiency of Catfish Farming in Edo State, Nigeria

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Abstract
This study examined the technical efficiency (TE) of fish farming in Edo State, Nigeria. A multistage sampling technique was used to select 180 respondents from whom data was collected using well-structured questionnaire and interview schedules. These were analyzed using both descriptive statistics and stochastic frontier production function. The result showed that the TE of the farmers ranged from 0.46 to 0.99, with a mean of 0.95 at which 77% of them were operating. The efficiency was significantly (p<influenced positively by stocking rate and negatively by the farmers' age, educational level as well as poor access to extension services. Serious constraints that affected optimum production include high cost of feed, limited capital, poor power supply, high cost of pond construction, disposal of effluents, increased fish price created by middlemen and inadequate water supply. Determination of efficiency of resource use revealed that pond size, fingerlings, feeds and fixed cost of items were underutilized while labour and operating cost were over utilized. Farmers' access to suitable extension services and the implementation of policies aimed at tackling the detected constraints would help to increase the efficiency of fish farming in the state.
Keywords: Technical efficiency, Fish farming, Pond, Resource use, Edo State

INTRODUCTION

Background to the Study

Rapid increase in population of Nigeria has led to a huge increase in the demand for animal protein which is essentially higher in quality than that of plant as it contains all essential amino acids for growth (Awoyemi and Ajiboye, 2011). Our country has insufficient access to the amount and variety of food for a healthy and productive life because she has not fully exploited her agricultural potentials. Thus, the average protein intake in Nigeria which is about 19.38g/caput/day is low and far below FAO requirement of 75g/caput/day (Oladimeji, 2014).

Fish production is economically viable and Nigeria has the resources to produce up to 5 million metric tonnes annually (Zayyard, 2008). For instance, Edo State is richly endowed with abundant inland water-bodies, flood plains-wetlands which are highly productive and ideal for artisan fisheries and aquaculture development (Edo State Economic Empowerment and Development Strategy (Edo SEEDS), 2005). While artisan fisheries (fish production from freshwater lakes, dams and reservoir) is largely underdeveloped, investments in fish farming have grown recently but production and employment has been modest. Edo SEEDS aim to bridge this gap, among other policies, with particular emphasis on both improved productivity and socio-economic well-being of the fish farmers. In order to achieve this, there need to be an understanding of the resource use efficiency and constraints militating against such venture in the state.

Therefore, this study was designed to examine the technical efficiency of fish production in Edo State. The objectives are to: (i) estimate technical efficiency of the fish farms, (ii) determine resources which affect efficiency of the business (iii) determine the constraints in fish production, and (iv) determine the resource use efficiency in fish production.

MATERIALS AND METHODS

Study Area

This study was carried out in Edo State, Nigeria. The state which has a population of 3,218,332 people (National Population Commission (NPC, 2006) occupies a land area of 19,281.93 km^2 and lies roughly between latitudes 05^{O}44'N and 07^{O}34'N and longitudes 05^{O}4'E and 06^{O}45'E. The tropical region which usually experience a mean temperature of 25^{O}C is characterized by two distinct seasons: wet (April – October) and dry (November to April) with an average rainfall in the range of 1500 - 2500mm.

Sampling Technique and data collection

A multi-stage sampling technique was used to select catfish farmers in the area. The first stage involved the selection of six (6) Local Government Areas (LGAs) namely Egor, Esan Central, Etsako East, Ikpoba-Okha, Oredo and Uhunmwode from the three (3) Senatorial districts that make up the state based on their high involvement in fish farming. Data were obtained from the Federal Bureau of Statistics (FBS), Edo State Ministry of Agriculture and Natural Resources (ESMANR), Agricultural Development Programme (ADP), and Federal Department of Fisheries (FDF). The second stage was the random selection of three communities from each of the 6 LGAs, namely: Aduwawa, Aduhanhan, Agenebode, Ekosodin, Eyean, Idogbo, Ikhimwinri, Igieduma, Irrua, Oguola, Okhoro, Oko, Ugbor, Ugbowo, Ugonoba, Urora, Uselu and Uteh; making total of 18 communities. The final stage involved the random selection of ten fish farmers from each of the communities, bringing the total number of respondents to 180.

Finally**,** primary data were collected using structured questionnaire aided with an interview schedule for those that could not read or write and these were analyzed using
descriptive statistics (frequency count, percentages, means and standard deviation and inferential statistics) and inferential statistics which used the Maximum Likelihood Estimation (MLE) technique of the stochastic frontier production function.

The general model: The production activities of the fish farmers in the six selected LGAs were estimated using the Stochastic Frontier Production function defined by the functional form specified as:

$InY = B_0 = B_1InX_1 + B_2InX_2 + B_3InX_3 + B_4InX_4 + B_5InX_5 + B_6InX_6 + Vi\text{-}U_i$

Where: Y_i = The fish output of the ith fish farmers (kg) per pond size.

X_1 = Value of fingerlings (₦) per pond size.
X_2 = Hired labour (mandays) per pond size
X_3 = Family labour (mandays) per pond size
X_4 = Quantity of feeds (kg) per pond size.
X_5 = Annual cost of materials (₦) per pond size
X_6 = Operating cost (₦) per pond size
β_1 = unknown parameters to be estimated
V_i = Random component of error term
U_i = Technical inefficiency effect

Inefficiency model: This was used in determining the contribution of the socio-economic variables to the observed technical inefficiency (TI) of the fish farmers. The inefficiency model was estimated jointly with the general model, using the statistical software, FRONTIER version 4.1c. Usually, TI model is composed of vector variables (z), which will be hypothesized to affect the TE of the fish farmers which was specified as:-

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

Where:
U_i = Technical inefficiency effect
δ_0= constant term.
Z_1= Educational level of Respondents (years of schooling)
Z_2= Experience of the fish farmers (years in fish farming)
Z_3= Access to Extension Agents (dummy variable, with 1= Access, 0= no access)
Z_4= Access to credit facilities (dummy variable, with 1= Access, 0= No access

The Generalized Likelihood Ratio Test

$$X^2$$

This is defined by a test statistic given as: C = -2 In {L (Ho) – L (Ha)}
Where:
L (H_o) = null hypothesis i.e. no TI effects in fish production.
L (H_a) = alternative hypothesis i.e. TI effects exist.

The generalized likelihood ratio tests for the presence of inefficiency effect in the frontier model. H_o is accepted when the computed is less than (<) the tabulated chi-square at 5% level of probability or H_a is accepted otherwise.

The mean of 3-point Likert Scale (Osuala, 1993) was used to determine the seriousness of the constraints affecting the fish farmers. The constraints were scored as follows: Very serious = 3, Serious constraints = 2, Not serious = 1.

Mean score of ≥ 2 formed the bench mark for judgment d; observed by the formula:

$$\bar{X} = \frac{\sum Xi}{N}$$

where:

$\overline{X}$= mean
i = 1, 2, 3…180.

$\sum$ = Summation notation.
X = the assigned value of constraint (i.e. very serious = 3, serious =2, not serious =1)
N = the number of occurrence (i.e. N=180)

Resource use Efficiency

The marginal value productivity (MVP) analysis was used for determining resource use efficiency (r) using the equation: r = MVP/Pxi; where xi = mean value of inputs.

RESULTS AND DISCUSSION

The distribution of respondents according to socio-economic characteristics (Table 1) showed that a large proportion (87.8%) of the fish farmers in the study area are 40 years old and above. This result conforms to those of Agbamu and Fubusoro (2001) as well as Ajayi and Allagenyi (2001), who stated that the ageing proportion of the population is more involved in farming. This study showed that majority (96%) of the respondents was married and the males were more (88.3%) than the females (11.7%). Data collected revealed that the literacy level of the respondents was high with all the fish farmers (100%) having attained a minimum of primary education. The relevance of education in agricultural production has been documented (Onuabugu and Nnadozie, 2005; Erie, 2008). The business is relatively new in the study area as majority (52%) of the respondents had an experience of 4 years and below. While a large proportion of them (88.9%) operate the business on full-time basis while the others were on part-time. Only few of the respondents (34%) operated a pond size of 401-500 m^2 (0.41- 0.5ha) while a majority of them (66%) operated a pond size even below 400 m^2 (0.4ha). The dominance of small size fish farms in the study area deprived the farmers from enjoying the benefits of economics of scale which is associated with large scale farming. It was also noticed that most of the respondents (81.7%) had no access to extension services in the study area.

The coefficients of the maximum likelihood estimates (MLE) of stochastic frontier production function (Table 2) showed that all the variables included in the model are significant and positively related to the output of fish farmers. This implies that fish production can be increased by increasing the variables under consideration. An increment of 100%, for example, would increase the total fish output of the pond size, feed, fingerlings, fixed cost items, operating expenses and labour by 52.2%, 30.5% 6.5%, 6.1%, 2.4%, and 2.2%, respectively based on the order of importance. These entire variables indicate that collectively the fish farmers were operating at a rational stage (stage II) of production as indicated by the return to scale (RTS) score of 0.999. The figure, a summation of the coefficients of the estimated variables (elasticity), which serves as measure of total productivity indicate a positive decreasing returns to scale, hence, most of the fish farmers output was optimally produced at this stage.

The TE score was within the range of 0.459 and 0.991, with a mean value of 0.947 (Table 3). About 77% of the farmers were quite efficient beyond this mean value. This suggests that there is room for about 5.3% improvement. Over 97% and 71.11% of the fish farmers operated on a TE of 0.8 and above as well as 9.5 and above, respectively; an indication the most farmers are quite efficient in fish production. The maximum likelihood estimates are shown in Table 4. The positive signs of the parameter imply that the associated variables increase inefficiency while the reverse is true for the negative signs. The coefficients of age, education, and access to extension agents were positively and significantly related to technical inefficiency (TE gap) but contributed negatively to technical efficiency. Thus, as age increases, farmers tend to be less productive. The contribution of age variable to technical inefficiency conformed to a priori expectation that as the fish farmers grew older, their TE would drop. This finding however, negated the findings of Esobhawan (2007) that age was a positive contributor to technical efficiency. The contribution of education variable to technical inefficiency negated *a priori* expectation and the finding that all the fish farmers (100%) were literate, having obtained primary education and above. It could, however, be due to lack of technical education on aquaculture production. The positive contribution of access to extension agents to technical inefficiency was the result of the majority of them (87%) not having access to extension agents. Farming experience and stocking rate contributed positively to technical efficiency of the fish farmers. This was consistent with a priori expectation that business experience could be an indication of the practical knowledge acquired which enhance their business operations. Finally, the positive contribution of stocking rate to technical efficiency indicated the farmers' ability to maintain the required stocking rate which could enhance productivity and output growth.

The sigma squared (σ^2) which is an indication of goodness of fit was statistically significant at 5% level (Table 4), showing the goodness of it of the survey data with the model used and the correctness of the specified distributional assumption of the composite error term. The estimated value of gamma (γ) (0.935) implies that 93.5% of the total variation in fish output is due to technical inefficiency or farmers' practices rather than random variability. Thus, the hypothesis that there is no significant relationship between fish output and the factors of production is rejected and that there are significantly inefficiency effects was confirmed by the Log Ratio Test (Table 5).

The serious constraints affecting of fish production were rated (Table 6) following the decreasing order: high cost of feed, limited of capital, electrical problems, high cost of pond construction, disposal of effluents, increased fish price by middlemen and inadequate water supply with means of 2.82, 2.60, 2.58, 2.46, 2.34, 2.28 and 2.18, respectively.

Economic efficiency of resource use which was computed using MVP (Table 7) showed that no optimization condition was obtained for fish production. The ratios obtained were either greater than unity (underutilization) or less than unity (overutilization). Pond size, fingerlings, fixed cost of items and feed were underutilized, while labour and operating cost were over utilized. Consequently, allocating more resources to the underutilized variables and reducing the employment of resources in the over utilized ones will increase efficiency.

CONCLUSION AND RECOMMENDATIONS

The study revealed that most of the farmers in Edo State were technically efficient in the use of resources for fish production as over 97% of them operated efficiently at 80% and beyond. The average technical efficiency was 94.7%; leaving only about 5.3% room for improvement. Thus, constraints such as high cost of feed, limited of capital, poor power supply, high cost of pond construction, and disposal of effluents, increased fish price created by middlemen and inadequate water supply were discovered to have seriously affected optimum production. Stocking rate had a positive influence on technical efficiency while age and education of the farmers as well as poor access to extension workers had a negative influence. Government should formulate and implement proper policies that would eliminate these constraints and employ well trained extension agents to educate these farmers.

REFERENCES

Agbamu J.U. and Fubusoro E. (2001). Economic Analysis of Rice farming in Ogun State of Nigeria and the implication for Extension services. *Journal of Agriculture Extension*, 5:54-66.

Ajayi A. R. and Allagenyi L. D. (2001). Organizational factors in sustainable service delivery in Nigeria: The effects of job-related stress on organizational involvement and quality of family life of extension agents of the benue state agricultural development programme. *Journal of Agricultural Extension*, 5:9-21.

Awoyemi, T. T. and Ajiboye, A. J. 2011. Analysis of profitability of fish farming among women in Osun State, Nigeria. *Journal of Economics and Sustainable Development*, 2: 1-8.

Edo SEEDS, 2005. State Economic Empowerment and Development Strategy Report, June 2005. 179p.

Erie, G. O. 2008. Gender differentials in productive efficiency in food crop farmers in Edo State, Nigeria. PhD Thesis. Ambrose Alli University, Ekpoma. 139p.

Esobhawan, A. O. (2007): Efficiency Analysis of Artisanal Fishery Production in Edo State, Nigeria. PhD Thesis. Ambrose Alli University, Ekpoma. 143p.

National Population Commission (NPC) 2006. Population Census of the Federal Republic of Nigeria. Analytical Report at the National Population Commission, Abuja, Nigeria

Oladimeji, Y. U. Omokore, D. F. Abdulsalam, Z. Damisa, M. A (2014). Structure and Profitability Differentials among Fishermen in Kwara State, Nigeria. *Journal of Environmental Issues and Agriculture in Developing Countries*, 6: 2141-2731

Onuabugu, G. C. and Nnadozie 2005. "Socio-Economic Factors Affecting Brioler Brooding in Obowo Local Govt. Area of Imo State."Proceedings of the 39th Annual Conference of the Agricultural Society of Nigeria. Benin City. 132 – 135.

Osuala, E. C. 1993): *Introduction to Research Methodology*. Africana Publishers Ltd. Ibadan. 16p.

Zaayyad, R.. 2008. Opening up Nigeria's agriculture to meet domestic world market demand. *Nigerian Tribune*, May 2. 21p.

Table 1: Distribution of fish farmers due to socio-economic character

Characteristic	Frequency	Percentage
Age Category		
30 -39	22	12.2
40-49	75	41.7
50-59	60	33.3
60 and above	23	12.8
Total	180	100
Marital Status		
Single	7	3. 9
Married	173	96.1
Total	180	100
Gender		
Female	21	11.7
Male	159	88.3
Total	180	100
Educational Level		
Primary	55	30.6
Secondary	69	38.3
Tertiary	56	31.1
Total	180	100
Farming Experience (years)		
4 and below	93	51.7
5 – 8	71	39.4
9 and above	16	8.9
Total	180	100
Farming Status		
Full – Time	160	88.9
Part – Time	20	11.1
Total	180	100
Pond Size (m^2)		
200 and below	49	27
201 – 300	52	29
301 – 400	18	10
401 – 500	61	34
Total	180	100
Extension Service		
Lack Access	147	81.7
Have Access	33	18.3
Total	180	100

Table 2: Maximum likelihood of stochastic frontier production function

Variables	Elasticity	t-ratio
Pond size	0.522*	13.564
Cost of fingerlings	0.065*	2.637
Labour	0.022*	2.044
Operating cost	0.024*	3.373
Depreciated fixed cost	0.061*	4.702
Feed cost	0.305*	7.427
Returen to scale	0.999*	

* Significant at 5%

Table 3: Frequency distribution of technical efficiency in fish production

Efficiency class	No. of Respondents	Percentages
< 0.800	5	2.78
0.800 – 0.849	4	2.22
0.850 – 0.899	12	6.62
0.900 – 0.949	31	17.22
≥ 0.950	128	71.11
Total	180	100
Maximum	0.991	
Mean	0.947	
Minimum	0.459	

Table 4: Maximum likelihood estimates of the inefficiency model

Variables	Coefficient	t – ratio
Constant	3. 160*	2.948
Age	0.003*	0.778
Education	0. 022*	1.826
Experience	-0. 086	-2.451
Access to extension agents	0. 051*	0.767
Stocking Rate	-0.002*	-2.831
Sigma squared (σ^2)	0.082*	3.240
Gamma (γ)	0.935*	41.177
Log likelihood function	171.2497	

* Significant at 5%

Table 5: Likelihood ratio test

Null hypothesis	Log Ratio Statistics	Critical value	Decision
H_o: $\delta 1 = \delta 1$ ……… $\delta 1 = 0$	53.852	12.6	Reject Ho
No technical inefficiency			

Table 6: Rating of production constraints by the respondents

Constraints	Mean	SD
High cost of feed	2.82*	0.586
Limited of capital	2.60*	0.676
Electrical problems	2.58*	0.731
High cost of pond construction	2.46*	0.637
Disposal of effluents	2.34*	0.654
Increase in fish price by middle men	2.28*	0.777
Problem of water supply	2.18*	0.815
Production, processing and marketing	1.83*	0.697
Shortage of fingerlings	1.51	0.681
Credit sales	1.41	0.556
Land availability	1.27	0.577
Scarcity of labour	1.25	0.483
Fish spoilage	1.22	0.455
Transportation	1.12	0.426
Others	0.16	0.505

* Significant at 5%. *Serious (mean > 2.0).

Table 7: Economic efficiency of resource use in fish production

Variables	EP	AP	MPP	Py	MVP	Pxi	MVP/Pxi
Pond size	0.522	741.216	356.915	421.05	162910.56	43894.98	3.71 > 1
Fingerlings	0.065	21.366	1.389	421.05	584.84	14.85	39.38 >1
Labour	0.022	6.086	0.134	421.05	56.42	1207.63	0.05 < 1
Op. cost	0.024	1.211	0.078	421.05	32.84	200.00++	0.16 <1
Fixed cost	0.061	43.791	2.671	421.05	1124.63	200.00++	5.62 > 1
Feed	0.305	9.796	2.988	421.05	1285.1	233.86	5.38 > 1

Op. = operating; EP = elasticity of production; AP = average product; MPP = marginal physical product; Py = price of unit output; MVP= marginal value product; xi = mean value of inputs; ++: interest rate of 20%