

Small-scale Fisheries In Lagos State, Nigeria: Economic Sustainable Yield Determination.

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Abstract

The objective of this study was to determine the sustainable yield of the small - scale fisheries operations in Lagos State. Between January and December 1991, 113 mechanized and 43 non-mechanized fishing units in 21 coastal villages were purposively chosen and surveyed on a bi-monthly basis through questionnaire administration. Costs components of fishing operations and landings of five highly targeted fish families namely: Sciaenidae, Ariidae, Polynemidae, Clupeidae and Carangidae were collected. Multiple linear regression and Cobb-Douglas technique were employed to determine the sustainable yield of the fisheries through the economies of scale in the wet and dry seasons. The multiple linear regression output of the non-mechanized category in monetary terms showed a range of adjusted R^2 values of 0.91 and 0.98 in the two seasons. The F-ratio values were significant at the 0.05 level and highly significant also at the 0.01 level in the two seasons. The respondent categories were unable to combine their cost of operation efficiently from the result of the elasticity. The economies of scale showed that the small-scale fisheries in Lagos State were largely undercapitalized. It was proposed that the Lagos State Government should rejuvenate the defunct subsidy scheme, which on the long run will optimize the catches. Measures recommended to achieve sustainability were those that could stimulate investments into the fisheries so that coastal fishing operations will on the long run be optimal in Lagos State, Nigeria.

Keywords: small-scale, sustainable, yield, multispecies, mechanization, undercapitalization

1.00 INTRODUCTION

Over the years different governments in Nigeria have recognized the relevance of the fisheries sub-sectors, which are composed of the marine, brackish and freshwater. Several attempts were made over the years to boost their productivity through institutional reforms and the various fiscal and economic measures. Some of these measures involved tax exemption and input subsidy schemes for distribution to fishermen to stimulate increased production. Despite all these forms of external intervention in the development plans, the fisheries sector still showed a deficit in the supply and demand of fish to the populace. It was also thought that the sub-sector was a temporary phase of transition to the industrial sector, but today the small-scale fisheries have come to stay as a permanent feature in the fisheries of developing nations worldwide, Nigeria inclusive. For Nigeria to have a meaningful fisheries development policy, information is required on the allocation and utilization of all the input resources or the resource use efficiency in addition to other economic data. The availability of such knowledge will assist the policy makers in pointing the right direction of future development or management.

1.01 Objectives Of Fisheries Management and Development.

A lot of literary studies exist on the objectives of fisheries management and development. These objectives

have been classified into three major types, which are biological, economic and social. Their maximum levels in active fisheries have been determined using the Maximum Sustainable Yield (MSY) by the biologists, Maximum Economic Yield (MEY) by the economists, and the Maximum Social Yield (MSoY) by the sociologists. These three determining levels were developed against the background of the law of diminishing returns applying to fish stock and the inputs - influenciabile and uninfluenciabile- and output relationships pertaining to the scale of fishing operations generally in the fresh, brackish and marine waters. There were pros and cons of the biological and economic objectives like difficulties in setting detailed objectives, inappropriateness of objectives due to changed priorities, technical difficulties in complying with details, the complex and unmechanistic natures of fish stocks. Panayotou (1983) defined MEY, while MacSween (1983) outlined and enumerated its limitations. As a result of the limitations associated with the individual objectives and their working prediction models, Roedel (1976) proposed the use of an amalgam of these three objectives called Optimum Sustainable Yield (OSY).

Fisheries workers in different parts of the globe have worked extensively on the problems facing the development and management of - the industrial and small-scale - fisheries and their failures are indicators of the limitations imposed on research by its complexity.

There are problems of the resource base (common property nature, easy entry, finite and renewable nature and open access), heterogeneity and variations in technology of extraction, characterizations, operations (lack of alternative form of employment, profit maximizing behavior, inter and intra competition, and dualism) and definitions from one location to the other. Studies by Firth (1946, 1966); Norbeck (1954); and Gulland (1974,1979) are some of those who highlighted these constraining factors.

1.02 Characteristics Of Artisanal, Small-scale And Peasant Fisheries.

Tredten and Hersoug, (1992) attempted a traditional definition of artisanal, small-scale, peasant and subsistence fisheries and used Smith's, (1979) classical definition for the purpose of generalization. Haakonsen, (1992) noted the ambiguity of the terms used to define artisanal fisheries in West Africa which he asserted are simpler to categorize as they are assumed to be the equivalent of canoe or pirogue fisheries. These include planked versions such as the "Ghana boat" in Sierra Leone, and to a very minor extent, fiberglass duplicates of traditional vessels such as the Nigerian "banana boat" (Haakonsen, 1992). A potential source of problem according to Haakonsen (1992) is the question of distinguishing professional from part-time fishermen because a large number of the half a million canoe fishermen in West Africa for example are actually occasional fishermen. They fish either for subsistence or to supplement incomes derivable from other economic activities. These part-timers are characterized by the utilization of low cost craft, usually one to three - man canoes, and the employment of gear requiring relatively moderate capital investments. It is also necessary to look primarily at the contribution of fishing to the fisherman's household income, secondly, how much time and effort is put into fishing; and thirdly how he and others perceive him or whether his status in the community is that of a fisherman. Haakonsen, (1992) further affirmed that this should be regardless of whether this may be "high" or "low" in his particular society and the above assertions are of course difficult to determine statistically but they are normally easily observable.

Thompson, (1983), successfully compared the attributes of the fisheries of the industrialized and developing countries and elaborated that most developing countries fisheries have very large artisanal sections and these constitute both social and economic problems. The FAO (1979) enumerated the attributes of the artisanal fisheries of developing nations like Nigeria. Thompson, (1983) asserted that all the drastic resource failures of more than 30 years ago may have been due to the pressure of commercial fleets on artisanal fishing grounds, and then over-exploitation may well occur.

1.03 Need, Importance And Limitations Of Prediction Models.

Prediction models are necessary for fisheries administrators to foresee in advance the evolution of the resource abundance. This is necessary for development and management measures to be taken in time (Garcia and Le Reste, 1981) and Le Reste, (1982). The production function model is widely used in fisheries economics and can be injected with the universal economic model, The standard model assumes that there is an equilibrium point at which the development of the fishery will stop and where the economic profit will be nil. The existence, therefore, of natural variations in abundance involves the theoretical existence of a family of bio-economic models. The consequences will be fluctuations in profits and likely increases in overexploited fisheries (Garcia, 1984).

Caddy, (1983) noted differences between the multispecies tropical and steady state fisheries. The limitations of the use of stock assessment models that are geared towards the steady state fisheries for multispecies were observed by Pauly, (1979) using the Schaefer Growth model, for instance, takes care of virgin fishery expansion and the relationships or interactions are easy for single species fishery. Multispecies fishery on the other hand is a complex composition of fish species and technical interactions aside, when non-discriminatory gear is applied to such a fishery, total mortality that occurs is a function of stock abundance. One can get more than a hundred to two hundred species in a haul and changes in fishing intensity alter these ecological relationships of age, species, and overall biomass. This could lead to biological extinction of some species and expansion of some as exemplified in the Gulf of Thailand where flat fishes (*Heterosomata* sp) were kept in check by small prey fishes (*Leiognathus equulus*).

Padilla and Charles (1994) defined bio-economic models as quantitative models characterized by the integration of the natural and human sides of the fisheries equation, linking the biological and economic elements. They identified the behavioral and optimization models and noted the challenges of bio-economic models in tropical capture fisheries, which are multiple gears and technological inter-relationships in the harvesting process with limited selectivity. From the failures of the past biological models it was affirmed that bio-economic models can address three complexities that characterize tropical fisheries where pervasive overexploitation is rife: the multispecies nature of the fisheries resource, the multi-objective nature of the exploitation and management, and the multifaceted independent nature of the fishery system as a whole.

1.04 Definition, Causes And Consequences Of

Overfishing.

Characterization, causes, symptoms and bio-socio-economic consequences of overfishing in multi-species fisheries have been defined by Pauly, (1984 and 1990). Pauly, (1987) characterized overfishing while Hardin, (1968), coined it the "tragedy of the commons" and this is when the lower bound of economic fishing is reached and fishermen will leave the fishery. McGoodwin, (1983) added that it is a happier state of affairs to maintain a fishery above the lower bounds of economic and biological overfishing. Aguero, (1987), asserted that in quantitative terms, overfishing or excessive effort is not new and is the "turning point" in the yield levels of an exploitable fishery resource. In management terms, it is the last signal calling for regulations or controlling measures. He believed that the theoretical foundations, manifestations, causes and effects are not yet fully or consistently defined for management purposes.

Clark, (1976) and Waugh, (1984), have distinguished between biological and economic overfishing. Biological "overfishing" is any level of effort which prevents the stock from generating the maximum sustainable yield. Waugh, (1984), Bailey, (1987) and Pauly, (1987) believed that overfishing is essentially an economic problem with strong social and biological implications. Chumpol, (1987), McGoodwin, (1984) and Aguero, (1987), Bailey, (1983,1987), and Firth, (1966), are some of the workers who elucidated on some of the consequences of social overfishing

Since Gordon's first formalization of the economic theory of a 'common property' in 1954, (Clark, 1976, 1985), "economic overfishing" has generally been loosely defined and handled in empirical works without clear recognition or account of several important elements. Aguero (1987) added the inherent nature of fisheries as the causes of overfishing McGoodwin (1983) mentioned a high population while Pauly, (1987) blamed fish biologists or politicians. This is because the fishery biologists are guilty for conservative advice of recommended and adopted levels of management techniques like total allowable catches (TAC), licenses, and quotas in fishery bulletins of steady state fisheries globally especially in the developed nations. Three examples were described where a number of models routinely used by fishery biologists to formulate management advice have the common feature of positing management goals that induce overfishing viz.:

(1) Using erroneous techniques for fitting surplus yield models to time series of catch - and effort data e.g. production models by Schaefer, (1957) or Fox, (1970). These apply to single species fisheries but are applied to multispecies fisheries also. Gulland, (1969) also noticed that example. The use of Arithmetic mean (AM) or predictive regression for their catch per effort versus

effort plots. This regression type assumes that the data on the abscissa scale i.e. effort is to be measured without error (Ricker, 1973) which is clearly unrealistic. Instead, Pauly (1987) suggested the use of Geometric mean (GM) or functional regression.

(2) Estimating optimum mesh sizes from length - per recruit analysis based on the assumption of knife-edge selection. Here, Beverton and Holt, (1957) assumed that a gear like trawl is knife - edged. This is not realistic in the small fish typical of tropical demersal stocks.

(3) Continuing the use of Gulland's equation for potential yield estimates. Gulland, (1970) proposed that the fishing mortality generating $MSY (= F_{msy})$ should be approximately equal to M . M is the rate of natural mortality in a stock, and based on this assumption used the proceeding equation.

$$MSY = 0.5 \times M \times \text{unexploited biomass..} \quad (1)$$

Where

MSY = Maximum Sustainable Yield

M = the rate of natural mortality in a stock

The above equation (1) has been used to estimate (potential) MSY in a variety of tropical stocks. A mean value of M is extremely hard to define. Francis, (1974), Beddington and Cookie, (1983) have shown that it is grossly misleading, this model is still universally used. They showed that $F_{msy} = M$ applies only in fishes with low values of M . such as North plaice and F_{msy} is much smaller than M when the latter is high. This is because it occurs in the small short-lived species characteristic of tropical waters (Pauly, 1980).

Waters, (1991) reviewed the incentives of the open access to overfish using the earlier arguments of Hardin, (1968) and defined the different types of externalities based on studies by Gordon (1954); Scott, (1955); Cheung, (1970); Bell, (1978); Christy, (1978); and Anderson (1986). Complete and detailed studies on the economic inefficiencies of open access regulations were done by Crutchfield and Wellner, (1963); Crutchfield and Pontecorvo (1969); Bell, (1978); Christy, (1978); Anderson (1986) and Hanneson (1989). Different forms of restricting access to a fishery have been discussed in details by Rettig and Ginter, (1978); Rettig, (1984); Mollet (1986); Huppert (1987); Clark et al, (1988); Geen and Nayar, (1988); and Townsend (1990). Other less frequently mentioned alternatives include territorial use right (TURF) by Christy, (1982), Smith and Panayotou, (1984) and sole ownership (Scott, 1955 and Keen 1988).

Much has been written locally about the Nigerian fisheries by Longhurst, (1960a, 1960b, 1962,1963 and 1964a); Bayagbona (1965); Fagade (1969); Troadec and Bayagbona (1973); Tobor (1973, 1978, 1990, and 1993); Kusemiju (1981, 1991 and 1993); Nsetip (1983); Ajayi and Talabi (1984); Akinyemi (1986); and Elliot (1993).

These workers concentrated mainly on the inter-relationships between the biological characteristics of the various fish species and their abundance and hence catchability. Mabawonku (1979, 1981 and 1986) however placed attention on the economics of fishing as a business concern and, the public policies (interventions) that affect returns to the fishing operators. It is noteworthy to mention that studies by Tobor (1983), Kusemiju (1993), and Elliot (1993) reported instances of possible overfishing either in the inshore and inland waters in Nigeria. This study was an attempt to determine the economic sustainable yield of the coastal small-scale fisheries in Lagos State, Nigeria through the cost route method, the impacts of seasonality and outboard engine mechanization, and the policy implications of the findings.

2.00 Area Of Study.

Lagos State lies to the southwestern part of Nigeria and has boundaries with Ogun State both in the north and east. It is bordered on the west by the Republic of Benin and in the south, stretches for 180 km. along the coast of the Atlantic Ocean. It therefore has 22.5% of Nigeria's coastline and occupies an area of 3,577 sq. km. landmass with about 786.94 sq. km. (22%) of it being lagoons and creeks in Lagos, Ikorodu, Badagry and Epe.

The State is endowed with marine, brackish and fresh water ecological zones with varying fish species that provide productive fishing opportunity for fishermen. FAO (1971) survey showed that at the inception of the State's creation, there were about 30,000 actively engaged fishermen with manual gears and craft types. Of the many policies inherited from the old Western Region, the canoe mechanization scheme was continued with at a period when catches were poor and morale and income very low.

2.01 Common Fishing Gears And Craft Types In Lagos State, Nigeria

A survey by the Lagos State's Ministry of Agriculture and Natural Resources (MANR) in 1985 showed that glass reinforced boats was yet to be adopted in the State but three craft types were in use. These were:(1) Ghanaian dugout canoes with planked free boards (2) smaller local dugout canoes, and (3) local planked canoes. The outboard engines used were of numerous brands with a range of horsepower from 5 to 55 HP. The gears in use were:-(1) gill nets which could be surface or bottom, set, drifting and/or encircling, (2) beach seines could be of 200 to 800 meters length, (3) cast nets, (4) hooks and lines, (5) stream weirs and, (6) traps (Udolis and Solarin, (1979).

The Ghanaian dugout canoes ranged from 8 - 12 meters length over-all (LOA) with beach seine as fishing gears. The canoes were made from silk samba trees (Triplochiton scleroxylon) in the western zone. The local dugout canoes had LOA range of 6.1 - 8 meters from silk

cotton trees of Ceiba penitandra and ironwood (Lophira alata) used by marine and inland gill net operators. Planked canoes of 5.5 - 8.5 meter LOA were also being used for gill netting, long lining and shark fisheries in the eastern zone. Woods used were Terminalia sp (white or black afara), Mahogany (Khaya ivorensis) or silk cotton tree of ceiba. The nettings were of mesh sizes with a range of 9 to 51 mm. in the codend, bunt and wings of beach seines; 24 to 52 mm. for encircling gill nets; 41 to 305 mm. for set gill nets and 300 mm. for shark nets. The crew of the marine encircling net was made up of seven to fifteen while for the beach seine net crew it was 20 to 50.

3.00 METHODOLOGY.

The traditional fisheries operations surveyed for this study were in the coastal and brackish water fisheries. The survey was carried out through questionnaire administration for a period of eleven months (covering the dry and wet seasons) in twenty-one (21) predominantly fishing villages in 1991. Since the fishing population is made up of indefinite strata with differing characteristics and each stratum has a proportionate ratio in terms of number of fishing units to every other stratum the villages were purposively chosen for being active fishing locations. The multispecies nature limited our choice and preference for certain economically viable and targeted fish families therefore the landings chosen for the survey were from the families of Sciaenidae (croakers), Polynemidae (threadfins), Carangidae (bumpers), Ariidae (sea catfishes) and the Clupeidae (sardines). The choice of these fish families was based on past studies by Nsetip (1983); Ajayi and Talabi (1984); FDF (1985, 1988 and 1990) and Akinyemi et al (1986) who observed the predominance of these fish families in artisanal landings.

Table 1: Distribution of the Respondent Fishing Units

Villages	No.	%	Gear Types	Fishing Gears
1) Okunfolu	22	14.1	Gillnet	Plank canoe
2) Okegelu	3	1.92	Gillnet	Plank canoe
3) Okun Ise	9	5.77	Gillnet	Plank canoe
4) Imedu	1	0.64	Gillnet	Plank canoe
5) Akodo	5	3.22	Gillnet	Plank canoe
6) Idasho	10	6.44	Gillnet	Plank canoe
7) Lekki	9	5.77	Gillnet	Plank canoe
8) Igbekodo	5	3.22	Gillnet	Plank canoe
9) Apakin	6	3.85	Gillnet	Plank canoe
10) Osoroko	10	6.44	Gillnet	Plank canoe
11) Otolu	10	6.44	Gillnet	Plank canoe
12) Oringanrigan	5	3.22	Gillnet	Plank canoe
13) Olomowewe	5	3.22	Gillnet	Plank canoe
14) Ikare	1	0.64	Beach Seine	Local dugout
15) Ibeshe	1	0.64	Beach seine	Local dugout
16) Liverpool*	4	2.6	Setnet	Plank canoe
17) Ashikpa	12	7.69	Beach Seine	Ghanain type
18) Agbonrin	7	4.49	Beach Seine	Ghanain type
19) Sakpo-Beach	13	8.33	Beach Seine	Ghanain type

			& Gillnet	
20) Sakpo-Falola	1	0.64	Beach Seine	Ghanain type
21) Gbagi-Aivoji	3	1.92	Beach Seine	Local dugout Gillnet
22) Ajido-Vivi	14	9.0	Beach Seine	(All above types) Setnet

Total: 160

* Omitted from the study.

Source: Study data (1991).

The primary data were collected using a purposive sample of one hundred and fifty six (156) respondent fishing units with considerations given to the common problem of seasonal redeployment of craft and gear types. Initial samples were collected on the stock of the fishing units with the cooperation of the Lagos State Agricultural Development (LSADP) agents in the villages. Information gathered were fishing inputs' sizes, life span, (yrs.) and types viz: length of boat, (m.), area and types of net (m²), outboard engine, ownership, capacity and types. Based on the ownership of outboard engines, the respondent fishing units were categorized into two with 113 mechanized and 43 non-mechanized Table 1 shows the distribution of the respondent units during the survey period.

The data collection was done on a fortnightly basis by the field enumerators who made actual observations of the fish sales transactions at the landing jetties. This enabled them to record the prices, quantities and types of fish landed and the general marketing situation. They additionally extracted information from the fishermen about the conditions at the fishing grounds, weights of the different species/families of interest to the study frame. Thereafter at a time most appropriate and convenient to the sample unit owner(s), the enumerators visited the household(s) and canvassed for details relating to the costs and earnings of the fishing trip(s). The data collected were directly entered into the schedules. After the monthly data were collected, the enumerators added the figures and entered them as the monthly totals. All the input data collected during the survey were standardized and processed using two weeks (14 days) of good fishing period as the yardstick of a monthly operation. The extrapolated monthly data were averaged and thereafter multiplied using the above factor of fourteen (14). Data processing on the variable costs (gear repairs, craft repairs, fuel, losses incurred during fishing, hired labor), earnings and total fishing effort, actual fishing time, voyage time, number of non-owners fishing were analyzed. The findings to be presented later are the results of analysis of the data in their highest state of consolidation at the monthly and seasonal levels.

3.01 Theoretical Consideration

Ogunmoroti (1989) quoting Smith (1982) asserted that the choice of the explanatory variables to

include and the appropriate functions depends largely on the assumption underlying the biological relationships in the production process. Frederick et al (1985), and Panayotou (1985) described the stock and fishing effort as the two major variables of relevance in the consideration of the production function. A production function can therefore be specified on the basis of these two variables as follows;

$$Q = f(s, e, Ei) \dots \dots \dots (2)$$

Where Q = catch

s = fish stock

e = fishing effort

Ei = error term

Khaled (1985) and Panayotou (1985) added that a fish stock could be assumed fixed for a given fishing season. The variation in catch will therefore be solely due to the variation in effort applied. This is implied in the above specification of equation (2). The fishing effort is however a composite input which could be broken into its component elements of capital, labor, time spent at sea, actual fishing time, length of craft, area of gear, depth of fishing, weather conditions at sea and on land. The capital item in particular can be broken down into costs of gear and craft, maintenance and repair of gear and craft types, depreciation, insurance, taxes, hired labor, fuel and other miscellaneous expenses. The present paper however concentrated on costs of labor, maintenance and repairs, fuel, losses (to craft and gears) during fishing; and the residual costs of craft and gears. In addition, variables without observable prices like length and area of craft and gears, actual fishing time, number of hired hands, actual fishing and total voyage times were considered in explaining the variations in output of the fishing units whether mechanized or not. This was stated implicitly as:

$$Q = f(X_1, X_2, \dots, X_n, Ei) \dots \dots \dots (3)$$

Where

Q = an index of catch from summation of quantities of individual species caught in kg. and weighted by their prices (=N= , \$1.00US = N100.00).

X₁ = cost of gear repairs

X₂ = cost of craft repairs

X₃ = fuel cost (where applicable)

X₄ = cost of losses incurred during fishing trips

X₅ = hired labor cost

X₆ = residual cost of craft

X₇ = residual cost of gear

X₈ = actual time spent fishing (hrs.)

X₉ = boat length

X₁₀ = area of gear

X₁₁ = total voyage time

X₁₂ = number of non-owners fishing

X₁₃ = outboard engine mechanization (where applicable)

This relationship could be quantified by making this equation 3 explicit. The ordinary least squares (OLS) technique was then employed to estimate the functions. The power function (Cobb-Douglas) had however been used in Asia (Thailand) for capture fisheries production by Panayotou (1987) and Rungrai et al (1987). In Nigeria, Okiya and Oguru, (1991) related catch to the components of fishing effort with specifications of the variables in monetary terms for their study of artisanal fisheries while Olomola (1992) used the production function for the mechanized and non-mechanized small-scale fisheries in Ondo State, Nigeria. They estimated the Cobb-Douglas function as

$$\ln Q = \ln a_1 + \ln X_1 + a_2 \ln X_2 + \dots + L_n X_n \dots (4)$$

The ease of estimation of the physical marginal product (MP) of the fishing inputs, production elasticities, returns to scale/economies of scale, technical and economic efficiencies are some of its advantages (Panayotou et al, 1982). Ogunmoroti, (1989) however enumerated some of the disadvantages of the power function as constraining the elasticity of substitution between inputs to be always equal to one. This study will however make use of this power function in spite of this demerit alongside the linear function. Using the ordinary least squares techniques (OLS), equations (3 and 4) were estimated for the two fishing categories and seasonality. The results obtained from equations (3 and 4) and the summation of the individual chosen variables were used to achieve the objective of sustainable economic yield with respect to the variations in the categories of mechanized and non-mechanized in the seasons. The choice of the variables included in the above models was based on the exploitative technology of fish production among the small-scale fishermen in Lagos State, Nigeria. The resultant adjusted R^2 determined which model fitted the analysis closely, that is, the one that gave the best fit with the higher adjusted R^2 .

The outputs of regression analyses for either the mechanized or non-mechanized fishing units in the seasons (wet and dry) were further tested for multicollinearity due to the number of the variables used. Kane (1969) asserted that multicollinearity arises whenever, either in the population or in the sample, several of the explanatory variables stand in an exact or almost exact relation to each other. When multicollinearity occurs, it is as if numbers of a subset of explanatory variables act always in unison. The greater the degree of multicollinearity that obtains, the more arbitrarily and unreliably does least squares allocate the sum of explained variation among the individual explanatory variables (Watson, 1951a; 1951b). Multicollinearity, according to Kane (1969) must be regarded as a black mark that reduces our confidence in

conventional tests of the significance of the various coefficients. To solve this problem a Durbin Watson statistic was employed.

3.02 Estimation Of Annual Cost And Revenue Of Fishing.

Revenue was based on sales from catches and the cost of fishing was based on annual expenses on fishing gear(s) and boat(s). Based on the formula of Harcourt, (1972), rental value of the cost of fishing, k, was calculated as:

$$k = \frac{n}{1-(1+r)} + \frac{rk}{1-(1+r)} \dots \dots \dots (5)$$

- where
- k = acquisition cost of fishing inputs (canoe, fishing gear).
- N = life span of boat and gear.
- r = interest rate (at 30% per annum).

Table 2: Result of the Linear Regression technique for the Non-mechanized Category in Lagos State, Nigeria. (1991).

Variables/ Seasons	Dry	Wet
Constant	na. (14809.4)	na. (1239.27)
X ₁ – Gear repairs cost	0.03 (2.00)	-0.44 (1.15)
X ₂ – Craft repairs cost	0.03 (1.87)	0.47 (1.41)
X ₃ – Fuel cost	-	-
X ₄ – Cost of fishing losses	0.03 (0.99)	0.36 (0.91)
X ₅ – Hired labor cost	0.33 (0.65)	0.08 (0.65)
X ₆ – Residual cost of craft	0.04 (53.64)	-0.03 (31.01)
X ₇ – Residual cost of gear	0.08 (130.75)	-0.37 (48.05)
X ₈ – Actual time spent fishing	0.11 (91.49)	0.25 (64.13)
X ₉ – Boat length	-1.84 (12401.54)	0.61 (1018.81)
X ₁₀ – Area of gear	0.04 (0.52)	0.02 (0.28)
	R ² 0.98	0.91
	Adjusted R ² 0.97	0.88
Durbin Watson Statistic	-	-
F – Ratio Calculated	109.22	35.37
df	9	9
N	43	43

() Figures for the standard errors of the b- coefficients
Source: Survey Data

Table 4: Result of Cobb-Douglas Technique of the

Mechanized category in Lagos State, Nigeria. (1991)

Variables/ Seasons	Dry	Wet
Constant	11.67 (4.3)	6.52 (1.27)
X ₁ – Gear repairs cost	0.06 (0.13)	-0.00284 (0.04)
X ₂ – Craft repairs cost	-0.31 (0.19)	0.1 (0.13)
X ₃ – Fuel cost	-0.0057	-0.16
X ₄ – Cost of fishing losses	0.09 (0.09)	0.14 (0.07)
X ₅ – Hired labor cost	0.55 (0.09)	0.45 (0.06)
X ₆ – Residual cost of craft	-0.06 (0.26)	-0.1 (0.08)
X ₇ – Residual cost of gear	0.05 (0.31)	0.04 (0.17)
X ₈ – Actual time spent fishing	-0.21 (0.12)	- 0.1 (0.09)
X ₉ – Boat length	-1.1 (0.33)	0.01 (0.02)
X ₁₀ – Area of gear	0.38 (0.18)	- 0.04 (0.05)
X ₁₁ – Total voyage time	-0.37 (0.33)	-0.05 (0.09)
X ₁₂ – No. of non-owners fishing	-0.53 (0.34)	0.09 (0.08)
R ²	0.71	0.95
Adjusted R ²	0.62	0.94
Durbin Watson Statistic	2.19	2.21
F – Ratio Calculated	7.26	106.22
df	11	11
N	113	113

() Figures for the standard errors of the b- coefficients

Source: Survey Data

4.00 RESULTS AND DISCUSSION.

4.01 Economies of Scale

The result of the regression techniques with their variable coefficients in the dry and wet seasons for the non-mechanized and the mechanized fishing categories are shown in Tables 2 and 3. The estimation of a production function yields further results such as the returns to scale (RTS). This indicates the proportionate increase in output resulting from a proportionate increase of all inputs. If doubling of all inputs brings about a doubling of outputs, constant returns to scale are said to prevail, or the production function is homogeneous of degree one; if output more (or less) than double as a result of doubling of all inputs, we have increasing (or decreasing) returns to scale or the production function is homogeneous of degree greater (or less than) one. In Cobb-Douglas production function, the returns to scale (RTS) are given by the sum of the explanatory input coefficients (Wattanatchariya et al, (1982) and Panayotou,

(1987).

$$RTS = \sum a_i \quad (6)$$

Table 4: Sum of the coefficient from the Linear and Cobb Douglas production functions for fishing categories in Lagos State, Nigeria. (1991).

Categories	Non-mechanized		Mechanized	
Seasons	Dry	Wet	Dry	Wet
	-1.15*	0.15*	10.21	6.89

(*) The summed coefficients are devoid of the constants from the linear regression technique.

Source: Survey data (1991).

The range of the summed coefficients for the non-mechanized and mechanized in the dry and wet seasons in Table 4 is between -1.15 (without the constants added) being the least in the dry season for the non-mechanized and 10.21 as the highest by the mechanized category in the dry season. If the constants of the Linear regression outputs of the non-mechanized category in the wet and dry seasons are added for the purpose of the economies of scale the values would have been in the range of three digit figures, therefore the sums of the coefficients of the non-mechanized category of fishing units would be interpreted with caution.

From the empirical results, the implication of the values in Table 4 is that all the categories of the fishing units whether in the dry or wet seasons and in the small-scale fisheries of Lagos State, Nigeria depict a typical stage one of the production function. This stage represents the irrational region as far as production economics is concerned. The use of the resources therefore can be increased further to increase profit.

According to our empirical result, the non-mechanized category would have had the highest summed values of RTS relative to the mechanized respondents. This is expected because Jinadu (1998) has shown that the non-mechanized operators are limited by their financial ability to engage in a more financially risky operation because they only invested the minimum cost required to be operational in the fisheries unlike the mechanized operators. It was further asserted that the mechanized operators had additional advantages for their fishing expeditions in physical terms like the type, area and size of gear; larger sized and longer craft types; age and the general efficiency of their gears and craft types; ability to engage more hands for their fishing trips; and the advanced motor ability from the outboard engine ownership which allows for multiple fishing trips per day.

5.0 CONCLUSION AND POLICY IMPLICATIONS

The sum of the individual coefficients from the different regression techniques for the categorized fishing units in the seasons was relevant for the economic sustainability of the small-scale fisheries of Lagos State, Nigeria. The implication is that the potential fisheries

resources and the benefits from the resource to the society, is not maximized whether mechanized or not. According to our findings there was gross under-exploitation and it can be assumed and concluded that the small-scale operators in the coastal fisheries of Lagos State, Nigeria were in the stage of development of their fisheries and therefore undercapitalized. It is recommended that the State government should look for ways and means to assist the small-scale fishing operators through external interventionary measures. One of these measures could be the rejuvenation of the defunct input subsidy scheme with an improved preparation and organization of operation with phased implementation so that the expected stimulation of the developing fisheries operations through the external intervention could be achieved and the subsequent removal will not traumatize the small-scale fishing operators in Lagos State, Nigeria.

Acknowledgements

The data for this study were collected with the assistance of the Fisheries Extension Agents (FEA's) of the Lagos State Agricultural Development Agency. Appreciation is expressed for the contributions of the late Professor A. F. Mabawonku (Department of Agricultural Economics) who was the architect of the study, Dr. O. Akinyemi (Department of Wildlife and Fisheries Management and Professor S. O. Fagade (Department of Zoology, University of Ibadan for their critical review of the draft, comments and suggestions, and the contributions of the Director of the Nigerian Institute for Oceanography and Marine Research, Victoria Island, Lagos State, Nigeria.

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