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Fishing in oil spillages zone: A case study of Burutu Local Government Area of Delta State, Nigeria

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The study considered fishing in oil spillages zone with special reference to Burutu local Government area of Delta State, Nigeria. The study area was particularly chosen for this study because of its prime place in artisanal fishing and oil exploitation activities. Data collection was through well structured questionnaire administered to 120 artisanal fishermen selected through random sampling technique. The method of analysis used were descriptive statistics, costs and return analysis and production function analysis using ordinary least square (OLS) criterion to estimate the parameters of the production function. The software used was SPSS 9.0. Results showed that majority of the fishermen were ageing. The result also showed that we have more male (61%) artisanal fishermen than females (39%) artisanal fishermen in the study area. Again, the results further revealed that there was high level of illiteracy as about 63% of total respondents did not attend primary school, while 28, 8 and 1% had attended primary, secondary and tertiary institution, respectively. The result of the analysis showed that the mean household size was 6 persons and mean annual farm income was about 32,883.33. The results of the regression analysis showed that the independent variables, labor, fishing experience, income level of fishermen, cost of fishing nets/bait were positive and significant at 5% level of probability except age of fishermen that was negative and significance at 5% probability level and all the factors were related to output. Artisanal fishing was not profitable in the study area with gross margin and net returns of 45,550 and 34,350 per annum respectively. The result showed that the surveyed fishermen were producing at a diminishing return to scale.

Key words: Fishing, fish production function, costs and returns analysis, Delta State, Nigeria.

INTRODUCTION

Delta State which is one of the nine (9) States in the Niger Delta region of Nigeria is blessed with abundant natural water resources. According to Ita and Sado (1987), Nigeria has an estimated inland water mass of about 12.5 million hectares capable of producing about 512,000 metric tons of fish annually. Nigeria is blessed with a long coastline, extensive brackish and mangrove swamps supporting a wide range of fish species, such as tilapia, thread fins, moon fish, sea cat fish, snappers, cray fish, sea turtle, lobsters, sardines and razor fish West African Croakers, Bonga fish, shark, shrimps, bivalves, periwinkle and many others. Available statistics showed that Nigeria's inland water bodies are producing less than 13% of their estimated fishery potential (Sule et al., 2002). The effect of oil resource extraction on the environment of the Niger Delta has been very glaring in

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terms of its negative effect on the region. Eteng (1997) stated that oil exploration and exploitation has over the last four decades impacted disastrously on the socio-physical environment of the Niger bearing communities, massively threatening the subsistent peasant economy and the environment and hence, the entire livelihood and basic survival of the people. Suffice it to say that, while oil exploitation has caused negative socio-economic and environmental problems in the Niger Delta, it has contributed enormously to the country's economic growth since it was discovered in commercial quantities in 1956 at Oloibiri located in Bayelsa State. NEST (1991) reported that oil spillages in the country's oil producing riverine areas were increasingly reducingsome of the Nigerian water bodies to veritable sewage depots for toxic chemicals which either kill or contaminate fish and other aquatic life. It was further reported that at 1981, about six million tones of petroleum was discharged into off-shore water annually. Out of this amount, about 600,000 tones resulted from sudden accidental spillages while the constant dripping of petroleum products from activities in all sphere of the oil industry accounted for the remainder. Following this development, fisheries occurrence in Nigeria's wetlands could be limited by activities which pollute water and the greatest threat in this regard is oil pollution resulting from crude oil exploitation (NEST, 1991). The exploration and exploitation has impact on the environment through frequent spills, pipe explosions, pollution, sabotage, gas flaring and effluent emission. Other sources of oil include transportation and marketing, effluent water from oil refineries, lubrication oils and other wastes in the form of sludge, bitumen, slops and oil sand/sediment present in large amount within oil flow stations, storage terminals and tanks (Nwilo et al., 2000; Ogri, 2001).

Nwilo and Badejo (2001) posited that where there is oil spill, it covers the surface of the water. This reduces oxygen exchange thereby, causing death of fishes because the oil coats the gills of the fishes preventing them from inhaling oxygen. In addition, oil spills endangers fish hatcheries in coastal waters, contaminates the flesh of commercially valuable fish and oil slicks prevent sunlight from reaching deeper levels of water where coral thrive, thus, limiting food production of plants (photosynthesis).

Further reports on the effect of oil exploration and exploitation activities on aquatic lives showed that an oil spill can directly damage the boats and gear used for catching or cultivating marine species. Floating equipment and fixed traps extending above the sea surface are more likely to become contaminated by floating oil. In a study, on the effect of hydrocarbon pollution on water in the Niger Delta, Ukpong and Akpabio (2003) reported that hydrocarbon pollution causes great damage to spawning grounds; aquatic vegetation having economic values had degenerated in productivity while fish and crustaceans become carriers of toxic hydrocarbon substances along the food chain and fishing as an economic activity is lost or threatened, exacerbating hunger and poverty in fishing communities. Anderson et al. (1974) reported cases of oil spillage in Sangana, Koluama, Akassa and Brass communities in Bayelsa State, in which tremendous damage was done to fisheries in the wild. Oil spillage has a list of deleterious effect on the biota particularly, the fish which includes fin erosion, respiratory difficulties and mortality (Ziskowki and Murchelano, 1995). Keke (1989) observed massive fish deaths at Bayelsa State because of the incessant oil pollution in the coastal waters.

In the Gulf region, TED case studies (1996) asserted that the fishing industry was deleteriously affected by the oil spillage into the Gulf, which was important due to the fact that it is one of the most vibrant productive activities in the region after the production of oil. As an example of the vibrancy of this industry, prior to the Iraqi Invasion of Kuwait the Gulf yielded harvests of marine life up to 120,000 tons of fish a year; after the oil spillage, these numbers significantly dropped. As a matter of fact, the incidence of oil spillage often results in total extermination of fish, leading to reduced fish output. Such losses adversely affected fishermen active economic livelihood. This has a backward integration in the national economic development. Although, the impacts of oil pollution in the Niger Delta are enormous, the objective of this study is to examine fishing in oil spillage zone and its effects on total fish catch and profitability in the study area.

MATERIALS AND METHODS

The study area

Burutu Local Government Area (LGA) which is a home to several oil producing communities is the area of study; and it is a leading source of on-shore crude oil production in Delta State. Delta State is located between Latitudes 4°N and 6°N and Longitudes 5°E and 7°E. Bayelsa, Anambra, Edo and Bight of Benin bound the State on the Southeast, Northeast, North, Northwest and South respectively. It has a land area of 17,011 km^2 and a population of 4, 0981,391 (Federal Republic of Nigeria Official Gazette, 2007).The topography of the area is low, lying with a Coastline of about 160 km on the River Niger with rivulets and streams, criss-crossed with creeks through which the River Niger empties into the Atlantic Ocean, thus, forming the larger part of the Niger Delta area.

The State has a tropical climate marked by two distinct seasons, the dry season lasting November to March and rainy season lasting April to October. Average rainfall ranges from about 267 in Coastal areas to 191cm in the North of the State. It has a minimum temperature of 28°C and a maximum of 34°C. Inhabitants of communities are mainly fishermen.

The area is endowed with mangrove swamps, rivers, creeks and flood plains which offer great opportunities for fishing. The communities or ethnic groups are Ekeremo, Sokebolou, Yeye, Ogunlagha, Forcados, Yonkri, Odimodi, Ezon-Burutu and Ojobo. The fishing season spans seven months from the end of one rainy season (usually in October) to the beginning of another rainy season (most commonly in April).

The bulk of oil exploration and exploitation activities both on-shore and off-shore is concentrated in the area, and the fact that

fishing is the major occupation besides farming of the people. Cases of incessant oil spillages have been reported there.

Sampling and data collection

Ten (10) major fishing communities were purposely selected from the Local Government areas which were affected by oil spills in the study area. Twelve fishermen were randomly selected from them to make a total sample size of 120 fishermen used for the study. Primary data were collected using a set of pre-tested structured questionnaire administered through the interview schedule method during the last fishing season. Information collected included age, years of fishing experience of the fishermen, their household size, and level of education and level of income. Other data include number of canoes, fishing nets together with their acquisition costs, quantities of fish caught, and quantities sold together with their sales revenues as well as, man days of labor utilized during the season.

Analytical framework

Koutsoyiannis (2003) observed that regression analysis is one most commonly used techniques in analyzing dependence among variables. According to Eboh (1998) and Kedison (2003), the aim of regression analysis is to establish and prove how one variable is related to another variable. It is based on the functional relationship between the variables. They noted that the key relationship in a regression is the regression equation which contains the regression parameters whose values are to be estimated using the data. The parameters measure the relationship between dependant and each of the explanatory (independent) variables. The X (s) are fixed or predetermined outside the model and are called independent variables. The Y (s) are to be determined within the model by the X (s) hence, they are called dependent variables because their value depend on the values of the X (s).

The way the Xs are transformed to Y is the functional relationship, the error term 'e' is introduced into the function to capture the effects of omitted variables, erratic nature of human behavior, errors of measurement, and the effects of aggregation (Awoke, 2001). Mbanasor and Obioha (2003) pointed out that, there are many functional forms that could be used to describe production relationship, but in practice the commonly used forms include linear, quadratic, semi-log and Cobb- Douglas functional forms. Depending on the number of independent variables used to estimate the dependent variable, regression analysis is divided into simple and multiple regression analysis. Multiple regression analysis is an econometric method used to study relationship involving more than two variables. The variation in the dependent variable is explained by more than one independent variable. Gujarati (2003) and Gbigbi (2008) opined that most regression models are multiple regression models because few economic phenomena can be explained by only one variable. The ordinary least squares (OLS) is one of the most commonly employed techniques in the multiple regression analysis, especially, in constructing the production models as it gives the best fit (Subair, 2009). The ordinary least squares (OLS) are based on certain assumptions, namely, the distribution of the random variable, and the relationship between the explanatory variables themselves (Koutsoyiannis, 2003).

Model specification and estimation

In order to estimate fish production in oil spillages zone, the following econometric models relating to quantity of fish caught (Kg), with the under listed explanatory variables were specified and subsequently estimated. The implicit form of equation for this study is specified as follows:

$$Q = f(X_1, X_2, X_3, X_4 \ldots\ldots\ldots X_{n,e}) \quad (1)$$

Where Q = Quantity of fish caught (kg), X_1 = Labor input in man days, X_2 = Fishing experience (years), X_3 = Income level of fishermen (₦), X_4 = Age of fishermen (years), X_5 = Cost of fishing nets / baits incurred by fishermen (₦), e = Error term (which was assumed to be normally distributed with zero mean and constant variance).

Three functional forms of the equation, linear, Semi-log and double log were tried and the one with the best fit was chosen as the lead equation. The criteria for selecting the lead equation were based on the value of "Coefficient of determination" (R^2), the significance of the Coefficients as well as the a priori expectation (Olayemi, 1998). The Cobb-Douglas functional form (Linearized in Logarithm) fitted the observed data very well. Thus, the explicit format of the specified fishermen production function is presented:

$$\text{Log } Q = b_0 + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4 + b_5 \log X_5 + e \quad (2)$$

Where b_0 = Intercept, b_1 - b_6 = regression coefficients and X_1 = X_5 = explanatory variables.

Cost and returns analysis

This analytical technique is otherwise referred to as enterprise budget. It provides information on the financial and physical transaction or plan for the farm enterprise for a given production period. Costs and returns analysis is often composed of two components, the costs or expenditure component and the returns, revenue or income components. According to Olukosi and Erhabor (1988), the costs component is sub-divided further into variable costs and fixed costs.

Costs

Variable cost (VC): This cost changes with the variation in the output level. All costs are associated with the variable inputs such as labor, fuel and lubricant boat repair, net repair fish processing, transportation as well as service and maintenance charges.

Fixed cost (FC): This involves depreciation of the set of tools and equipments used. Straight line method was used and the useful life was estimated using the average life span (year) obtained during the study. Therefore, the fixed cost involves cost of fishing canoe, paddle, fishing net and other implements which do not change at least in the short run. The total cost of production, however, is the total sum of the variable costs and fixed costs.

Income

Gross revenue (GR): This component shows the outputs or returns both in physical terms and the corresponding monetary values or fish revenue.

Gross margin (GM): This is the difference between the gross revenue and variable costs. The formula used for this calculation is given as:

Table 1. Distribution of socio-economic characteristics of respondents (n = 120).

Parameter	Frequency	Mean
Age of fishermen		
27-35	4 (3.3)	
36-44	13 (10.8)	
45-53	62 (51.7)	51 years
54-62	33 (27.5)	
63-71	8 (6.7)	
Gender of fishermen		
Male	73 (60.8)	
Female	47 (39.2)	
Educational level		
No primary education	75 (62.5)	
Primary education	34 (28.3)	1.0
Secondary education	10 (8.3)	
Tertiary education	1 (0.8)	
Household size		
2-5	68 (56.7)	
6-9	41 (34.2)	6 persons
10-13	10 (8.3)	
14-17	1 (0.8)	
Annual farm income		
19,000 – 34,000	81 (67.5)	
35,000 – 50, 000	29 (24. 2)	32,883.33
51,000 – 56, 000	8 (6.7)	
57,000 – 82,000	2 (1.7)	

Figure in parenthesis are percentages (Field survey, 2009).

$$G.M = \sum_{i=1}^{n} Piqi - \sum_{i=1}^{m} CjXj$$

Where; GM = Gross margin, Pi = Market unit price of output I, qi = Quantity of output I, Cj = Unit cost of the variable input j, Xj = Quantity of variable input j, m = Number of input used and n = Number of output produced

Net returns / profit (NR): This is the difference between gross revenue and total cost. The formula used for this calculation is given as:

NR = TR-TC

Where; NR= Net return (in Naira), TR= Total revenue (Naira) and TC= Total cost (Naira)

The use of costs and returns technique as an analytical tool is often criticized on the ground that it does not provide satisfactory information on the relative importance of the various inputs in contributing to outputs. Besides, the use of data obtained can only be applied in the area from which the data were generated since it uses only money as a unit of measurement. However, its ease of computation and simplicity appropriate once the data have been generated. This method was used by Olagunju et al. (2007) to analyze the economic viability of cat fish production in Oyo State, Nigeria and it was found to be suitable. Other researchers stressed that the method is used extensively to measure profitability of farm enterprise (Gbigbi, 2008; Ogundari and Ojo, 2009; Ojo and Ehinmowo, 2010).

RESULTS AND DISCUSSION

Socio-economic analysis

The socio-economic characteristics of the artisanal fishermen surveyed are presented in Table 1. The results indicate that 86% of the fishermen had ages ranging between 45 to 71 years with an average age of 51 years. With such an aged agricultural work force, agricultural productivity is bound to be low. As the fishermen grow older, their performance drops and so does the general fish catch levels. These results are, however, in agreement with the findings of Akwiwu (2002), Olomola (1991) and Mabawonku et al. (1984). This development could be attributed to youth's abandonment of fishing

Table 2. Estimates of input elasticities and returns to scale for artisanal fishermen.

Production inputs	Elasticity estimated	t –values
Labor input in Man days	0.124	5.90
Fishing experience in years	0.101	2.53
Income level of fishermen	0.137	4.28
Age of fishermen	-0.142	2.73
Fishing nets / baits	0.214	6.69
Return to scale	0.576	-

Field survey (2009).

work for highly paying oil company seismic jobs and white-collar jobs. Table 1 also indicates that 60.8% of the fishermen in the study area were males, while the females were 39.2% indicating that more males are involved in artisanal fishing than female. The result might be attributed to high energy, labor intensive demand of fishing which female fisher folks could not give. This result is also in agreement with the traditional gender pattern of fishing (Williams and Awoyomi, 1998).

A major proportion of the artisanal fishermen did not attend primary school (62.5%), while 28.3% of them had primary education. On the whole, only 9.1% of the respondents have secondary school and above. This is an indication that the illiteracy rate is high in rural communities.

This finding is consistent with the result by Forde (1994) that the low levels of education of the artisanal fishermen were some of the constraints to their fishing catching levels and indeed their development. However, a higher level of education attainment many discourage some people from participating actively in artisanal fishing operators.

A relative household size was found in the study with a mean size of 6 persons per household. About 34% of thehouseholds have a family size that range between 6 to 9 persons despite the relative family size of 6 persons per household; it is plaque with rural-urban migration of able-bodies young men and women.

This could be attributed to the fact that a reduced family size that is prevalent in the oil producing areas is an indication of non-availability of enough family labor for the fishing operations. In fact, the intensity of agricultural production has been found to have a direct relation to household size.

The level of income realized from fishing by the respondents reveals that fishing income is very low. This is not unexpected given the rate of incessant oil spills that have destroyed aquatic life and traditional fishing grounds. Annual farm income ranged between ₦19, 000 to N82000, though, about 92% of the fishermen actually earned income of between ₦19, 000 and N50, 000 from fishing activities. The average fishing income was ₦32, 883.33. This findings supports that of Inoni and Oyaide (2007); NEST (1991) and Awobajo (1993) that the low level of fish income may be due to oil spillage.

Regression result

Results of the fish production function are given as:

$$\text{Log } Q = 2.306\ (0.047) + 0.124*\log X_1\ (0.021) + 0.101*\log X_2\ (0.040) + 0.137*\log X_3\ (0.032) - 0.142*\log X_4\ (0.52) + 0.214*\log X_5\ (0.032) \quad (5)$$

The figures in parenthesis are the standard errors; the coefficient asterisk (* are significant at 5% probability level; R- square = 0.839 and F- ratio = 111.68 (significant at 5% level).

The regression results as indicated by the co-efficient of multiple determination (R^2 = 0.839) showed that the combined effects of the identified production resources explained 84% of the total variation on fish caught. Other factors not reflected in the model might have combined with the stochastic term to account for the remaining 16% variation in output of fish caught not explained by the combined effects of the stated resources. The F statistics indicated that the model was highly significant at the 5% level. The t-test of significance for the independent variables were positive except the age of the fishermen that was negative and significant at 5% level of probability indicating that the production factors were related to output for artisanal fishermen in a manner consistent with a prior expectation. This implies that each of these variables are increased. While the negative coefficient of age shows that as fishermen become ageing, fish output decreases, reflecting the mean age of 51 years obtained from the analysis. This implies that the fishermen are relatively old; hence, they lack vigor to accomplish the task associated with fishing that depends heavily on human labor. This confirmed with the reports by Ojo (2000). The coefficients or b-values; 0.124 for b_1; 0.101 for b_2; 0.137 for b_3; 0.142 for b_4 and 0.214 for b_5 indicated that one percent increase in labor, fishing experience, income level of fishermen, age of fishermen and fishing nets/baits would bring about 12, 10, 14, 14 and 21% increase in fish caught respectively. The results of the estimated model indicate that the b-valves for b_1, b_2, b_3, b_4 and b_5 added together resulted to 0.576 (Table 2).

Table 3. Average costs and returns per Artisanal fisherman in Burutu L.G.A.

Items /operations	Total value (₦)
Variable cost (₦)	
Labor	30,750
Fuel and Lubricant	3000
Boat repair	2600
Net repair	1800
Fish processing	4500
Transportation	3800
Miscellaneous	4000
Total variable cost	50,450
Fixed cost	
Fishing canoe	8,000
Fishing paddle	700
Fish Net	2500
Total fixed cost	11,200
Total cost	61,650
Output revenue	
Fish catch (kg)	800
Price (N/kg)	120
Gross return	96,000.00
Gross margin	45,550.00
Net fishing income	34,350.00

Field survey (2009).

This is less than unity implying that the survey fishermen were producing at a decreasing or diminishing return to scale. This means that a unit increase in all the production resources put together would bring about less than unit increase in output of fish caught. Hence, it is advisable that the production units should maintain the level of input utilization at this stage as this will ensure maximum fish output from a given level of input ceteris paribus.

Analysis of cost and returns

Analysis of cost: The costs concept can be viewed from many perspectives. The incurred cost items were grouped as either variable or fixed costs. The variable cost items considered included expenses on labor, fuel lubricant, boat repair, net repair, fish processing and transportation. The fixed cost items were depreciation on equipment used such as fishing canoe fishing paddle and fishing net. Straight-line depreciation method was used. The average cost composition per harvest for fish caught is presented in Table 3. It could be noticed that the variable cost made up the bulk of the total cost of production.

This high level of the variable cost shows the flexibility of the business. According to Table 3, the labor cost accounted for about 61% of the variable costs for the artisanal fishermen. This is followed by expenditure on fish processing.

Gross return: The gross return that accrued to individual fish farmer during the survey year was calculated by multiplying their respective fish output with the market price. On the average, the selling price was N120 per kg. Table 3 shows the average fish caught and revenue per harvest. The revenue from the sales of fish caught was ₦96,000.00. The study reveals that average gross revenue of ₦96, 000 per harvest was realized by the artisanal fishermen.

Gross margin and net returns: The gross margin for each artisanal fisherman was calculated as the difference between the gross revenue and variable costs. The average gross margin per harvest by artisanal fishermen was ₦45, 550. The net return is the difference between the gross revenue and total costs. The average net returns on artisanal fisherman per harvest was N34, 350. The result of the study revealed that artisanal fishermen in the oil producing areas incurred higher costs of production and poor fish harvest presumably as a result of oil exploitation activities leading to lower profit for fishing activities in the study area.

RECOMMENDATION AND CONCLUSION

Based on the findings of the study, it can be concluded that majority of the artisanal fishermen in the study area were ageing. Majority of the people are males with household size of 6 to 9 persons. The result shows that the average income earned by artisanal fishermen was N34, 350.00. The study revealed that oil spillage has presumably had a negative impact on fishing activities leading to reduced agricultural output, poor harvest and low income level among the artisanal fishermen. These have led to calls for resource control by oil producing areas in the country. The result further revealed that artisanal fishermen in the study area incurred higher cost of production leading to lower profit and poverty.

Based on the findings of the study, the following recommendations are made:

1. That the impact assessment of oil exploration and exploitation on fishing be carried out,
2. The petroleum industry should work closely with government agencies, Universities and research centres so as to reduce the frequency and impact of oil spills.

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