



TECHNICAL EFFICIENCY OF ARTISANAL FISHING ON WATERWEED INFESTED LAKES IN RIVERINE COMMUNITIES OF OGUN STATE, NIGERIA

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ABSTRACT

The study examined the technical efficiency of artisanal fishing in water weed infested lakes and riverine communities of Ogun State, Nigeria. Random sampling technique was used in selecting 120 respondents. Data were collected through the administration of questionnaire and analyzed using both descriptive and inferential statistics. The results revealed that 39.2% of the respondents were between the age bracket of 41- 50 years with a mean of 44.19 years and dominantly male (73.3%) and married (90.8%). The study further revealed that all (100%) of the fisher folks had former education ranging from primary education to tertiary education. Findings further showed that 27.5% had household size of 10-12 members with a mean of 8 persons and had between 21-30 years fishing experience. The result revealed that 62.5% of the respondents are into full-time artisanal fishing. The results of regression analysis showed that fishing time per trip ($P<0.01$), number of fisher folk per trip ($P<0.10$) and time of fishing ($P<0.01$) were the factors influencing the level of fish catch. Results of the stochastic frontier showed that fishing time per trip ($P<0.05$) and hired labour ($P<0.01$) were the factors influencing the technical efficiency. The mean efficiency of the fisher folks in the study area was 0.76 implying that 24% of the inefficiency of the fisher folks was caused by water weed and other unforeseen constraints. The study finally concluded that fisher folks fisher folk in the study area were technically efficient and their efficiency is influenced by fishing time and hired labour among others. The study therefore recommends that both natural and artificial coping strategies be adopted by fisher folks to improve on the technical efficiency of artisanal fish capture on water weed-infested lakes in the study area.

Keyword: Artisanal, Fishing, Water, Weed, Technical, Efficiency.

INTRODUCTION

Fishing is one of the oldest livelihood income-generating activities of man since the world was created (Christopher *et al.*, 2003). The history of fishing industry in Nigeria dates back to the pre-colonial era where basically small-scale fishing (artisanal) has been a major source of food for the inhabitants of coastal and riverine areas. It also provides employment and economic benefit to those engaged in artisanal fishery activity. The fish sector is a key contributor to fulfilling the population's nutritional requirements, accounting for about 50% of animal-source food protein (Subasinghe *et al.*, 2021). Fish production in Nigeria comes from three sources: artisanal (inland rivers, lakes, costal and brackish water), aquaculture (fish farm) and industrial fishing (Aminu *et al.*, 2022); though, the vast majority of the fish supply in most cases come from the artisanal sub-sector. Artisanal fisheries utilize open access resources in which the only human intervention is the harvesting of fish stocks. From the FAOSTAT (2021) report, Nigeria as a country is capable of produces 1,212,470 metric tonnes of fish and sea food annually. Fish typically plays an important role in improving and sustaining food security and nutritional security around the world, they are a vital and affordable source of food with high-quality protein (FAO, 2010). Fish is also a good source of sulphur and essential amino acids such as lysine, leucine, valine and arginine. It is therefore suitable for supplementing diets of high carbohydrates contents. It has high content of Polyunsaturated (Omega III) fatty acids, which are



important in lowering blood cholesterol level and high blood pressure. It has also been implicated to have decreased the risk of bowel cancer and reduces insulin resistance in skeletal muscles.

Artisanal, subsistence, or traditional fishing consists of various small-scale, low technology, fishing practices undertaken by individual fishermen (as opposed to commercial fishing); most of whom are usually of coastal household settlements. Artisanal inland fisheries in Nigeria does not only serve as an important alternative source of animal protein; it is also an important contributor to the economy, yielding an average gross domestic products (GDP) of 10.77% of the country economy (FAO, 2019). The inland artisanal fisheries accounted for over 85% of domestic fish production between 1991 and 2003 with a total fish production of 615, 507 metric tons in 2007 (Nwabeze and Erie, 2013). Artisanal fisheries serve as sources of nourishment, foreign exchange for the country, employment-creation, income-generation, while increase in fish production is required to meet up the dietary need of the ever-increasing population (Boro and Agbugba, 2022). Water weed (hyacinth), *E. crassipes*, is among the worst aquatic hyacinths affecting many parts of the world (Gichuki *et al.*, 2012). This is because it exhibits prolific growth and exhausts nutrients and oxygen in high volumes from water bodies thus harmfully affecting the surrounding environment. Its growth also causes complete blockage of channels making commercial and recreational activities very difficult. The plant is known to be robust and extremely hard to eliminate, since it is able to withstand severe conditions. For instance, during unfavorable conditions such as drought, the plant sinks into the bottom of the water and remains dormant until the conditions become conducive for growth (Ndimele, 2012).

However, Mujingni, (2012) opined that aquatic habitats have been under treat for several years from human activities such as alien invasive species of micro-organisms, plants and animals one of which is water hyacinth. Water hyacinth plant is indigenous to the amazon Basin of South America (Mujingni, 2012). Water hyacinth (*Eichhornia crassipes*) that invested Nigerian water ways almost one and the half decades ago belongs to the family *pontederiaceae* and sub-family *Lilolinaeaceae*. Aquatic hyacinth has been found to reduce the effectiveness of water bodies for fish production. Aquatic hyacinths can assimilate large quantities of nutrients from the water reducing their availability for planktonic algae. They also cause reduction in oxygen levels and present gaseous exchange with water resulting in adverse fish production. They have been found to interfere with navigation aesthetic value. Ogun Waterside Area has been gravely affected by the growth of water hyacinth over the past few decades. Economic activities in such as commercial fishing, transport, recreational activities have declined due to the invasion of the hyacinth. The growth of water hyacinth has posed a health risk to the people in the area because the mats are habitats for mosquitoes and snails which spread diseases. The coastline in Nigeria, and especially of the Ogun Waterside Area of Ogun State, is well-endowed with river networks, and a large expanse of exclusive ocean waters for commercial fishing.

Water hyacinth has posed serious problems on residence and users of the aquatic resources in the study area. Identification of the particular specie of the invading water hyacinth in the area has also made it a huge and costly task in the eradication of the parasitic plant. Water hyacinth causes a variety of problem when its mat-like proliferation covers the surface area of the water bodies; some of which include clogging of irrigation intakes; complicated hydropower and water supply systems; blockage of canals and rivers, thereby causing flooding; serving as a natural micro-habitat for the proliferation of aquatic disease vectors; increased evapo-transpiration through the leaf surface; difficulties in navigating the canoe across the fishing channels, thereby increasing the attendant cost of the fishing activities; as well as reduction of aquatic biodiversity (Harley, 2010). This research study was aimed at determining the fish catch level of fisher folks, and estimating the technical efficiency of artisanal fishing systems in the water weed (hyacinth) infested coastal areas of Ogun State, Nigeria.

METHODOLOGY

Study Area

The area chosen for the study was Ogun Waterside Local Government Area in Ijebu Division of Ogun State, Nigeria. Ogun State in general is a relatively homogeneous socio-cultural region



inhabited predominantly by Yoruba. The State was created in February 1978 with its capital located in Abeokuta and it is regarded as fast growing part of Nigeria. The state lies within the 6°N and 8°N and longitude 2°E and 5°E and is bounded in the west by republic of Benin. Ogun Waterside is one of the twenty (20) Local Government Areas (LGAs) in Ogun state and about 170 kilometers away from Abeokuta the state Capital. It covers an area of about 1000Km² (400sqm) with some towns and villages on fringes of the lagoon and the Atlantic Ocean. Although, some parts of the area are fairly urbanized, majority of the population still living in rural areas. Ogun Waterside is bordered by Ijebu East local government to the Northwest, Odigbo, Okitipupa and Ilaje local government areas of Ondo state to the Northeast, East and Southeast respectively, Epe local government of Lagos state to the West, and the Atlantic Ocean to the South. There are ten (10) major towns and about 100 sub-urban settlement and satellites villages in the local government. The major riverine suburb towns in Ogun Waterside, listing from the core rear, are Iwopin (home of the defunct Nigerian Pulp and Paper Company), Olojumeta, Oni, Alo, Ibiade, Lukogbe, Ita-Otu, Ita-Ogun, Agbure, Ilushin, Abigi, Efire, Ibu-Arijan, Aiyede, Ayila, Itebu-Elero, Ode-Omi, and Olokola.

Sampling Techniques

Simple random sampling technique was adopted for this research work. Five (5) communities was selected from the study area, namely; Makun-omi, Iwopin, Olojumeta, Oni and Abigi. The respondent was selected proportionate to size. A pilot survey was conducted to get the estimate of fisher folks within the study area. The resultant figures are given as: Makun-omi- (430), Iwopin (240), Olojumeta (120), Oni (52) and Abigi (36) fisher households.

The number of respondents from each community was estimated using the relation:

$$X_j = \frac{q_i}{Q_i} \times 10$$

where X_i = number of sampled communities

q_i = number of major communities

Q_i = total sum of major communities

i represents the referenced ward.

This led to 5 major coastal communities covered in the course of data collection.

$$H_i = \frac{s_i}{S_i} \times 120$$

where H_i = number of sampled households

s_i = number of households in the particular coastal community

S_i = total sum of households in the 5 coastal communities selected

i represents the referenced community.

Thus, 120 households were interviewed in this study. The distributions of the 120 households in the communities were as follows: Makun-omi (59), Iwopin (33), Olojumeta (16), Oni (7) and Abigi (5).

Method of Data Collection

Information were gathered through secondary and primary sources. Primary data were collected through personal interviews and sets of well-designed questionnaires which will be administered to collect information on the effect of water weed on the artisanal fish farming in the study area. Secondary data were obtained from relevant publications, journals, documented books and repositories.

Methods of Data Analysis

The data were analyzed using descriptive statistics, the Ordinary Least Square regression (OLS) regression model and Stochastic frontier production function.

Socio-economic characteristics of the fisher folks.

The socio-economic characteristics of the fisher folks in the study area as well as the coping strategies adopted by the fisher folks in the study area were analyzed using descriptive analysis.

Determinants of fish catch level of fisher folks

The fish catch level of fisher folks in the study area was analyzed using the ordinary least square (OLS) regression model, modeled thus:



$$Q = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, e)$$

Q = quantity of fish catch (kg)

X_1 = quantity of labour used on the artisanal fishing trips (man days)

X_2 = costs associated with the fishing trip (feeding, fueling, baits, etc) (Naira)

X_3 = fishing time per trip (hours)

X_4 = numbers of fishers per fishing trip

X_5 = fishing technology (1=use of mechanically powered/outboard engine canoe; 0 = otherwise)

X_6 = period of fishing (night =1, 0 = otherwise)

X_7 = intensity of water weed infestation (mass/per unit area)

X_8 = distance covered on the water channels during fishing activities (meters)

e = error term

Technical efficiency in artisanal fishing among the sampled fisher folks

Stochastic frontier production function was employed for the technical efficiency analysis.

The specified Cobb-Douglas production function is given as;

$$\ln Y_i = \beta_{0i} + \beta_1 \ln X_{1i} + \beta_2 \ln X_{2i} + \beta_3 \ln X_{3i} + \beta_4 \ln X_{4i} + \beta_5 \ln X_{5i} + V_i - U_i$$

where:

Y is fisher folks fish catch (kg);

X_1 = Hired labour (number)

X_2 = Household labour (number)

X_3 = fishing time per trip (hours)

X_4 = quantity of bait used (kg)

X_5 = Volume of fuel utilised in the fishing trip (litres)

U_i = representing the inefficiency aspect of the study.

V_i = Stochastic noise variable

The inefficiency model based on Battese and Coeli (1995) was specified as:

$$U_i = \delta_0 + \delta_1 Z_{1i} + \delta_2 Z_{2i} + \delta_3 Z_{3i} + \delta_4 Z_{4i} + \delta_5 Z_{5i} + \delta_6 Z_{6i} + \delta_7 Z_{7i}$$

Z_1 = age of fisher (years)

Z_2 = sex (male = 1, 0 otherwise)

Z_3 = dependency ratio (ratio of working to non-working members of the household)

Z_4 = water weed control strategies during fishing trips (manual control =1, 0 otherwise)

Z_5 = years of fisher's education

Z_6 = period of fishing (night =1, 0 = otherwise)

Z_7 = distance covered on the water channels during fishing activities (meters)

RESULTS AND DISCUSSION

Socio-economic Characteristics of Fisher Folks

Age of the respondents is an important factor that determines the level of participation in artisanal fish farming. Age is believed to influence the level of physical work and the willingness to take risk. Table 1 shows the distribution of respondents. In terms of age, evidence on table 1 shows that majority (39.2 percent) of the respondents in the study area have the age of their household head falling between 41-50 years, while 15% were with the age of 30 years and below. 21.7% of the respondents were found in the age bracket of 31-40 years, also 17.5% of respondents were found to have the age between 51-60 years and 6.7% of the respondents have above 60 years of age. Thus finding was in agreement with those Ojo (2004), who found that most of the fisher folks are in their economic active ages to undertake strenuous task associated to the fishing enterprise. It also agrees with the findings from Baiyewu (2020) that sampled fishers were within the workforce of the nation, that is, younger persons were less involved in fishing and that the fishers were ageing indicating that the production of fish from artisanal fisheries sector cannot be sustainable due to young adult non-involvement and no replacement for the older generation as they retire either through death or sickness from fishing.



Table 1: Distribution of Respondents based on Socio-economic Characteristics.

Variables	Frequency	Percentage (%)
Age		
30 years and below	18	15.0
31 -40 years	26	21.7
41 – 50 years	47	39.2
51 – 60 years	21	17.5
Above 60 years	8	6.7
Sex		
Male	88	73.3
Female	32	26.7
Marital Status		
Single	9	7.5
Married	109	90.8
Widowed	1	.8
Divorced	1	.8
Household size		
1 – 3	18	15.0
4 – 6	25	20.8
7 – 9	29	24.2
10 -12	33	27.5
Above 12	15	12.5
Level of education		
Primary education	48	40.0
Secondary education	58	48.3
Tertiary education	14	11.7
Religion		
Christianity	54	45.0
Islamic	64	53.3
Traditionalist	2	1.7
Fishing experience		
1 – 10 years	23	19.2
11 – 20 years	23	19.2
21 -30 years	36	30.0
31 – 40 years	22	18.3
Above 40 years	16	13.3
Full time capture		
Yes	75	62.5
No	45	37.5
Income Generation		
Yes	59	49.2
No	61	50.8
Total	120	100

Source: filed survey, 2023.

Table 1 shows that majority (73.3%) of the respondents are male while 26.7% were female, many of whom still use traps and nets to catch fish in most fishing communities in Nigeria. Majority (about 90.8%) of the respondents are married, effectively comparing with the findings of Raufu *et al.* (2009) who observed 81.3% of the fishermen were married. Mafimisebi *et al.* (2016) also positioned that married fishers were into fishing probably to be able to have access to a steady income source to meet their obligations. Evidence from Table 1 further showed a mean household size of 7 members in the study area, with many of the respondents (about 28%) having household size ranging from 10-12 persons. The finding supports the preponderance of large family sizes among the poor in rural areas



(Kumolu-Johnson and Ndimele, 2010), and especially in coastal areas. Furthermore, Table 1 revealed that majority the respondents (48.8%) have secondary education. 40.0% of the respondents have primary education and 11.7% of the respondents have tertiary education.

Experience is expected to have a significant positive impact on the managerial ability of the fisher folks. Table 1 revealed that majority of the respondents (30.0%) had well over 20 years of fishing experience. On-the-job experience is seen as a form of social asset for productivity in line with the Schumpeterian theory of economic development, which suggests that technical efficiency is influenced by technical know how, vis-a-vis other socio-economic factors that producers (artisanal fisher folks) engage in taking business decisions (Kalirajan, 1990). Accordingly, more years of fishing experience enhances the fish catch level of fisher folks, since performance rating and fortune increase with the level of experience (Olomola, 1991). This implies that the more the number of years spent in fishing activities or business, the better the fishing methods and techniques that will be employed to make more income and increase profit. This is also agrees with the findings of Adebisi (2008), who observed that fishing experience is important in determining the profit levels of artisanal fisher folks. Majority of the fisher folks (62.5%) were engaged in full-time artisanal fishing while 37.5% had other types of livelihood engagements; suggesting that the proceeds from artisanal fishing activities alone were not sufficient to meet fisher households' financial obligations. Thus, as is evident on Table 1, majority (50.8%) of the fisher folks generates income from other sources while 49.2% depends solemnly on fishing activities as their sole income source.

Fish Catch Level of Fisher Folks

The results revealed that the linear functional form was the best model that fit this study, based on the statistical parameters. The R-square value (0.533) indicated that 53.3% of the variation in the dependent variable was explained by the variables included in the linear regression model. Result from Table 2 revealed that the fishing time per trip ($p < 0.01$) positively and significantly affected the level of fish catch; implying that the more the time devoted to fishing, the more the fish catch level. So also was the number of fisher folks per trip ($p < 0.01$); underscoring the relevance of fishing skills specialisation among the fishing team on board, and efficient resource utilization. Also, appropriateness of the scheduled fishing time ($p < 0.01$) significantly enhanced effectiveness of fishing activities, thus increasing the level of catch from the fishing trips.

Table 2: Factors Affecting Fish Catch Level among the Surveyed Fisher Folks

Variables	Coefficients	t - ratio
(constant)		
Cost of feeding	0.064	0.665
Fishing time per trip	0.295***	2.839
Numbers of fisher folks per trip	0.326*	1.855
Fishing technology	-0.014	-0.130
Time of fishing activity	0.255***	2.624
Intensity of water weed infestation	-0.040	-0.423
Distance covered on water	-0.091	-0.937

Source: filed survey, 2023

Legend (* significant at 10%, *** significant at 1%)

Technical Efficiency Estimates and their Determinants among Surveyed Fisher Folks

Table 2 shows the result of the stochastic frontier of the fisher folks, the estimated parameters and the relevant statistical test results obtained from the analysis. There was evidence of technical efficiency using the likelihood ratio test. The gamma coefficient was 0.77 and statistically different from zero ($p < 0.01$), suggesting that about 77% of variation in fish cash output was as a result of technical inefficiency effects; the unexplained portion being attributed to factors beyond the control of the fisher folks. The efficiency model also shows the effect of hired labour (0.7529; $p < 0.01$) to be significant, and positively affecting the technical efficiency of the fisher folks.



Table 3: Maximum Likelihood Estimates (MLE) of the Stochastic Frontier Production Model of the Fisher Folks

Variables	Parameters	OLS Coefficient	MLE coefficient
Production efficiency			
Constant	X ₀	2.8989 (6.7614)	3.0395 (5.3582)***
Hired labour	X ₁	0.7301 (3.9897)	0.7529 (4.0095)***
Household labour	X ₂	0.1620 (1.0290)	-0.0683 (-0.3884)
Fishing time per trip	X ₃	0.5206 (1.9759)	0.6622 (2.3810)**
Quantity of bait	X ₄	0.09518 (0.7927)	-0.0834 (0.7093)
Volume of fuel	X ₅	-0.0561 (-0.3190)	-0.0511 (0.2886)
Inefficiency variables			
Constant	Z ₀		0.9164 (0.6996)
Age of the fisher folks	Z ₁		-1.9421 (2.2493)**
Sex	Z ₂		0.9662 (1.0067)
Household size	Z ₃		-0.3699 (0.5110)
Water weed control strategies	Z ₄		4.1511 (4.1490)***
Years of education	Z ₅		-0.0062 (0.0062)
Time fishing activity took place	Z ₆		0.0210 (0.0209)
Distance covered during fishing activities	Z ₇		1.6833 (3.1598)***
Sigma squared		1.2415	1.6583*
Gamma			0.7570
Log likelihood		-180.1761	-173.1521
LR test			14.0479

Source: filed survey, 2023

Legend (* significant at 10%, ** significant at 5%, *** significant at 1%)

The result in Table 3 showed that the fishing time per trip was significant ($p < 0.05$); implying that the more time committed into artisanal fishing by the fisher folk, the more the yield. The inefficiency component of the stochastic frontier production function showed that age (-1.0421) of the fisher folk was negatively significant ($p < 0.05$); suggesting fishing inefficiency with increasing age. Water weed control strategies (4.1511; $p < 0.01$) was positively significant; establishing the effectiveness of simple manual control for water weed at a micro level of natural fish harvesting. Distance covered on the fishing channels (1.6833; $p < 0.01$) was positively significant; signifying larger fish catch level with wider spatial coverage on the water surface, amidst the resistance posed to effective channel/route navigation by water weed infestation.

Efficiency Level of Artisanal Fishing

The mean efficiency level of artisanal fishing systems in the study area was 76%; which compares favourably with the findings of Squires (2003) and Lokina (2004), conducted among artisanal trawl fisher folks in Victoria and Malaysia. The result from Table 4 indicates that about 36.7% of fishermen are operating at 80% or more technical efficiency levels. Furthermore, about 71.7% of fishers are operating at a technical efficiency level of 70% or more. The result also reveal that about 95.1% of the fishers operate at a technical efficiency level below 50%.



Table 4: Distribution of Respondents based on Technical Efficiency Level in Artisanal Fishing

Technical efficiency class	Frequency	Percentage (%)
0.30 and below	5	4.2
0.31 – 0.40	1	0.8
0.51 – 0.60	8	6.7
0.61 – 0.70	20	16.7
0.71 – 0.80	42	35.0
0.81 – 0.90	44	36.7
Total	120	100
Mean	0.76	
Maximum	0.8903	
Minimum	0.0422	

Source: filed survey, 2023

Coping Strategies of Fisher Folks in the Study Area

In order to remain in the business of fishing artisanal farmers in the coastal areas of Ogun State engaged different strategies to combat the menace of water weed infestation on fishing channels/routes to effectively cope with the challenges.

Table 5: Distribution of Fishers' based on Coping Strategies

Coping strategies	Frequency	Percentage (%)
Natural control strategies		
• Dependence on wave direction	41	34.26
• Short cycle/duration fishing strategy	35	29.17
Artificial control strategies		
• Weed clearing	32	26.67
	12	10.00
• Herbicidal treatment of weed		
Total	120	100

Source: filed survey, 2023

As shown on Table 5, fisher folks' coping strategies were basically of two major types, namely; *natural control strategies*, including total dependence on wave effect and direction, and the short duration/cycle fishing strategy; as well as *artificial control strategies*, which include constant weed clearing and herbicidal treatment of weeds along the fishing channels/routes. The percentage of the fisher folks that adopted natural control strategies was 63.43%, while artificial control strategies accounts for 36.67%.

CONCLUSION AND RECOMMENDATIONS

The study examined the technical efficiency of fisher folks in water weed infested communities in Ogun Waterside coastal area of Ogun State. A total of one hundred and twenty (120) respondents were randomly selected for the study and data collected using structured questionnaire. Specifically, the study estimated the technical efficiency of the artisanal fishing systems; examined the level of fish catch; as well as the coping strategies adopted by the fisher folks in the study area. the stochastic frontier models. With a mean efficiency level of 76%, artisanal fisher folks in the study area were technically efficient, with an observed inefficiency level of merely 24% operating away from the frontier; attributed to the constraints posed by water weed infestation, and a host of other unexplained factors not captured in the model.

The study recommended increased fishing time; night fishing schedule; adoption of natural weed control strategies and less dependence on artificial methods that may be detrimental on the fishing environment and the captured fish to achieve higher fish catch level and enhanced technical efficiency of the artisanal fishing systems.



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