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Estimates of Profitability and Technical Efficiency of Artisanal Fishermen: A Case of Natural Lakes from Plateau State, Nigeria

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Abstract: This study examines the Net Farm Income (NFI), profitability index and technical efficiency of artisanal fishing in five natural lakes in plateau state, central Nigeria, with a view to examine the level of exploitation of captured inland fisheries as a renewable resource in the country. Data were collected using questionnaire from 110 sample fishermen selected from Polmakat, Shimankar, Deben, Janta and Pandam lakes using multi-stage sampling technique and analysed using descriptive statistics, farm budgeting techniques (net farm income) and stochastic frontier production function model. The study reveals a net farm income of ₦48, 734.57 and a profitability index of ₦7.67. The mean technical efficiency of 83% was obtained, indicating that the sample fishermen were relatively efficient in allocating their limited resources. The result of the analysis indicates that 72% of variation in the fishermen output was as a result of the presence of technical inefficiency effect in the fishery, showing a potential of about 17% chance for improvement in technical efficiency level. Some observable variables relating to socioeconomics characteristics such as extension contact, experience and educational status significantly explain variation in technical efficiency. Transformation for effective and sustainable fisheries exploitation will need the education of fishermen, extension education and redefinition of property rights.

Key words: Fisheries, income, overexploitation, productivity, renewable, sustainability

INTRODUCTION

The global captured fishery is in a crisis with a majority of the world's fisheries being fully exploited and about one third of them being either depleted or over-exploited (FAO, 2003). According to FAO (2004), deterioration of global fisheries is raising significant concern, mainly because an estimated one billion people, mostly in low-income countries, depend on fish as their primary source of protein. They further stated that fish, long regarded as "poor man's protein" is diminishing globally as result of increasing market demand and over fishing. On the average, fish supplies 16% of animal protein consumed by people. The industry, ranges from subsistence fishermen to large-scale mechanized fishing vessels, directly or indirectly employs some 200 million people worldwide (UNEP, 2006). This crisis has been wrought about by both market and policy failures which manifest themselves through among other things, improper management and inadequate property rights.

Poor people are frequently compelled to exploit their surroundings for short-term survival, and make up the group most regularly exposed to natural resources (World Bank, 2002). Fisheries are renewable natural resources which are often of a common pool resource type, which implies problems with overexploitation that sometimes are hard to manage, even in well-developed countries. These fisheries are frequently "open access" with no restrictions on entry or total catch, and regularly lack even rudimentary tools for management. The results of these are extinction of species, disturbances of delicate ecosystem, collapse of important fisheries, and destruction of natural environment, less dramatic, but of enormous importance, is the decrease in yield, income, and employment from fisheries.

In Nigeria, it is estimated that about 10 million people particularly youths, are engaged in artisanal fishing (CBN, 2004). Fish production in Nigeria is practiced in two environments namely fresh and salts waters. The fresh water fish production is classified into three major subsectors; artisanal captured fishery, industrial captured and Aquaculture. The artisanal captured fishery, production is achieved by individual or by small groups by the use of labour intensive gears. This is the most important subsector as it represents between 85-90% of domestic production and providing means of economic support and livelihood for millions of rural dwellers, particularly in Niger Delta, Northeast and Middle belt regions of the country (FOS, 1996). With a huge potential area of between 12-14 million hectares, and a low production estimate put at about 700,000 million tons of fish annually, while current needs put at a

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minimum of 2 million metric tons of fish to feed the population of over 140 million Dawang *et al.* (2011). The fish production problem has been heightened by the characteristic use of dug-out, wooden canoes that are more often than not motorized, production by individual or by small groups by the use of labour intensive gears and relatively low level of productivity of resources used Ojo (2004).

And to examine the profitability and efficiency of resource use of the full time fishing in the region, this paper is therefore designed to determine net farm income, estimate current level of technical efficiency and as well as demographic factors that influence the level of efficiency of the fishermen. A comprehensive development policy on artisanal fisheries in Nigeria requires information on the Profitability of daily fishing activity and technical efficiency of full time fish harvest in the existing property right of the fish resources. This study is therefore, generally aimed at assessing the productivity of artisanal fishermen in Plateau State in central region of Nigeria.

Research objectives: The broad objective of this research was to determine productivity of fishing enterprise in the study area against the backdrop that captured fisheries are depleted or overexploited. The specific objectives were to:

- Estimate the net farm income and profitability index of fishermen in the study area
- Estimate technical efficiency of the individual fishermen in the study area
- Determine the fishing-specific constraints existing in the study area

Hypotheses: This study tested the following hypotheses:

- That Cob-Douglass specification is the appropriate functional form for the existing fishing system technology structure
- That fishing in the study area is not profitable
- That the fishermen in the study area are not efficient and
- There is no technical inefficiency effects existing among fishers in the study area

THEORETICAL FRAMEWORK

The stochastic frontier modelling is becoming increasingly popular because of its flexibility and ability to closely marry economic concepts with modelling reality. And, based on this, the model is employed in this paper to provide the basis for measuring farm-level technical efficiency as a basis for assessment of current property rights, management and exploitation levels for beneficial and sustainable fishery indicator. The modelling, estimation and application of stochastic frontier production function to economic analysis assumed prominence in econometrics and applied economic analysis following Farrell (1957), seminar paper where he introduced a methodology to measure technical, allocative and economic efficiency of a firm. According to Farrell (1957), technical efficiency (TE) is associated with the ability of a firm to produce on the isoquant frontier.

Over the years, Farrell's methodology had been applied widely, while undergoing many refinement and improvements. And of such improvement is the development of stochastic frontier model which enables one to, measure firm level technical and economic efficiency using maximum likelihood estimate (a corrected form of ordinary least square –COLS). Aigner *et al.* (1992) and Meeusen and van den Broeck (1977) were first to proposed stochastic frontier production function and since then many modifications had been made to stochastic frontier analysis. Aigner *et al.* (1992), applied the stochastic frontier production function in the analysis of the U.S agricultural data. Battese and Corra (1997) applied the technique to the pastoral zone of eastern Australia.

Technical efficiency is defined by Kumbhakar and Lovell (2000) as the ability of a decision-making unit (DMU) to obtain the maximum output from a set of inputs (output orientation) or to produce an output using the lowest possible amount of inputs (input orientation). Technical efficiency of a DMU and the degree of use of variable inputs determine the output and capacity utilization. In the fisheries context, there is a growing interest in the measurement of technical efficiency of different fishing management scenarios. This interest is twofold: to establish the underlying factors (Sharma and Leung, 1998), as determining those factors affecting it allows stakeholders to take measures to limit or improve it and to assess the effects of management tools and measures on technical efficiency and potential catch. Fishery managers may reduce technical efficiency by constraining the use of certain inputs (Kirkley *et al.*, 1995) or alternatively, they may improve it by expanding these inputs or by taking measures that properly define the property rights of the fishery.

The empirical model:

Farm business analysis: The farm business analysis measures the strength and weakness of the farm (Olukosi and Erhabor, 1987). The indicators used in this work were the Net farm Income (NFI) and Profitability Index. NFI is a difference between total revenue and total cost (i.e. sum of variable and fixed costs). The item of revenue was sales of total daily catch for the whole catch assessment survey period. The cost items considered were; cost of fishing gears; gillnets, hook line, gura traps, mallia trap, canoes, calabashes and labour. The total return was estimated by multiply the total weight of catch by the prevailing market prices. The model used was represented by the equation:

$$NFI = \sum_{i=1}^{n} P_i Y_i - \sum_{j=1}^{m} P_{xi} Y_j - \sum_{k=1}^{k} F_k$$

where,

- NFI = Net farm Income
- Y_i = Fish output (total weight in kg)
- P_i = Unit price of the fish/per kg
- X_j = Quantity of variable input (where j = 1,2,3, ..., m)
- Px_j = Price/Unit of variable input (N)
- F_k = Cost of fixed inputs (where k = 1, 2, 3…k fixed input)
- ∑ = Summation (addition) sign

The Net Farm Income (NF1) is gross receipt less total cost. Fixed cost item were calabashes and canoes depreciated using straight line method. While variable cost items include cost of fishing items such as; labour, gillnets, mallia traps, gura traps and hook lines.

Stochastic frontier production function analysis (SFA): The analysis was carried out using FRONTIER version 4.1c (coelli, 1996) and this has the advantage of separating the impact of weather and luck from contribution of variation in technical efficiency. A frontier model with output-oriented technical efficiency is specified as follows:

$$Y_i = X_i \beta + (\epsilon_i = V_i - U_i) \quad (1)$$

where, Yi is output in kg of individual i (i = 1, 2,... N) X_i is the corresponding matrix of K inputs and β is a k×1 vector of unknown parameter to be estimated. The disturbance term is made up of two independent components, $\epsilon i = V_i - U_i$ where $V_i \sim N(0, \sigma_v^2)$, and U_i is a one-side error term. The noise component V_i is assumed to be i.i.d and symmetrically distributed independent of U_i. The term V_i allows random variation of the production function across individual and captures the effects of statistical noise, measurement error and exogenous shocks beyond the control of the individuals. If Ui = 0, then $\epsilon_i = V_i$ suggesting that production lies on the frontier and production is said to be technically efficient. If $U_i>0$, production lies below the frontier and thus there is evidence of inefficiency.

As indicated by Jondrow *et al*. (1992), ϵ_i contains information about Ui and makes it possible to estimate mean technical efficiency over all observations. It is also shown that firm-specific technical efficiency can be inferred from asymmetry in the residuals around a fitted production and its calculation rests on the higher moments of these residuals. Following Jondrow *et al*. (1992), we find the expected value of Ui conditional on the value of ϵ_i i.e. E (Ui/ϵ_i). The maximum likelihood estimation of equation (i) provides the estimators for βs and variance parameters $\sigma^2 = \sigma_v^2+\sigma_u^2$ and $r = \sigma_u^2/\sigma^2$. Technical Efficiency (TE) of each individual is obtained by $TE_i = Y/f(x;\beta) * \exp(v)*\exp(-U)$, hence we can define $TE_i = \exp(-u)$; exp is the exponential operator Battese *et al*. (1996). The range of technical efficiency for individual i, (TE_i) is in the range of 0-1, where $TE_i = 1$ represents the achievement of the achievement of maximum output (adjusted for random fluctuations) for the given input.

Specification for stochastic frontier: This paper uses the approach by Battese and Coelli (1995), analyse the relationship between technical efficiency and input variables. The estimated frontier is stochastic since fishing is sensitive to random factors such as weather, resource availability and environmental influences Garcia *et al*. (2001). The problem is choosing an appropriate functional form to represent fishing effort. The first-best option is to consider a translog flexible functional form, because it represents a second-order approximation of any arbitrarily chosen function as well as being theoretically possible (Berndt and Christensen, 1973); it is specified as follows:

$$\text{In } Y_j = \beta_o + \beta_1 \text{In}E_1 + \beta_2 \text{In}E_2 + \beta_3 \text{In}E_3 + \beta_{12} \text{In}E_1 \text{In}E_2 + \beta_{13} \text{In}E_1 \text{In}E_3 + \beta_{23} \text{In}E_2 \text{In}E_3 + ½ (\beta_{11} \text{In}E_1 + \beta_{22} \text{In}E_2 + \beta_{33} \text{In}E_3)^2 + (V_i - \mu_I) \quad (2)$$

where, subscript j refers to the jth fisher in the sample.

- E_1 = The length of fishing gears measured in meters
- E_2 = The time taken for passive gears to remain active in water (h) per fishing trip as a proxy for hours fished (Sharma and Leung, 1998)
- E_3 = The number of fishing gears owned by the individual fisher that were in activity during survey period
- In = The natural logarithm (base e)

In Eq. (2), the symmetry restriction is imposed a priori to be able to identify the coefficients (βij = βji). Consequently, different restrictions on the translog function can be tested to establish the most appropriate final form for the fish capture function (Garcia *et al*. 2001).

Technical inefficiency model: According to Battese and Coelli (1995) in the inefficiency effect model, the one-sided error term is specified as:

$$U_i = \delta_0 + + \Sigma_j^4 =_1 \delta j Zj + \omega \quad (3)$$

where, Zs are socioeconomics variables used to explain efficiency differentials among fishers, d's are unknown parameters to be estimated and i is an iid random variable with zero mean and variance defined by the truncation of the normal distribution. The specific Z-variables the above model can be specified as follows:

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \omega \quad (4)$$

where, Ui is individual fishers' technical inefficiency measure and Z_1, Z_2, Z_3 and Z_4 represents Age of fishers, family size, extension contact and level of formal education respectively.

The technical inefficiency Eq. (3) can be estimated if the technical inefficiency effects, Ui are stochastic and have particular distributional properties (Battese *et al.*, 1996). Under the null hypothesis g = 0, the stochastic frontier model reduces to a traditional average response function, thus no technical inefficiency effects. The null hypothesis was tested using the log likelihood ratio rest, given by:

$$\lambda = -2[\ln\{L(H0)\} - \ln\{L(Hi)\}] \quad (5)$$

where, $L(H_0)$ and $L(H_1)$ are values of likelihood function under the null hypothesis (H_0) and alternative (H_1) hypothesis, respectively. Technical inefficiency for each individual fishers, i is defined as the ratio of actual output to the potential frontier output.

METHODOLOGY

Study area: Plateau State is located in the middle belt zone of Nigeria and lies between latitude 8º30′ and 10º30′ N, longitude 7º30′ and 3º37′ E with a land mass covering 53,585 m^2, the state has an estimated population 3.5 million (NPC, 2006). The sites chosen for the study were Shimankar, Deben, Janta and Polmakat lakes located in the Southern agro-ecological zone of the State. The Polmakat Lake is located in Langtang South local Government area with projected 2010 population figure of 210,000, Shimankar and Deben are located in Shendam LGA with projected 2010 population figure of 230,000, while Janta and Pandam are located in QuaanPan LGA, with projected 2010 population figure of 222, 275 (NPC, 2006).

Data collection: Primary data were employed for the research and collected using questionnaires and a catch assessment logbook. The questionnaires were administered to 30 fishermen from Pandam Lake and 20 fishermen each from Shimankar, Polmakat, Deben, and Janta lakes. This give a total samples size of 110 respondents. Prior to the administration of the questionnaires, daily fishing observations were conducted on the fishermen that where randomly selected during the pre-study visit and frame survey conducted in April/May 2010. The daily fishing observations of selected fishermen were carried out through a catch assessment survey (CAS) conducted between July 2010 and January 2011.

The CAS was conducted to collect information regarding; daily catch weights, price and numbers of gears. The CAS was done to capture the lean months (July/September) and peak months (Nov/Jan) of fishing for period of two weeks each, and followed by the administration of the questionnaires to the selected fishers. The total observations of one thousand five hundred and forty in twenty weeks from one hundred and ten fishermen (observations: 1540; 4wks; 110 samples) were made. Information regarding; constraints, types of gears and their activity, prices, costs and returns in addition to socioeconomic characteristics. The data collected were used in the calculation of income, profitability, technical efficiency and inefficiency indicators.

RESULTS AND DISCUSSION

Descriptive statistic: The descriptive statistics of variables for the production frontier estimation are presented in Table 1. The result revealed that the average total value of fish caught (obtained by adding cash receipt from selling of fish and those consumed) was ₦57, 239.10 with a standard deviation of ₦24, 324.30. The large value of standard deviation implies that the fishers were operating at different number of fishing gears which is confirm by the minimum value of ₦11376.00 and maximum value of ₦131, 328.09 and this tends to influence their output levels. The minimum value of length of gears owned was 45.72 m, while maximum was 5943.60 m. The mean length of gear owned was 1341.63 m with a standard deviation of 1328.57 m. The variability in length of gears measured by the minimum, maximum values and confirm by standard deviation may be due to the high cost of fishing gears in study areas.

The minimum number of fishing gears used was 14 gears and maximum was 210 gears. The average number of fishing gears was 46.24 with a standard deviation of 38.24 gears, indicates that there is a high used of fishing gears in the fishing practice. The minimum total catch in sample was 758.40 kg while maximum was 8755.20 kg. Furthermore, the mean total catch was 3815.94 kg with a standard deviation of 1621.62 kg. The large value of standard deviation implies that the fishermen operated at different levels of fishing gears and skills and these tend to affect their levels of production or catch.

Table 1: Descriptive statistics of variables used in the stochastic frontier analysis

Variable	Notation	Mean	S±D	Min	Max
Average totalcatch (kg)	Q	3815.94	1621.62	758.40	8755.20
Total value of catch (₦)	Y	57239.10	24324.30	11376.00	131,328.09
Length of fishing gears (M)	E_1	1341.63	1328.57	45.72	5943.60
Time of passive gears in water	E_2	1046.77	1001.21	48.00	4920.00
Number of gears owned/fisher	E_3	46.24	38.24	14.00	210.00
Age of the sampled fishers	Z_1	38.51	11.61	20.00	75.00
Family size of fishers	Z_2	6.51	4.26	03.00	15.00
Extension contact	Z_3	18.57	11.68	02.00	55.00
Formal educational status	Z_4	8.05	6.27	00.00	13.00
Experience	Z_5	13.57	7.21	5.00	18.00
Catch-per-unit-of-effort		6.3	5.1	4.1	7.4

field survey 2010/2011

Table 2: Cost-return and profitability index

	Items	Amount/Period	%
A	Returns	-	-
•	Catch (Kg)	424.128	
•	Sales (N)	55,136.25	
B	Cost	-	-
•	Labour	3640	56.8
•	Gillnet	527.91	8.2
•	Malia trap	973.95	15.0
•	Hook lines	775.	12.0
•	Repair/Maintenance	39.33	1.05
•	Depreciation on crafts	445.49	6.95
C	Total cost	6,401.68	100
D	Net farm income	48, 734. 57	-
E	Profitability index	7.67	-

Field survey (2010/2011)

The average number of extension contact was 18.57 with a standard deviation of 11.68. The large average of extension contact indicated by the farmers is a reflection of the fact that local government extension agents are working and such extension education should be made more relevant considering the dual needs of benefit to fishers and environmental quality through sustainable fishing. The average age of the farmers was 38.5 years with a standard deviation of 11.68 years. This shows that most farmers were relatively middle aged people. The average fishing experience was 22.65 years with a standard deviation of 9.62 years, implies that the fishing experience varied significantly among the farmers. The average year of schooling was 8.52 with standard deviation of 6.18, showing that most of the farmers attended at least a Primary School. The average family size was 8.05, with a standard deviation of 6.27 while the maximum number was 35 and minimum was 03.00, this result shows there may be enough labour in an average household for fishing work daily from family labour. Catch-per-unit-of-effort (CPUE) is a measure of resource abundance as well as catch ability and the result indicated an average of 6.3 kg in the study area.

Costs, returns and profitability analysis of fishing activities: The estimate of Costs, returns and profitability index of fishing activities were considered and presented in Table 2. The variable costs were labour, gillnets, malia traps, gura traps; hook lines, repairs/maintenance of gears and fixed was depreciation on canoes and calabashes. The prevailing wage rate in the areas was used in computing the labour cost. The wage rate (fishing trip) prevailing in Polmakat, Shimankar, Deben, Janta and Pandam lakes were ₦200, ₦200, ₦150 and ₦150, respectively. The average wage rate at was ₦175.

The estimate of cost of fishers reveals that labour was the highest single cost item with about 58% of total cost, while the least cost item was repairs/maintenance with a 1.05%. The result indicated labour was the highest cost item, although, less than percentage in the country`s peasant agriculture, where the proportion of labour was found cost to be up to 80% of total cost (Sonaiya, 2001).

The profitability Index was calculated as ratios of net income to total cost of effort allocation (Production). The value indicated the return on every naira invested in the fishing business in the study area. Therefore, the value of 7.67 means that for every one kobo invested in fishing business, there is a return of seven Naira and sixty seven kobo in the study area. This is a very important parameter for investment decision as artisanal fishers like any other investors may wish to know the profit that can possibly be generating from their limited financial resource.

Stochastic frontier production analysis: The maximum likelihood estimates of the stochastic frontier production function using the translog function for natural lakes fishers in the study area are presented in Table 3. To test the assumption of translog specification for the capture fish function, a Cob-Douglass functional form was also run and a log likelihood ratio test carried out. The null hypothesis that the Cob-Douglass production function is an adequate representation plateau state natural lakes fisheries data (H_0: $\beta_{ij} = 0$ for all i - j = 1, 2, 3) is strongly rejected (The LR value was 8.90; at degree of freedom, 6, 095 χ^2 = 12.59), confirming our assumption of translog being the best specification of the fishery. Furthermore,using the translog specification form a log likelihood ratio test of the one-sided error, indicated that the test of no technical inefficiency was statistically significant (LR test statistic = 21.01; critical value for 5% level of significance: degree of freedom; 6 = 12.59 (Kodde and Palm, 1986).

Table 3: Maximum likelihood estimates of the stochastic frontier production function using the translog specification

	Model I		Model II	
General model	C	t-ratio	C	t-ratio
Constant	5.8	3.02	7.54	1.0*
LnE1	- 0.25	0.87	0.08	- 2.17**
LnE2	0.26	0.50	0.07	0.34
LnE3	0.17	0.03	- 0.04	0.57
LnE1lnE2	0.27	0.04	0.04	0.06
LnE1lnE3	0.02	0.20	0.02	5.08*
LnE2lnE3	0.03	0.57	0.02	0.04
$LnE1^2$	- 0.04	0.97	- 0.04	- 0.03
$LnE2^2$	- 0.06	1.24	- 0.07	- 0.05
$LnE3^2$	- 0.05	0.54	- 0.05	- 0.09
Inefficiency model				
Constant	Z_0	0	- 0.35	2.23**
Age	Z^1	0	- 0.08	0.02
Family size	Z_2	0	0.05	0.04
Ext. con	Z_3	0	- 0.07	- 3.1**
Education	Z_4	0	- 0.09	- 3.4**
Experience	Z_5	0	- 0.05	- 2.5**
Sigmad	δ^2	0.24	0.29	3.19**
Gammag	γ	0.67	0.72	4.15**
Log likelihood		-47.24	-32.73	
LR test	(df, χ^2 = 6,095 = 12.59)		21.01	

*: Statistical significance at 1%; **: Statistical significance at 5%

Table 4: Decile range of frequency distribution for technical efficiency of fishermen

Range	Frequency	Percentage
0.20-0.29	1	0.91
0.30-0.39	1	0.91
0.40-0.49	1	0.91
0.50-059	3	2.73
0.60-069	4	3.64
0.70-0.79	14	12.73
0.80-0.89	52	47.27
0.90-0.99	34	30.90
Total	110	100
Mean TE	0.8319	83.19

This suggest that the fishermen were operating below the output oriented frontier and that the traditional response function, i.e. ordinary least square (model 1) was not an adequate representation of data and therefore, maximum likelihood estimate (model 11) is the preferred for further analysis. Furthermore, gamma coefficient was 0.72 and statistically different from zero at 1% level of significance, suggesting that about 72% of variation in output of fishers at the fisheries were as a result technical inefficiency effects. The remaining portion is due to factors beyond the control of the fishers. Most variables in the frontier model were not statistical significant different from zero, however, interpretation of the individual parameters of a translog is not particularly meaningful in fisheries economics. Therefore, concentrate on the inefficiency model.

The inefficiency model estimates: The stochastic frontier production function inefficiency analysis result indicated the coefficients of experience, extension contact and educational status were all negative and statistically significant. This result suggests that increasing these variables will decrease technical inefficiency i.e. increase technical efficiency. Specifically, for every extra year of schooling that a fisher gets, there is a 9% increase in the chance or probability of being technically efficient. The negative coefficients of education and extension contact indicate that these factors can lead to increase in technical efficiency of fishers in the study area. This is in conformity with the work of Dawang (2006); on his work on local chickens' management innovation adoption of farmers in Plateau State, Nigeria, he found the estimated coefficient of educational status and extension contact in technical inefficiency model were negative and significant, implying that technical inefficiency level of farmers decreased with increase in age and extension contact.

Technical efficiency scores analysis: The frequency distributions of technical efficiency scores are also presented in Table 4. The result indicated that about 78% of fishermen are operating at 80% or more technical efficiency levels. Furthermore, about 90% of fishers are operating at a technical efficiency level of 70% or more. The result also suggests that for the technical efficiency level of not less than 50%, there were about 97% of the fishers operating at same. Also about 2.73% of the fishers are operating at technical efficiency level of 40% or less. The results further reveal that technical efficiency ranges between 20.74-94.57% with a mean technical efficiency of 83.19%. This suggest a relatively high technical efficiency level existing in the fisheries, pointing to a frightening level of exploitation and a wide range of efficiency level existing in the fisheries.

The arithmetic mean of the individual efficiency score of 0.8319 for the fisheries can compare well with lokina (2004), for Lake Victoria artisanal fisheries and Squires *et al.* (2003), also found similar result, for the Malaysian gillnet fleets of artisan fishermen. But these figures are comparatively higher than those found in Kuperan and Sutinen (1998) in Malaysian trawl fishery. These comparatively high efficiency scores are consistent with Schult (1964) thesis of "Poor and efficient" smallholders and peasant farmers in developing country agriculture.

CONCLUSION AND RECOMMENDATIONS

The analysis of profitability index and net farm income of the fisheries in the study area like any business enterprise reveals the strength and/or weakness of the business suggested that fishing if promoted and supported could be vital for livelihood of participants. A financial analysis of a business must be profitable if any meaningful investment can be made and if such a fisherman most continue in the business. There are indications that the captured fish business is capable of providing gainful employment, income and maintaining a good standard of living in an average household.

At the moment, fishing in the study area is carry out with no limit to entry or exit, no closed season, and property rights and management of the lakes in the hands of their immediate communities. The stochastic frontier model results indicate the possibilities for improving performance in the fisheries; this is from wide range of efficiency scores and the mean technical efficiency as well as the inefficiency model. And from the perspective of equity and distribution improved efficiency is desirable; but improving efficiency at the "open access" of the fisheries resource such as obtained at the moment in the study area, when neither effort nor catch is limited could lead to further depletion of stock. Increased efficiency at the aggregate level is thus only possible if fishing effort and/or catch is limited, therefore, government should implement limit entry measures.

And one potential policy option would be the retirement of a number of individuals preferably those with efficiency scores of less, than 50%. Improving efficiency would then lead to similar catch levels with a smaller number of fishermen. However, such a prescription is problematic for two reasons firstly, it presupposes control at the state level, which are currently lacking in study area. Secondly, it requires the expulsion of a number of fishermen and the unemployment of a number of fishermen. Though theory state, that in the long run, improved stocks and increased profits for the remaining fishermen should in principle be sufficient to compensate those who are force out of the industry.

However, in the absence of aggregate control of effort and exit of less efficient or part time fishermen. The situation may be resolve by taking reform measures that properly redefine the property right of the fisheries. With such reforms, the government of Plateau state could potentially carry out a limited entry, which would provide efficiency improvements and sustainable fishing on all natural lakes in the state. Finally, the statistically significant and negative sign of coefficient of education and extension contact means transformation for effective and sustainable fisheries exploitation will need the involvement of educated fishermen and extension education.

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