

Economic Analysis of Industrial Shrimp Fishery in Nigeria

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Abstract: The study assessed the yield and profitability of Industrial Shrimp Fishery in Nigeria. The study was carried out between January 2002 and December 2003 using data obtained from shrimp investors and government administrators in the Federal Department of Fisheries (FDF) in Lagos and Abuja and the Federal Inland Revenue Service (FIRS). Structured questionnaires were administered for the collection of primary data from companies licensed to shrimp in Nigeria. Out of a total of 32 companies with 216 vessels licensed to shrimp in 2001, 17 companies (53%) owning 139 vessels were randomly selected. Secondary data were obtained from FDF and FIRS. Maximum Sustainable Yield (MSY) was estimated using the Fox Model. Net Present Value (NPV) and Benefit-Cost-Ratio (BCR) were used to determine the profitability index. On average, an estimated profit per industrial vessel was N 9,843,265.00 per annum and the economic evaluation of the industry showed a BCR of 1.2 with a corresponding NPV of N 4,483,870.00. Average landing per vessel was 44,027.69 kg. Estimation of maximum sustainable yield revealed that MSY was at 12,191 kg per annum per vessel and the corresponding effort was 89 vessels. This study revealed that shrimp operations by industrial vessels in Nigeria are a highly profitable venture but there is also a high level of overfishing, therefore the government needs to take serious measures to reduce fishing operations in order to sustain the shrimp industry in Nigeria.

Key words: Economic evaluation, profitability, maximum sustainable yield, industrial shrimp

INTRODUCTION

The Nigerian shrimp resource: Tropical Penaeid shrimps are traditionally exploited in Nigeria by artisanal fishermen and industrially by specialized vessels i.e., bottom trawlers.

Industrial shrimping in Nigeria is operated on the continental shelf from 5 nautical miles. Vessels are licensed in accordance with the provisions of Fisheries Law and Regulations of Nigeria. Presently there are over 36 companies and owing about 271 Nigerian flagged vessels licensed to shrimp within the territorial waters of Nigeria.

The shrimp fishery in Nigeria is dominated by the Penaeidae shrimps. The notable specie caught in the coastal area of Nigeria is the *Penaeus (Farfantepenaeus) notalis* (Perez-Farfante, 1967) also known as the pink shrimp (FAO, 1985). *Penaeid* shrimp resources are concentrated in the Niger-Delta due to the broad continental shelf and the various outlets to the sea that allow movement of juvenile shrimp between the sea and the brackish waters favorable for its life cycle. The marine environment off the Niger Delta comes strongly under the influence of the Inter Tropical Continuity Zone (ITCZ) and its associated trade winds. The annual shift of the ITCZ brings heavy rain to the Delta area between April

and October. The resulting heavy load of rich organic debris brought down by various rivers on the delta supports rich shrimp resources.

The industrial shrimp fishery has attracted a large number of expatriates and the fishery is energy intensive, require frequently considerable amounts of imported inputs. The industry generates substantial amounts of foreign exchange earnings but often a considerable share of profits and incomes derived from these fisheries is, alike to the product itself, i.e., transferred to industrialized countries. The outstanding benefits are their contribution to foreign exchange earnings.

Objective of the study: The main objective of economic evaluation in this study is the employment of economic principles for resource use assessment in order to estimate the benefits that accrue to the investors and invariably the society.

Cost structure and profitability in commercial fishing operations: The Nigerian industrial shrimp trawl fishery is presently concentrated within her inshore waters (Fig. 1). The supply of shrimp from a trawl fleet is a function of environmental factors that affect the fertility of the ocean and the economic factors that determine the effort man will expend in harvesting from the ocean. If all other

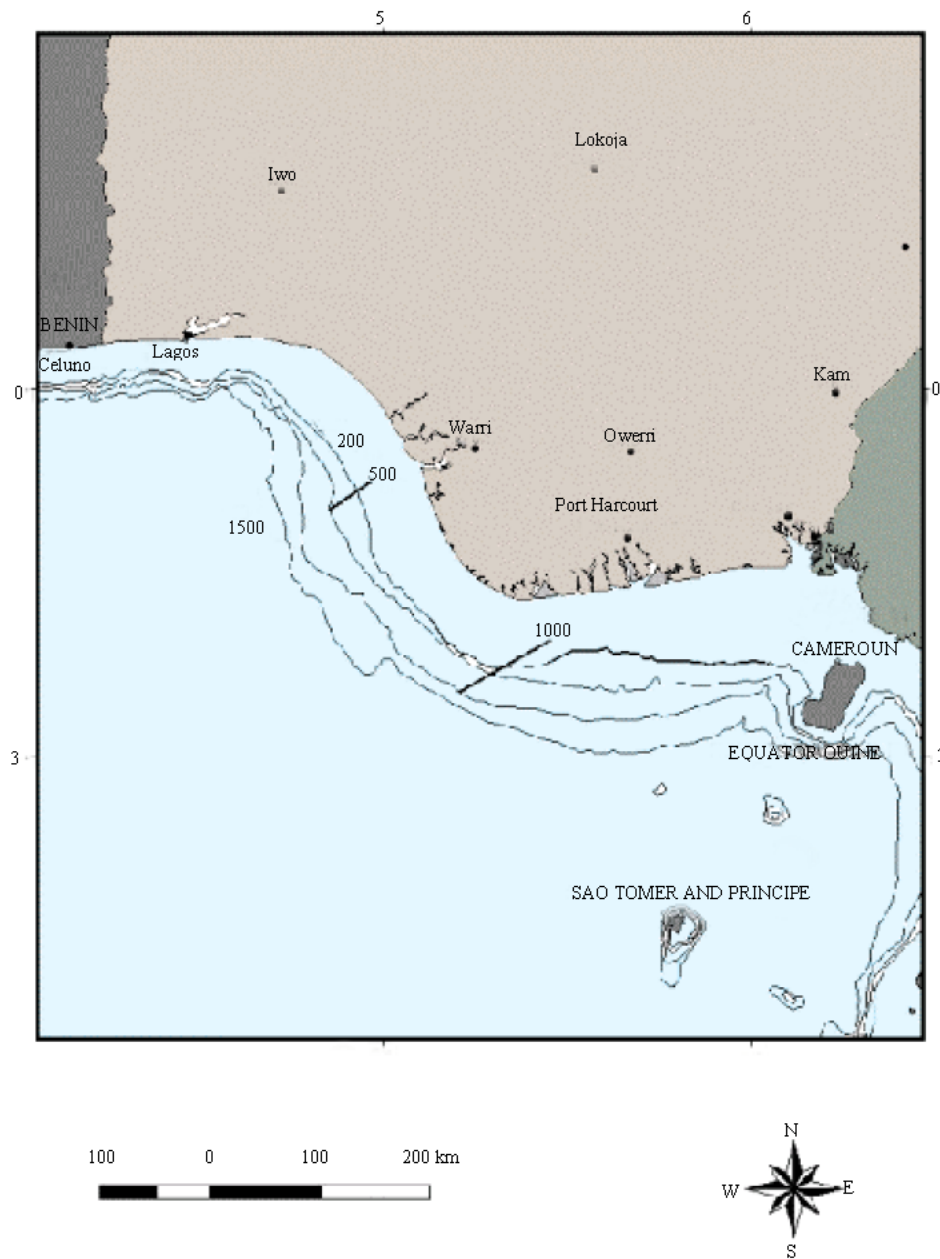


Fig. 1: Nigeria's coastal area

factors, such as growth rate and instantaneous coefficient of natural mortality as well as environmental factors among others remain constant, the supply of fish will be a factor of economic consideration.

The goal of private investment decision is that costs and revenues from sales must be such that there will be profit. The objective of the entrepreneur will therefore be to harvest and sell the most fish possible at the lowest possible cost. Norton (1968) identified three cost

categories, namely Variable costs, fixed costs and Owner's opportunity costs in fishing enterprises.

Fredrick *et al.* (1985) indicated that costs of fishing operations may be divided into:

- Capital costs, incorporating all expenditure on assets and
- Operating costs, which is made up of running costs, repair costs, maintenance and crew salaries.

Fixed costs are incurred whether the fishing unit operates or not because they relate to sunk capital investment that cannot be retrieved at short notice without undue loss. These include insurance, property taxes, license fees and lease payments which as Norton (1968) showed, do not vary with output.

Variable costs on the other hand are costs that tend to be directly related to production. Panayotou (1985) distinguished three kinds of variable costs;

- Running costs such as fuel, oil, ice, nets and maintenance costs, all of which depend on fishing effort;
- Labor costs, such as fixed wages and food which depend on effort and crew shares and bonuses which are tied to the catch and
- Shore costs, such as landing, packaging and marketing fees which depend also on catch.

The opportunity costs (interest foregone) on owned capital invested in the fishing assets can also be included as part of the fixed cost (Panayotou, 1985). In maximizing rent to an open access resource, all costs, according to Griffin *et al.* (1976) are assumed to be directly proportional to effort.

An investment or project is deemed viable or profitable if its benefits exceed the cost it generates. That is; the investment can repay the amount invested within a chosen number of years, or the annual rate of return of investment (level of profit expressed as a percentage) is higher than the prevailing interest rates charged by financial houses during the project period, or

- The Net Present Value (NPV) is positive
- The Internal Rate of Return (IRR) is equal to zero
- The Benefit/Costs (B/C) ratio is greater than 1.0.

In Nigerian fisheries, (Tobor *et al.*, 1976) analyzed the performance of 32 inshore fishing trawlers and gave 249.92% as the accounting rate of return, while the inshore shrimping and distant water fishery had corresponding values of 5.6 and 63.59%, respectively. Udolisa and Solarin (1985) reported an accounting rate of return of 27.10% in an experimental fishing trial with a shallow draft vessel (13 m LOA) in Nigeria coastal waters.

In this study the Maximum Sustainable Yield (MSY) was also estimated to determine the capacity of the Nigerian shrimp industry. According to FAO (2001) capacity may also be defined with reference either to fishing inputs (vessels, potential effort) or to fishing output (potential catch). Fishing capacity is, for a given resource condition, the amount of fish (or fishing effort)

that can be produced over time (e.g., a year) by a vessel or a fleet if fully utilized, that is if effort and catch were not constrained by restrictive management measures (Cunningham and Greboval, 2001).

Data collection: Questionnaires were administered for the collection of primary data from the companies licensed to shrimp within Nigeria's territorial waters and secondary data was collected from the Federal Department of Fishery and Federal Inland Revenue Service, between January, 2002 and December 2003.

A total of 32 companies with 216 vessels were licensed to shrimp in 2001. Seventeen companies (53% of the vessels in operation in 2001) owning 139 vessels were randomly selected and sampled.

The questionnaire was designed to obtain information from the fishing companies on their operations. Questions were asked on; vessel characteristics belonging to each firm, crew size, days spent at sea, etc. Economic questions were asked on revenue acquisition and cost of operations.

Analytical tools

Profitability analysis: Profitability analysis deals with the catch, the costs and returns of a representative vessel, the dynamics of the shrimp fishing fleets and prices. The type of gear considered in this study is large trawlers. An individual vessel can be viewed as a producer of effort (Anderson, 1986). Like other production process effort is actually produced from a multitude of inputs and it is assumed that the production of effort is subject to the law of diminishing returns.

Profit to a fishing unit *j* is the difference between its total revenue and total costs:

$$VPROFIT_{jt} = VTR_{jt} - VTC_{jt}$$

Where:

VTC_{jt} is the sum of fixed and variable costs which represents the total cost of a fishing unit at time *t*.

$$VTC_{jt} = FC_j + VARC_{jt}$$

Where FC_j is the fixed costs per vessel which consists of the costs of investment associated with vessels and fishing gears.

$VARC_{jt}$ is the variable costs component.

VTR_{jt} denotes total revenue.

The Total Revenue of representative vessel *j* can be calculated as:

$$VTR_{jt} = P V H_{jt}$$

Where: VH_j denotes total catch of a representative vessel j , respectively. And P is the average price of shrimp.

Economic performance: The various techniques to be used in this analysis consist of different discounting methods which include the following:

- Net Present Value (NPV)
- Benefit/cost ratio

Net Present Value (NPV): This measures the profit or surplus income from a project after the project has satisfied the rate of return desired by the investor. This rate of return desired by the investor is used to discount both the costs and revenue of the project, usually the higher the discount rate, the more unfavorable the result of the business appraisal.

The formula for NPV is given as:

$$NPV = \sum_{t=1}^n \frac{(Bt - Ct)}{(1 + i)^t}$$

Where:

Bt = Benefits in each project year t

Ct = Costs in each project year t

n = Number of years to the end of the project

i = Discount rate.

The computation will involve the following steps:

- Obtain discount rate
- Yearly costs and benefit will be identified for the period under investigation.
- Costs and benefit will then be discounted to the present for every year.
- Costs and benefits will be estimated in monetary value per year.
- Discounted gross costs and benefits will be estimated for the periods under investigation.
- The net values will be added to obtain the NPV

The higher the NPV, the higher the profit therefore the more profitable the business.

Benefit/cost ratio: The benefit/cost ratio is the ratio of discounted revenue and is given by the formula:

$$B/C = \frac{\sum_{t=1}^n (Bt)}{\sum_{t=1}^n (Ct)} \geq 1$$

Bt , Ct , n and i are as defined for NPV.

The benefit/cost ratio employs the same procedure as NPV in computation. If the ratio is greater than 1 (>1) the business is profitable and if it is exactly 1, (\geq) it means the business just breaks even, i.e., neither making profit or loss. When the ratio is less than 1 (<1) the business is operating at a loss.

Estimation of Maximum Sustainable Yield (MSY) using a surplus production model: Maximum Sustainable Yield (MSY) can be estimated using the Fox Model of 1970 which is based on the Schaefer Model of 1954 (FAO, 1985).

The MSY will be estimated using the following input data:

$F(i)$ = effort in year where $i = 1, 2, 3, \dots, n$.

Y/F = Yield (catch in weight) per unit effort in year.

$\ln(Y(i)/f(i)) = a + b f(i)$

a = intercept

b = Slope

Therefore: $MSY = -(1/a) \exp(b-1)$

Effort at this level will also be estimated according to the following:

$F_{(MSY)} = -1/b$

RESULTS AND DISCUSSION

Table 1 shows the total production of the industry between 1992-2001. The average number of vessels licensed to catch shrimps within the 10 year period under studied was 195 and the corresponding average No. of shrimps landed was 8,714,134.9 kg.

The maximum sustainable number of vessels was calculated to be 89 vessels and the maximum sustainable yield was calculated as 12190.8862 kg per vessel and 1,084,988.87 kg for the industry.

This reveals that the industry is operating above an environmentally sustainable yield.

Table 1: Total production of shrimp industry (1992-2001)

Year	No. of vessels	Quantity shrimps landed (kg)	Quantity of fish landed (kg)	Fishing hours	Quantity of Shrimps landed per vessel(kg)
1992	179	8103416	16626772	611019.8	45270.48
1993	178	8194740	18170808.1	552595.6	46037.87
1994	200	7074910	15980444.5	473001	35374.55
1995	203	7294744	14227723.1	506916	35934.7
1996	195	5552226	10902569.4	572734	28472.95
1997	180	6249695	11557045.3	472194	34720.53
1998	168	14574584	6327577.46	498391.5	86753.48
1999	211	14978664	13988834.5	714559	70988.93
2000	206	7814712	36474863.18	790962	37935.49
2001	225	5796159	11508404.9	769576.6	25760.71
Total	1945	85633849	155765042.4	5961949	447249.7

Source: Computed from Field data, 2003

Economic evaluation of shrimp harvest operation in the territorial waters of Nigeria: Shrimp harvest operations are entirely carried out by private firms in Nigeria. In recent years there has been a greater deployment of vessels to trawl for shrimps than for fish.

Profitability analysis: Profitability of the enterprise was estimated in three phases: The inputs (Total cost) which include Fixed cost and variable cost were identified The Revenue i.e., sales of catch was also estimated and The estimates of fixed and variable cost (Total Cost) were

subtracted from the revenue of sales in order to obtain the profit per annum of a vessel in the shrimp industry (Table 2 and 3). i.e., $VPROFIT_{jt} = VTR_{jt} - VTC_{jt}$

Discounted cash flow analysis: The discounted cash flow analysis was used to evaluate the economic efficiency of shrimp trawling operations in Nigeria and also to examine how beneficial how shrimp harvest operations will continue to be to its investors. A discount factor of 35% was used in consonance with the lending rates to private

Table 2: Items included in total cost of operation

Staff salaries and Remunerations	Salaries of expatriates and Nigerians
Office and general expenses	Which includes; annual rent, electricity charges, audit fees, local transport and traveling, housing and leave allowance for Nigerian employees (25% of gross earnings), Leave allowance and passage for expatriate employees (25% of gross earnings).
Workmen compensations and insurance	Includes pension schemes and Insurance policy cover.
Guest house accommodation	Includes cost of food, cleaning service and security.
Maintenance of vehicles and vessels	Cost of spare parts and workmanship.
Insurance on vehicles and vessels	
Depreciation of fixed assets	These assets include; Plants and Equipments, Vessels, Fishing gears, Vehicles, Guest house and Furniture.
Fishing operation expenses	Which include terminal expenses i.e., berthing fees, Cost of AGO, lubricant oil requirements, packaging materials, crew food and provision supply, maintenance of vessels and vehicles, annual fishing expenses, registration and survey of vessels, bonus to crew members, shrimp export handling and distribution cost, cold storage facilities.

Source: Field Survey, 2003

Table 3: Profit Analysis of a typical shrimping company with 12 vessels

Category	Component	Value (N)
Fixed Cost		
FC_j	Estab. charges	8372887.04
	Admin. charges	35278643.8
	Finance charges	11919917.55
		55571448.39
Variable Cost $VARC_{jt}$	opening stock	14717288
	Purchases	214269399
	operating stock	189258088
		418244775
	Less closing stock	109987143
		308257632
Total cost		
VTC_{jt}		363829080.4
Revenue		
VTR_{jt}	Sale of catch	481948259
Profit $VPROFIT_{jt}$		118119178.6
Average profit per vessel		9,843,264.884

Source: Estimated from Field Data, 2003

Table 4: Calculation of benefit/cost ratio

Year	Benefit ₦	Cost ₦	Discount Factor	Discounted Benefit (₦)	Discounted Cost (₦)
1992	10733713.84	3567272.52	0.74	7942948.239	2639781.665
1993	9728440.419	4530436.1	0.54	5253357.826	2446435.494
1994	8936886.546	5753653.848	0.4	3574754.619	2301461.539
1995	8314899.976	7303077.6	0.3	2494469.993	2190923.28
1996	7824964.792	9269290.8	0.22	1721492.254	2039243.976
1997	7435016.381	11797279.2	0.16	1189602.621	1887564.672
1998	7138263.187	14887042.8	0.12	856591.5825	1786445.136
1999	6888324	19100356.8	0.085	585507.54	1623530.328
2000	6703485.252	24156333.6	0.063	422319.5709	1521849.017
2001	6551133.315	30897636	0.046	301352.1325	1421291.256
Total				24342396.38	19858526.36

Source: Computed from field data, 2003, BCR=1.225790672

Table 5: Calculation of net present value

Year	Benefit ₦	Cost ₦	Discount Factor	Discounted benefit (₦)	Discounted cost (₦)	DB-DC ₦
\1992	10733713.84	3567272.52	0.74	7942948.239	2639781.665	5303166.574
1993	9728440.419	4530436.1	0.54	5253357.826	2446435.494	2806922.332
1994	8936886.546	5753653.848	0.4	3574754.619	2301461.539	1273293.08
1995	8314899.976	7303077.6	0.3	2494469.993	2190923.28	303546.7129
1996	7824964.792	9269290.8	0.22	1721492.254	2039243.976	-317751.7217
1997	7435016.381	11797279.2	0.16	1189602.621	1887564.672	-697962.0511
1998	7138263.187	14887042.8	0.12	856591.5825	1786445.136	-929853.5535
1999	6888324	19100356.8	0.085	585507.54	1623530.328	-1038022.788
2000	6703485.252	24156333.6	0.063	422319.5709	1521849.017	-1099529.446
2001	6551133.315	30897636	0.046	301352.1325	1421291.256	-1119939.124
Total						4483870.015

Source: Computed from Field data, 2003, Net Present Value = N 4,483,870.02

investors in Nigeria. The analysis employed Net Present Value (NPV) and Benefit-Cost Ratio (B/C). The benefit and cost estimates and calculations are as shown in Table 4 and 5.

Economic evaluation of industrial shrimp harvest operations was based on a consideration of profitability analysis and discounted cash flow analysis.

An estimated profit of N 9,843,264.884 was derived for a vessel in a company with 12 vessels in the year 2003 (Table 3).

The lending rate to private investors in Nigeria was estimated at 35%. Therefore in the Nigerian Shrimp Trawl industry, a Net Present Value (NPV) of N 4,483,870.02 with a corresponding Benefit Cost Ratio (BCR) of 1.2 was derived for the industry. This reveals that the enterprise is highly profitable and financially desirable.

The major markets of the Nigerian shrimp are in USA and Europe (Belgium, Portugal, Spain and France). The semi processed white prawns attract higher price (ranging according to sizes 1-7 from US\$3-18 kg⁻¹) than the peeled, deveined and decapitated brown shrimps sold between US\$2 and US\$3. All are usually packed in 2.2 kg packets into master cartons. Prices are important as they determine revenues, profits and the supply of fishing effort. These prices are primarily determined at the international market.

CONCLUSION AND RECOMMENDATIONS

In conclusion the Nigerian Industrial Shrimp fishery though highly profitable, there is a shadow over its future as the estimation of the maximum sustainable yield reveals that the industry is operating above a sustainable level.

The federal government has been in charge of all aspects, from the elaboration to the implementation of management measures, including the definition of regulation objectives, laws, decrees to preserve fish population, to monitor and control fisheries and to enforce the measures to achieve these targets. It is

obvious that with such a technocrat model the governmental agencies do not have enough human nor financial resources to execute these chores, particularly to secure the control over fishing management in the coastal areas. So in order to attain a sustainable balance between the capacity of the Nigerian shrimping fleet and the available resources and to reduce inefficient race to fish behaviour, a comprehensive structural policy has to be in force. Such policy should consider and source for various stakeholder views in the industry.

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