A STUDY OF THE SUPPLY FUNCTION FOR FISH IN THE KENYA WATERS OF LAKE VICTORIA AND ON THE KENYA COAST

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1. INTRODUCTION

The location of fishing areas is determined by such diverse factors as the availability of water, its temperature and salinity, its chemical composition,, the nature and strength of the Ocean currents, the configuration of the coastline, the presence of submarine ridges and deeps, as well as the availability of food supply and its distribution.[1] The relative abundance of fish on the continental slope is an important factor in the development of sea fisheries, a factor which the Kenya Coastline lacks. Climatic factors, as well as other periodic influences also play a major role, as will be seen below. These factors therefore help to explain why some areas are more favoured with abundance of fish than others.

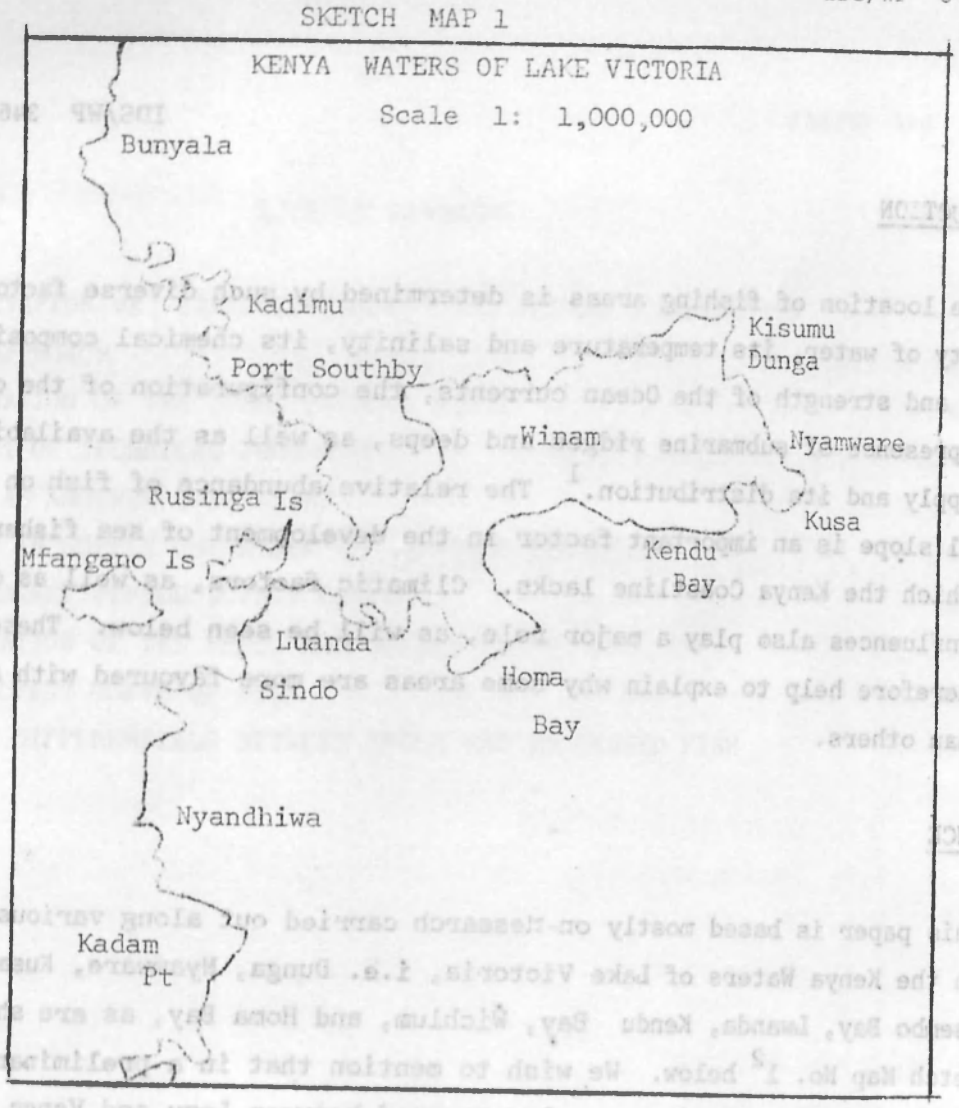
2. EVIDENCE

This paper is based mostly on-Research carried out along various major beaches on the Kenya Waters of Lake Victoria, i.e. Dunga, Nyamware, Kusa, Kaloka, Asembo Bay, Lwanda, Kendu Bay, Wichlum, and Homa Bay, as are shown on the Sketch Map No. 1[2] below. We wish to mention that in a preliminary research earlier on, the Kenya Coastline was also covered between Lamu and Vanga as can be seen in the Sketch Map No. 2[3] below. In this preliminary research, no questionnaires were distributed. Later questionnaires were administered on the southern coast, a partial analysis of their results is included in this paper. It is worth noting, however, that many of the general features of fishing along Lake Victoria are very similar to those observed at the Coast, hence unless differentiated herein it should be understood that the two areas are being treated similarly.

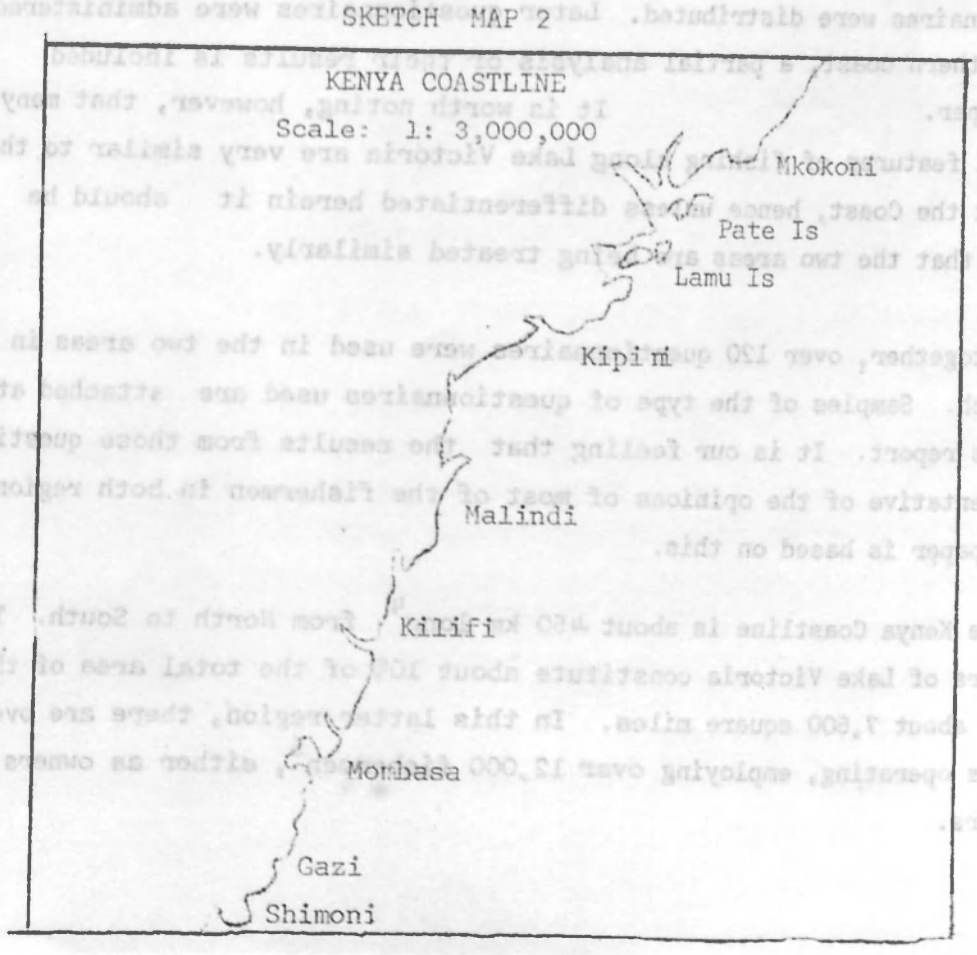
Altogether, over 120 questionnaires were used in the two areas in conducting the research. Samples of the type of questionnaires used are attached at the end of this report. It is our feeling that the results from those questionnaires are representative of the opinions of most of the fishermen in both regions, hence our paper is based on this.

The Kenya Coastline is about 450 km long[4] from North to South. The Kenya Waters of Lake Victoria constitute about 10% of the total area of the Lake, i.e. about 7,600 square miles. In this latter region, there are over 4100 canoes operating, employing over 12,000 fishermen[5], either as owners or as labourers.

SKETCH MAP 1



SKETCH MAP 2



Along the Coast, most of the fishing is done in the shallow waters along the continental shelf, which is very wide in the north, particularly at Ungwana Bay, but which narrows rapidly towards the south. It is important to note also that along the coast, most of the fishing is done where the fish can easily be put onto the market, and where storage facilities are available.

We wish to mention here also that apart from the two areas dealt with in this paper, i.e. the Kenya Waters of Lake Victoria and the Kenya Coastline, other major sources of fish are to be found especially in Lake Turkana, all the other Lakes and Rivers, and the fish ponds around the country. References to these areas will be encountered throughout this paper. Note also that as used in this paper, the word, "Coast" will refer to the Kenya Coastline of the Indian Ocean, and the word, "Lake", will refer to the Kenya Waters of Lake Victoria, unless stated otherwise. These words will be used in reference to the areas covered in the research, as specified in the opening paragraph of this section.

We feel it necessary at the start, to mention that in our report below, we shall be concerned strictly with the "Supply Function of Fish" as will be defined later. In this context, we shall therefore exclude other aspects of the fishing industry such as demand, marketing structure and systems, role of the government in the industry, the future of fishing, its development possibilities and suggested strategies, and any other aspects which do not relate directly to the supply of fish as at the time of writing of this paper. Our concern therefore will be mainly with the productive resources and techniques in fishing, and following this, an evaluation of the supply system on the basis of economic theory and graphical models.

The research revealed that entry into the fishing industry was open to anybody interested in joining it, and meeting the following conditions:[6]

(i) Non-citizens unless legally authorized are not allowed entry into the trade.

(ii) Possession of a Certificateof Registration from the Government.

(iii) Ability to meet the fees for Licence, boat label and registration, all amounting to about KShs. 50. These fees differ from area to area.

(iv) Finally of course ability to purchase or hire a canoe[7], nets and other necessary fishing gear, or to join the industry as a labourer, hired by the owner of the gear.

It is worth noting here that many people who are not fishermen by heritage and tradition have turned to fishing as a last resort for earning money due to the ease of entry in the fishing occupation since there is almost always opportunity to get a job provided one will accept a "low salary." The low earnings of the fishermen is illustrated by a quotation from a fisherman, Bakari Juwa of Vanga who says: "..... I need help from somewhere at least so that I could change my living..... I have only a shirt and a pair of trousers. Otherwise I can't afford. If I had more fishing equipment I could be able to get more fish thus more money, then I will educate my children." Most fishermen are in this state of not having modern fishing equipment, hence the low earnings as will be further noted elsewhere in the paper.

Private ownership is prevalent in the firms of this industry. The owners are usually members of the family, sometimes with a number of ..... hired workers. Although the great majority of Lake Victoria fishermen and indeed even those at the Coast dwell in Coastal communities and thus close to the element from which they derive their main livelihood, many venture appreciable distances from their home areas during the fishing seasons. The need for mobility in operations is in part due to the dispersed nature of the fishery. Such mobility therefore implies the relative unimportance of their home areas in fishing operations, with slight exceptions that will be noted later. Recruitment to the fisheries takes place from both the Lake region as well as from further inland. The latter trend involved mainly young men who have failed to get employment in their own areas, and who have friends or relatives in the fishing community. Few of them have their own canoes or nets, but rather most are employed to operate gear belonging to people living in the Lake region and thus receive a remuneration as per contract. Tribal bonds and loyalty to one's duty determine the type of persons engaged in the fishing. Together with these go the necessary skills for efficient and effective fishing, which include knowledge about the winds, and the currents, depth of the water, movement of fish and location of fishing banks, etc.

Organised fishing groups like-large partnerships or corporations are rare, due to the unavailability of sufficient capital for such investment. The majority of the fishermen are either totally illiterate or have very little formal education. Over 85% of our sample were either totally illiterate or were below Standard 5 level of education, the highest level of education encountered was Form 1 level (about 4%). It is worth noting that most of these illiterate people are of the older generation, i.e. over 35 years. It was

also noted that on average the fishermen at the coast are older than those found around the Lake. This can be seen from the frequency distribution showing the ages in the two areas below (Table 1) .

TABLE 1 FREQUENCY DISTRIBUTION OF THE AGES OF 65 FISHERMEN

AGE (IN YEARS)	NUMBER OF FISHERMEN		
	COAST	LAKE	TOTAL
15-19	-	2	2
20-24	1	4	5
25-29	-	7	7
30-34	-	8	8
35-39	3	3	6
40-44	6	4	10
45-49	7	1	8
50-54	-	1	1
55-59	3	3	6
60-64	1	1	2
65-69	4	1	5
70-74	5	-	5
TOTAL	30	35	65

Over 60% of the fishermen over 24 were married and so had family obligations to cater for. No female fishermen were encountered.

For most fishermen on the Lake (over 85%), fishing is a fulltime occupation. In this context the word "fishermen" refers to those people who actually go out into the water, be they labourers or owners of the equipment. Daily or contract labour constitute only about 5% of the fishing population. These are mostly school boys working on weekends, or people hired during a period of abundance of fish. The other 10% are seasonal or part-time fishermen who only come in during certain parts of the year. These may be established agriculturalists who work on the Lake on a seasonal basis. They may own their own equipment and use them during the good season, but may hire them out during periods when they are not fishing. At the coast too, most of the fishermen are fulltime.

This is evidenced by the fact that many of them have accumulated many years of fishing experience and have no intention of quiting very soon. Years of fishing experience of 30 fishermen from the South Coast are given in the Table 2 below.

TABLE 2: FREQUENCY DISTRIBUTION OF YEARS OF FISHING EXPERIENCE OF 30 FISHERMEN ON THE SOUTH COAST

EXPERIENCE (IN YEARS)	NO. OF FISHERMEN
Less than 5	2
5-9	-
10-14	1
15-19	5
20-24	6
25-29	3
30-34	5
35-39	3
40-44	-
45-49	2
50-54	3
TOTAL	30

Most of the fulltime fishermen are married, and are gear owners, and so having much equipment they are in a position where it is necessary to hire fulltime labour to help operate the gear. They mostly have few or no alternatives to fishing as a source of money income, and so have a more stable altitude towards their occupation. As E.C. Jansen remarks. ".....it is largely the fisherman's social and economic position which decides the degree of permanency of his recruitment to work on the Lake."[8]

As a starting point we find it necessary to include in this section a table showing the number of registered fishing boats in the research areas. This will serve as a reference point in the subsequent sections. Note here the difference between the figures of both fishermen and boats obtained by our research and those given in Dr. Okidi's paper (Marine fisheries).[9]

TABLE 3. NUMBER OF REGISTERED FISHING BOATS

CENTRE	NO. OF BOATS		NO. OF FISHERMEN	
COAST	Okidi's Figure	Ours	Okidi's	Ours
Vanga	106	100	440	400
Shimoni	168	300	446	600
Majoreni	90	-	380	-
Tiwi	50	45	363	200
Diani	189	80	450	240
Msambweni	258	70	466	160
TOTAL	861	595	2,545	1,600
LAKE:				
Kusa	-	80	-	250
Wichlum	-	45	-	145
Dunga	-	40	-	160
Uhanya	-	70	-	200
Nyamware	-	40	-	80
Kaloka	-	50	-	180
Waseda	-	45		150
TOTAL		370		1,165

The difference in figures arises due to the fact that all are just estimates and vary from period to period.

As has been noted above, boat or gear owners may hire labour to operate their equipment. These are then remunerated as per contract. It is worth noting that while cash wages are the standard practice, averaging about KShs. 30 to 40/= basic wage per month for permanent labour. or from =/50 to KShs. 3/= per day for contract labour, nets and fish are also used as forms of remuneration. In this latter case, a number of nets are assigned to the labourers and any fish caught within those nets (usually 5-8 nets for a person with over 40 nets) is theirs. Alternatively, a certain proportion of the daily catch is given to the labourers as remuneration, e.g., one fish out

of everh ten caught. Another popular method to that of giving the labourers all the fish caught on one day of the week as their remuneration for that week. Note here however, that where fish is used as a form of payment, the amount given away is usually taken as a reasonable estimate of the money value of fish. Apart from the basic remuneration as outlined above, there may be a bonus given for the high catch or special assignments (e.g., guarding nets in the water at night), and also a food allowance for those working during meal times. To increase his remuneration, the fishermen may "steal" some fish by landing it at a different site other than that at which the employer has his controls. Because of this latter possibility, very few fishermen own more than two canoes, since more could mean economic loss, as the labourers would take advantage of the owner's inability to check the movement of the canoes and the amount of fish which was caught. Instead of buying more fishing equipment, the successful fisherman may well decide to maintain only that level of investment in the fisheries which he can comfortably control, and then invest the remaining profit from the lake into other sectors.

Hiring of equipment is prevalent too as most of the fishermen cannot afford the high cost of equipment.

In this case, owners hire out their equipment and are paid as per agreement with the leassor. Usually a rent of Kshs. 40/= to 90/= per month is paid for a boat.

The research revealed too, that the fisherman were aware of the opportunity cost of fishing e.g., jobs on agricultural farms, in the forces, as watchmen, etc. Among our sample, those with prior fishing experience cited such previous occupations as fish mongering, boat repairing, M.O.W., shoe making, factory labourer, tailor, farmer, carpenter, clerk, mending nets etc. However, no notable turnover of labour has taken place despite this awareness of opportunity cost. Even if their educational levels are not the inhibiting factor, the fishermen feel more secure in their present occupations since:

(i) there is very little risk of loss of jobs,

(ii) the over head costs are very small,

(iii) for those with plenty of capital investment, quiting would mean loss since even the second hand prices of the equipment are quite low.

It is only when costs of factors of production rise drastically that fishermen may transfer to the next best alternative as happened in Lamu in 1977 when fishermen quit fishing and joined less remunerative mangrove cutting industry.

Fisheries cooperatives exist,-supported in many cases by the Government. These give loans to their members such funds being used in the purchase of fishing equipment by the members. However, very few people benefit from this cooperative system so far as only a few have joined the co-operatives. The government has also invested large amounts of capital in the industry, encouraging modern fishing especially at the coast. No major taxation of the average fisherman exists due to the inability or assessing the fisherman's income, i.e. the disparity in forms and amount of remuneration to the fishermen, and even the timing of this income has led to this inability to assess the earnings of the fisherman.

3. THE PRODUCTION FUNCTION

The term, "production function", refers to "the physical relationships between a firms inputs of resources and its outputs of goods or services per unit of time, leaving prices aside."[10] In our case, we can represent the fishermens' output in mathematical form as:

$$Q = f(t, p, N.L.).$$

where Q = the fisherman's output

t, p, N and L are the inputs, more specifically,

t = time

p = place

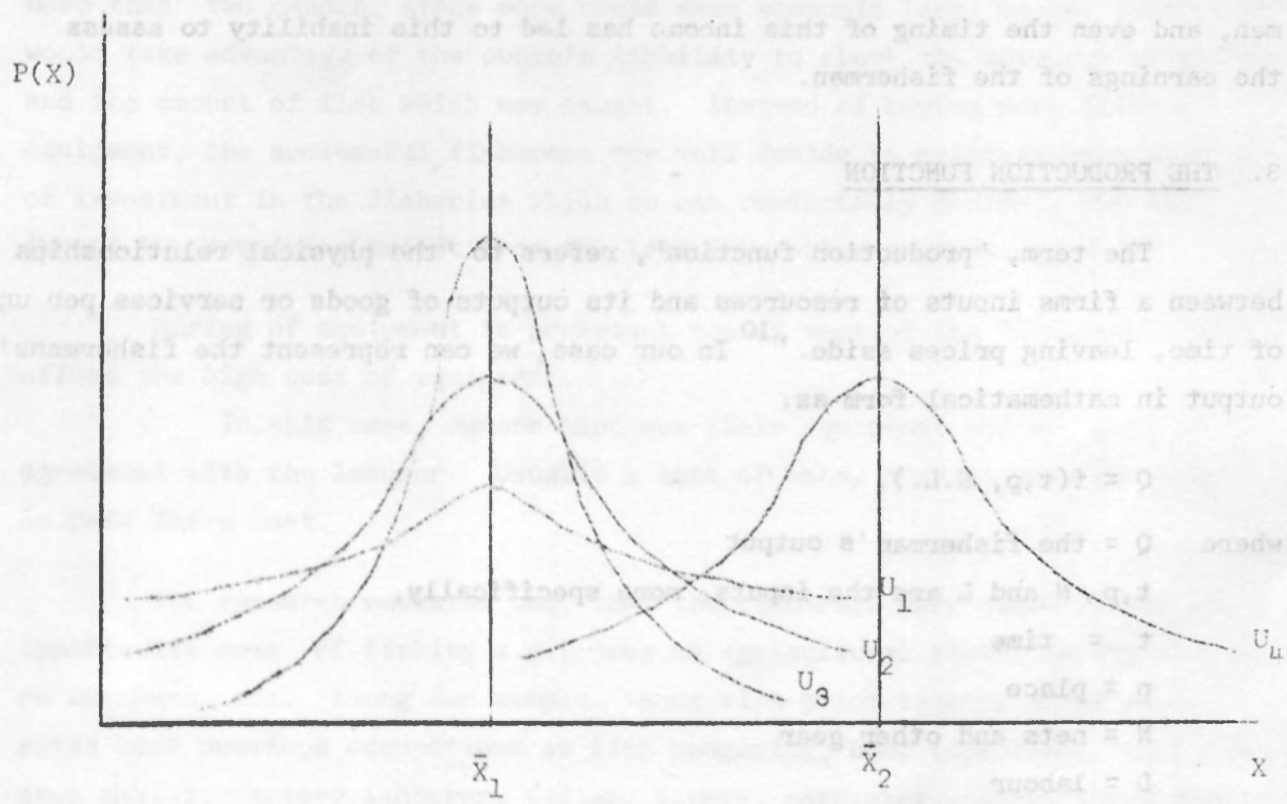
N = nets and other gear

L = labour

The research revealed that the fishermen had knowledge regarding all the inputs in their production function. Most of them knew about the times convenient, as well as the seasons; they had knowledge about differences in catches at different place along the shores, hence their migratory patterns in certain seasons, and finally they had knowledge of the importance of nets, boats, other gear, as well as labour in the production function of fish. As stated in the definition above, the physical relationships between these inputs determines the quantity of catch Q. Nevertheless, there is an expected catch E (Q), that fishermen would expect to derive from their combination of these

inputs. Apart from time, and labour, the other inputs are affected by the state of technology. It should be noted here then that technology changes the expectation of the fishermen. At the same time, improvement in the state of technology would raise the expected value of the catch. The distinction between the two can be illustrated by use of the Normal Curve Distribution[11], as in the diagram below. It could be examined by using a Means-Variance Analysis.[12]

FIGURE 1. EXPECTATION VS. EXPECTED VALUE - THE NORMAL DISTRIBUTION APPROACH



In the figure above, the curves U_1, U_2 and U_3 represent variations in expectations of the fishermen due to changes in technology. Starting with the expectation denoted by the normal curve, U_1, the expectation will draw closer and closer to the expected mean, $\bar{X}_1$, as technology improves. The fishermen actually expect a catch with greater certainty as the confidence limits draw closer and the standard deviation narrows. The curve, U_4 denotes the actual rise in the expected value, from $\bar{X}_1$ to $\bar{X}_2$ due to technogical innovation. Such innovation may take the form of better quality nets, boats, and other gear that can permit travelling further offshore in search of fresh fishing grounds.

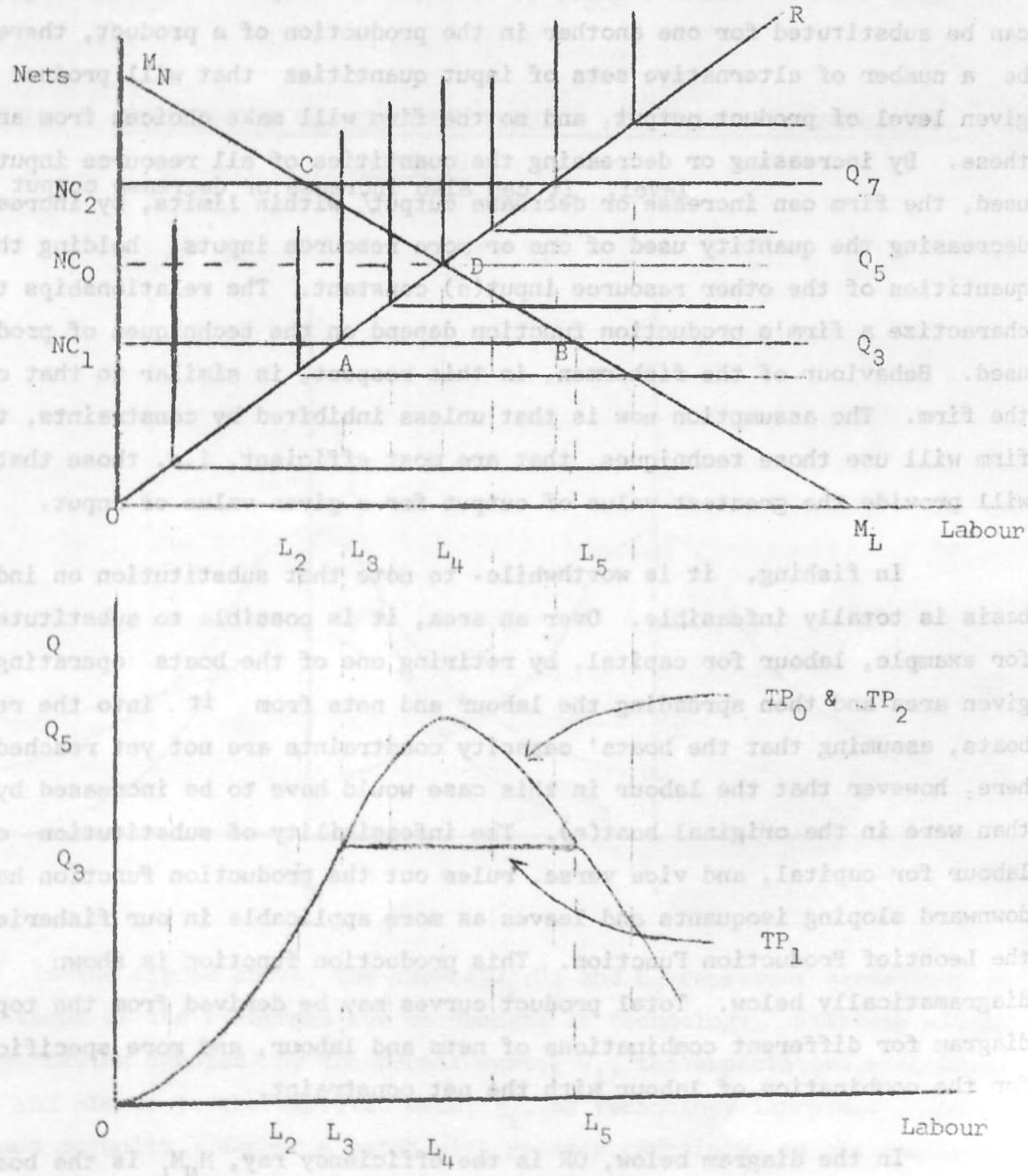
Because of the knowledge possessed by the fishermen, therefore, there is a possibility of varying the relationships between the inputs in the production function in such a manner as to improve the catch, subject to the constraints discussed elsewhere below. In classical economic theory, firms can usually vary the proportions in which resources are combined in production processes[13]. Where inputs can be substituted for one another in the production of a product, there will be a number of alternative sets of input quantities that will produce a given level of product output, and so the firm will make choices from among these. By increasing or decreasing the quantities of all resource inputs used, the firm can increase or decrease output level. It can also increase or decrease output, within limits, by increasing or decreasing the quantity used of one or more resource inputs, holding the quantities of the other resource input(s) constant. The relationships that charactize a firm's production function depend on the techniques of production used. Behaviour of the fishermen, in this respect, is similar to that of the firm. The assumption now is that unless inhibited by constraints, the firm will use those techniques, that are most efficient, i.e. those that will provide the greatest value of output for a given value of input.

In fishing, it is worthwhile to note that substitution on individual basis is totally infeasible. Over an area, it is possible to substitute, for example, labour for capital, by retiring one of the boats operating in a given area and then spreading the labour and nets from it into the remaining boats, assuming that the boats' capacity constraints are not yet reached. Note here, however that the labour in this case would have to be increased by more than were in the original boat(s). The infeasibility of substitution of labour for capital, and vice versa, rules out the production function having downward sloping isoquants and leaves as more applicable in our fisheries case the Leontief Production Function. This production function is shown diagramatically below. Total product curves may be derived from the top diagram for different combinations of nets and labour, and more specifically for the combination of labour with the net constraint.

In the diagram below, OR is the efficiency ray, $M_N M_L$ is the boat constraint, specifically, M_N is the maximum number of nets that can be in the boat with zero labour, and M_L is the maximum labour that the boat can accomodate with zero nets. NC_1 is the position of the net constraint. The

net constraint is determined by the various fishermen's abilities to purchase the nets. Such ability or capital availability differs between fishermen, and so the net constraint may be below NC. (the optimal net constraint) or above NC_o, such as NC_2.

FIGURE 2. DERIVATION OF THE TOTAL PRODUCT CURVE



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In the figure above we note a boat constraint, $^{M}N^{M}L$. The fishermen are aware of this constraint, though we did not get actual figures for points ^{M}N and ^{M}L. As the fishermen stated however, --- "too many people or nets in one boat can make the boat sink. In any case it is silly filling a boat with either men or nets alone since 100 men in one boat with no net would catch no fish just as 100 nets in a boat with no labour wouldn't yield any fish either." This position can be seen from the figure above. The total product curve TP_1 is derived assuming a net constraint at NC_1. In this case, catch increases up till point A. Additional units of labour do not give any further increase in output, but, as fishermen say, --- "more men, easy work; less men hard labour!" At B the boat capacity constraint is reached, and additional units of men mean a reduction in nets, and since the two are not substitutes, catch declines. TP_2 is the total product curve assuming a net constraint at NC_2. In this case the boat constraint is reached at point C and output can only be increased by reducing nets to NC_o and increasing labour to L_4. The implication here is that at C, there are more nets than the labour can handle efficiently. Beyond L_4, diminishing returns result as nets are further reduced. A third total product curve TP_3 can be constructed assuming an optimal position for the net constraint, NC_o. In this case, catch rises steadily upto point D after which it declines as with TP_2.

Research reveals that the constraint on fishermen's catch at the moment is lack of nets, due to lack of funds for the purchase of these. With this sort of evidence, NC_1 is a more practical position for the net constraint than either NC_o or NC_2.

Establishing the optimum number of men in a boat is not easy due to the different boat sizes. It is more realistic to give a range. The average boats carry between 3 and 6 people, while the larger Sese, Bao and the dugouts carry between 6 and 8 people. 60% of the boats on the Lake are of the Sese type, 23% are Taroma, 15% are Karuas while the rest are dugouts.[14] 30% of them use sails, while the rest are paddled. At the Coast, over 90% of the boats are dugouts.

While similar analysis could be proposed holding labour constant and varying nets, this is deemed unrealistic here since the research revealed that nets were the constraining factor, and not labour. Varying nets therefore would be unrealistic as the fishermen are not in a position to behave thus due to lack of sufficient funds with which to increase their nets.

boat constraint is reached at point

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the constraining factor, was not labour. Varying nets therefore would

sufficient funds with which to increase their nets.

As was noted above the Leontief production function is more relevant to the fishing industry, since capital (nets, gear, boats) and labour can only be used in fixed proportions. In neoclassical economics, output can be increased by increasing the inputs as desired. Due to the fixed proportionality of input ratios depicted by the Leontier production function, it is implicit that more output can only be produced with fixed/proportional increases of inputs. More specifically, increased output can be obtained over time by overcoming the binding constraint (men or nets). The production function in this case becomes:

$$Q = \text{Min}\left\{\frac{N}{a}, \frac{L}{b}\right\},$$

where Q= output

a= nets per unit of output

b= labour per unit of output

N= total number of nets

L= total units of labour

The minimum of $\frac{N}{a}$ and $\frac{L}{b}$ would be the output achieved.

The effects of technical progress in this production function are shown in the figure below. More output can be produced with constent inputs. It is as if the isoquants in figure 3 have been renumbered. Technical progress in this case represents the ability to get to better waters. In the figure below, hypothetical figures are used to illustrate this technical progress. Figures on the vertical parts of the isoquants show output before technical progress while those on the horizontal parts show output following the technical progress. NC is the net constraint. The total product curve TP represents output before progress while TP_1 represents output after technical progress. They are derived as previously illustrated. The type of technical progress illustrated here is the Hicks - Neutral Technical Progress.[15] Output increases in Figure from Q = 7 to Q=10 following the technical progress. The total product curve shifts accordingly.

Apart from the two major constraints, i.e. boat capacity constraint and the net constraint noted above, it is worth noting that cost too has a possibility of being a binding constraint on the fisherman. Although the issue of price will be considered later on, we can establish at this point the cost constraint. With the fisherman's available money resource to be used in the fisheries, he can either buy nets (and other gear) or labour, or a combination of these two. This daily total cost function will be given as :

$$C=P_N.N+P_L.L$$

Where C= daily total cost

P_N= daily cost of net

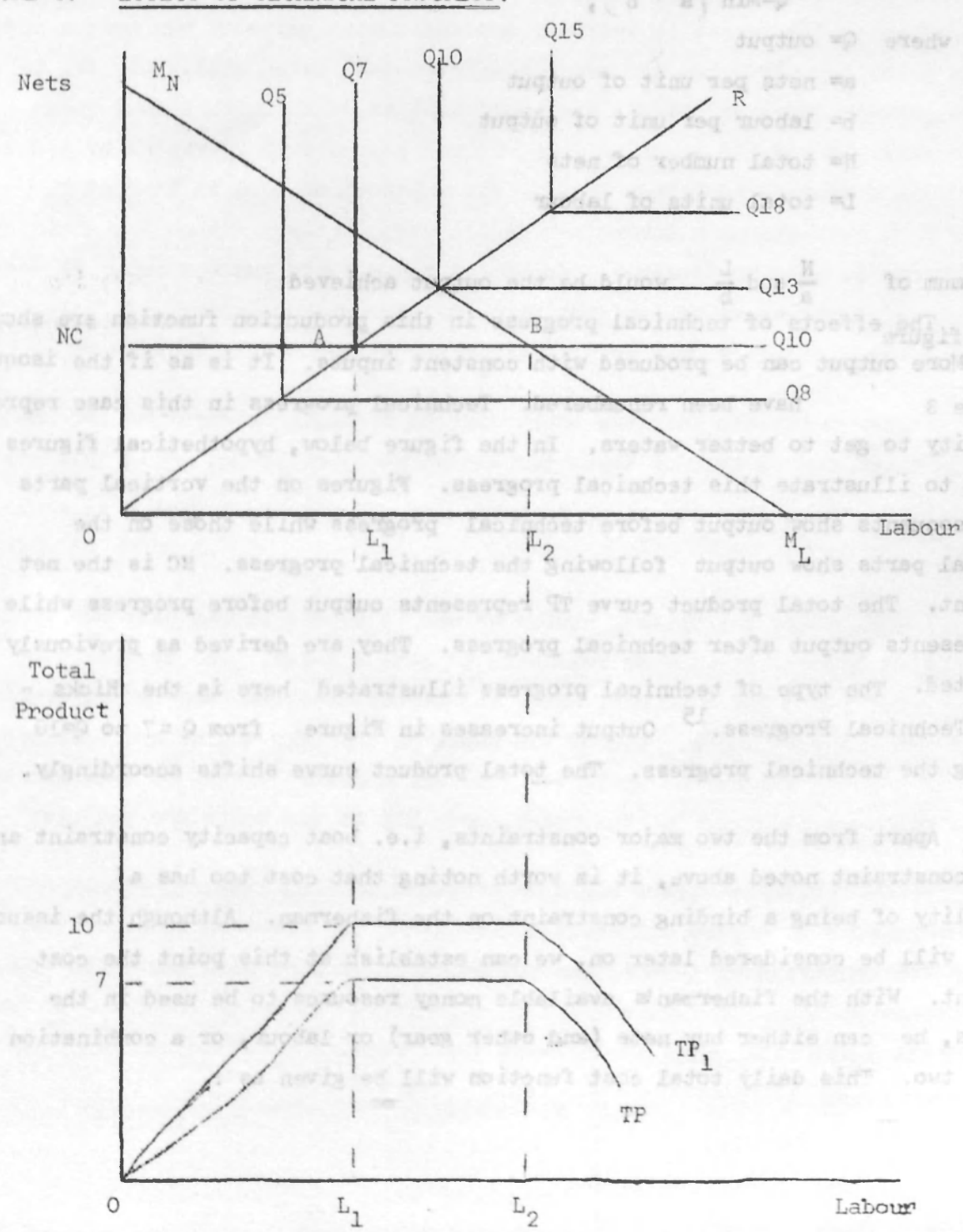
N= total number of nets possessed by fishermen

P_L= daily labour cost (unit)

L= total units of labour employed,

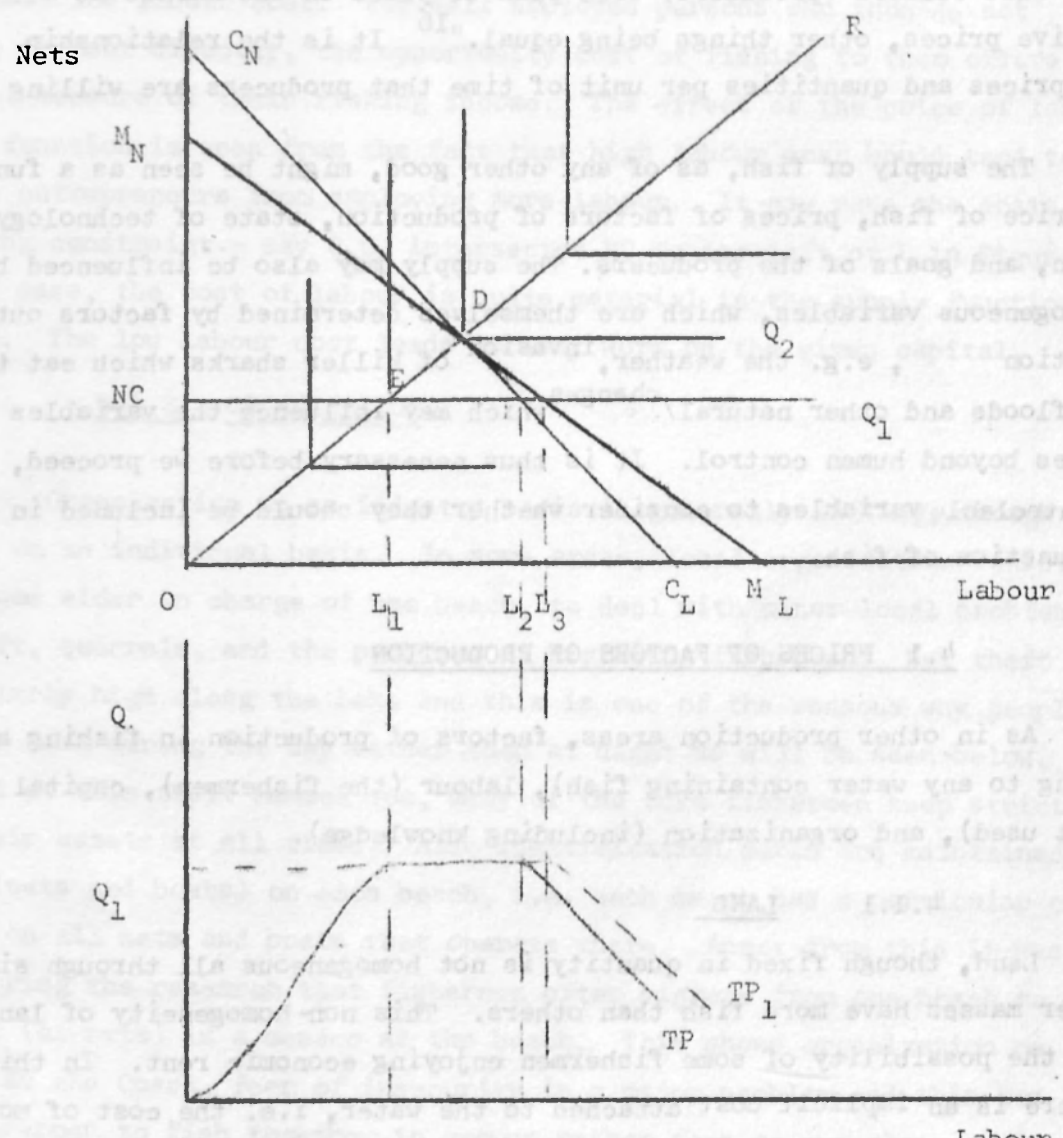
P_N can be found by dividing the total cost of a net by the number of days of its useful life. This will correspond to its daily depreciation charge, dealt with later.

FIGURE 3: EFFECT OF TECHNICAL PROGRESS.



Even if we do not calculate specific figures for P_N, N, P_L and even L, we can construct a diagram with the total expenditure function as a further constraint. In this case, the fishermen will operate only at a point which is feasable under his three constraints, i.e. net, capacity and cost. This is shown in Figure 4 below. OR is the efficiency ray, NC is the net constraint, $M_N M_L$ is the capacity constraint (it does not necessarily go through point D) $C_N C_L$ is the cost constraint and Qi are the isoquants.

FIGURE 4. COST AS ANOTHER CONSTRAINT



In the figure above, the cost constraint $C_N C_L$ allows the fishermen to employ only upto L_2 units of labour. This is less than L_3 which was the maximum allowed by the boat constraint before output starts to decline. TP is the total product curve resulting after the coat constraint is imposed. TP_1 is the original

total product curve. The shapes of the total product curve will depend on the nature of the various constraints and will thus alter as the positions of the relevant constraints change.

4. THE SUPPLY FUNCTION

The supply of a good is generally defined as "the various quantities of the good that sellers (producers) will plan to place on the market at all possible alternative prices, other things being equal."[16] It is the relationship between prices and quantities per unit of time that producers are willing to sell.

The supply of fish, as of any other good, might be seen as a function of the price of fish, prices of factors of production, state of technology, time variation, and goals of the producers. The supply may also be influenced by other exogeneous variables, which are themselves determined by factors outside the function , e.g. the weather, invasion of killer sharks which eat the lesser fishes, floods and other natural/changes which may influence the variables but are themselves beyond human control. It is thus necessary before we proceed, to look at the controlable variables to consider whether they should be included in the supply function of fish.

4.1 PRICES OF FACTORS OF PRODUCTION

As in other production areas, factors of production in fishing are land (referring to any water containing fish), labour (the fishermen), capital (the equipment used), and organization (including knowledge).

4.1.1 LAND

Land, though fixed in quantity is not homogeneous all through since some water masses have more fish than others. This non-homogeneity of land leads to the possibility of some fishermen enjoying economic rent. In this case, there is an implicit cost attached to the water, i.e. the cost of moving from one body of water to another. If we assume that this movement increases wear and tear of the boat, then this imlies accelerated depreciation, which means therefore a daily cost of boat higher than it would be if the movement had not occurred. Other than depreciation costs, there is the sociological cost of disruption involved in the movement. Since (as will be seen later) the private marginal cost here differs from the social marginal cost, everybody treats the water as being free and thus inflicts social costs on others.

Fish ponds are another aspect of land supplying fish. These have so far been constructed and maintained by the Government as an alternative to Lake fishing.

4.1.2 LABOUR

The low skill requirement in fishing as well as widespread under-employment has made for an excess supply of labour to this industry with a consequent low labour cost. For self employed persons who thus do not receive payment directly, the opportunity cost of fishing to them offers the best measure of their fishing income. The effect of the price of labour on the function is seen from the fact that high labour cost would tend to discourage entrepreneurs from employing more labour. It may make the costs into a binding constraint - say $C_N C_L$ intersected NC to the left of E in Figure 4. In this case, the cost of labour is quite material in the supply function of fish. The low labour cost leads to easy work on the given capital.

4.1.3. ORGANIZATION

Organization on an industry basis is generally lacking, though probably present on an individual basis. In some areas, local organization exists usually under some elder in charge of the beach, to deal with minor local problems like net theft, quarrels, and the problems of migrating fishermen. Net theft is particularly high along the Lake and this is one of the reasons why people along the Lake fish during the day rather than at night as will be seen below. As a result of this theft menace too, many of the Lake fishermen keep strict guard over their assets at all times. Also identification marks are maintained on all assets (nets and boats) on each beach, i.e. each beach has a particular colour painted on all nets and boats that operate there. Apart from this it was also noted during the research that fishermen often migrate from one beach to another if theft (of nets) is a menace at the beach. This shows organization on individual basis. At the Coast, fear of insecurity is a major problem and this has led most fishermen to fish together in groups rather than go out alone to further points in the ocean. Most of them are like Katoto Munai of Shimoni who says --- "I fear fishing alone." Omar Siwa of Msambweni echos similar fears of insecurity when he says,"... We fish together in the same ground so that we can help each other in case of trouble. Also I've got a big family so I can't leave them alone." Suleman Ali of Tiwi confirms this view, and adds,"... my partners won't agree to move further offshore, for rescue purposes." These views also tend to point to some sort of local organization among the fishermen of the coast.

However, proper organization is still lacking as was stated in the opening sentence of this section. The cause of this lack of proper organization is most probably the high rate of illiteracy among most fishermen. Also, the topography of Nyanza in terms of fish landing places, road network, means of communication and positioning of markets and towns control the scope and limits of organised fishing. The coastal region is no exception to this as can be seen from a quotation taken from the Coast Provincial Commissioner:[17] "..... the Ministry of Cooperative Development should help improve the fishing industry at the coast by organizing a better marketing system and providing storage and transport facilities." He also noted that the Ministry had a role to play in improving the fishing industry for the benefit of the poor. In his words, "... We have all the resources including the fishermen. What we now need is guidance from the Ministry or any other authority." He noted too that "... most local fishermen used antiquated methods."

In this case, the price of overall entrepreneurship is rather intangible on an industry basis. For entrepreneurs owning more than one boat, or even just a single unit of capital, organization is absolutely essential to success of their operations. Organization in this instance implies the ability to control properly the operations of the business. As Jansen notes, "... since profit is ultimately destined to return to particular persons, the best way to control one's invested resources in the fishing sector is to have individual ownership. This form of ownership means that no people own more equipment than they can control. This implies that there exists a very decentralized type of ownership of capital equipment in the fishing sector, devoid of any monopolistic tendency."[18] The importance of organization can be further seen from Jansen's observation that "... to some degree the owners of the gear and the people they employ have contrary interests. The owners of the gear want their crew to work as hard as possible, while at the same time they like to get as much as they can of the fish caught. The labourers for their part are not interested in exhausting themselves, but they want to get their fair share of the catch. The salary system used to pay the crew is a compromise and a modification of the conflicting interests between the two groups. It is necessary for the owners of the gear to give additional stimulants and bonuses to the crew on top of their basic salary. In this case, both groups would have an interest in getting a large catch."[19] From this quotation, the importance of organization as an element in the supply function cannot be overstressed. The cost of this organization, so far, entails a sacrifice by the owners of the gear to see to the success of their operations an can thus be viewed in terms of their opportunity cost.

Together with the importance of organization, it is worthwhile to note that the general awareness of the fishermen, i.e. possession of knowledge regarding relevant aspects of their trade, has been of great assistance to the minor forms of organization existing in the fisheries today. Fishermen have knowledge of alternative forms of capital equipment that they could use if money were available for their purchase, they know of the useful lives of these equipment, their costs, fishing seasons and times, migratory patterns of fish and better beaches, alternative forms of employment other than fishing, overfishing, as well as the general problems facing them. Such knowledge is derived either from personal experience, witnessing or hearing about other people's experiences, and enquiring about the goings on at other beaches. Others travel as far as those other beaches to confirm their suspicions. This possession of knowledge allows for the best planning possible, given the present constraints. The cost of organization in this instance, is again best viewed in terms of opportunity costs.

4.1.4. CAPITAL.

Capital may defined as "all non-human resources that contribute to the production of goods and services",[20] and technology as "as the know-how and the physical means of transforming resources into the production process".[21] These definitions allow us to review capital especially in the fisheries, as being embodied in the technology. We can thus isolate the major forms of capital used as hooks and lines, traps, gillnets, seine nets, canoes and other boats, sails, baskets, spears, traditional dugouts, traditional ngalawa,[22] uzio, oars, goggles, ndema, engines, shark nets, cast nets, prawn nets, etc. Initially, the cost of equipment used largely affects the supply function. Lack of capital of course means no fish, and so with each additional unit of capital an increase in the output is experienced. After the initial stages the units of capital are considered a fixed cost and during this period their prices are considered immaterial, as they have already been purchased and it is only when replacement is desired that their prices will affect the supply function again. This is dealt with more under the discussion on technology below.

The prices of the various forms of capital equipment are tabulated below. From these prices and combinations of input relationships, we can work out an approximation of the total investment in the fisheries for an average fisherman.

(i) Mosquito seine net - price= 1000/= per piece,
10 pieces are needed for effective fishing
10x1000 = 10,000/=

(ii) Good canoe, cost range 4,000/= - 7000/=

(iii) Gill nets - the ply (thickness of twine) determine the cost:
2 ply nets cost 35/=
3 ply nets cost 45/=

Also needed: 8 floats @ =/70 = 5/60

Mounting lines 3 per net @ 3/ = 9/=

Sinkers and sinker wrappers = 20/=

Labour in making the net = 15/=

Total cost of 2 ply nets = 35/= + 5/60 + 9/= + 20/= + 15/= = 84/60

Over 20 nets desirable: "Minimum Cost' of nets = 20 x 84/60 = 1692/=.

Total investment in boat and gear = 5692/= - 8692/= at the Lake.

Gill nets and canoes are the most common capital items used. For the purely subsistence fisherman (very few), their equipment is more traditional, e.g. traps, baskets, spears, etc., and these are often made and prepared by the people who operate them.

The durability of the capital items depend on:

(i) how often they are used; i.e. the frequency and size of the catch,

(ii) which areas of the lake they are used in; and

(iii) how well prepared and maintained they are (quality). Items used only seasonally may last several years, while those used frequently (continually) last much shorter. The average life times of these equipment, their costs, and the cost per period, i.e. depreciation expense, is tabulated below.

The amount of gear in any particular canoe will depend on:

(i) the economic resources of fishermen for the purchase of these;

(ii) the number of separate net owners working in the same canoe;

(iii) the sort of fishing season they get:

(iv) the number of hours it is possible for the fishermen to work in the lake before the waves get too big, and

(v) the size of canoes. The bigger canoes (over 25 ft. long) can carry up to 150 nets, while the medium ones carry 50-70 nets and the smaller ones 40-50. It was noted earlier on, the size of the canoe may hinder further investment in nets.

The issue of wear and tear of the capital items is important, in that it can help to estimate the daily cost of capital used, and consequently the cost of capital per unit of fish caught if we know the latter figures. Depreciation is defined as "the cost of the expired services of tangible plant assets."[23] The explanation here is that asset services have been acquired in advance of their use. The more pertinent factor in the estimation of service life is physical deterioration of the nets and boats due to wear and tear from operating use. Since the estimated net salvage value of much of the capital is negligible, the depreciation base is taken as the acquisition cost. It is possible to vie

TABLE 4. CAPITAL FORMS - TYPE, COST, USEFUL LIFE AND PERIODIC DEPRECIATION

TYPE	COST(KSHS)	USEFUL LIFE	DEPRECIATION
Canoe	3000/=	10 yrs	300/= p.a.
Bao 3½	1600/=	8 yrs	200/= p.a.
Sese Canoe	5000/=	9 yrs	555/= p.a.
Mtumbwi Canoe	2000/=	10 yrs	200/= p.a.
Dugout (trad.)	1500/=	15 yrs	100/= p.a.
Ngalwa (trad.)	840/=	7 yrs	126/= p.a.
Mashua (trad.)	2000/=	20 yrs	100/= p.a.
Sail	2500/=	2½ yrs	1000/= p.a.
Gill nets 3ply (one)	42/=	9 months	4/60 p.m.
Gill nets 2ply (one)	35/=	6 months	5/80 p.m.
Seine nets	1000/=	12 months	83/= p.m.
Shark nets	2000/=	4 yrs	500/= p.a.
Cast nets	200/=	8 months	25/= p.m.
Prawn nets	1500/=	2½ yrs	600/= p.a.
Soyo (trd.)	1200/=	6 months	200/= p.m.
Hook	25/=	5 months	5/= p.m.
Traps	40/=	-	-
Ndema	100/=	6 months	17/= p.m.
Spear	15/=	-	-
Goggles	45/=	5 yrs	9/= p.a.
Uzio	2000/=	12 months	166/= p.m.
Oars	15/=	12 months	
Anchors	-	2 - 3 yrs	-
Line (one)	40/=	8 months	5/= p.m.

boats and nets as being more productive in their earlier years than later. However, since catch is ultimately not totally dependent on the age of equipment, we have adapted the straightline method of depreciation, although we know that use of this method makes depreciation a fixed periodic cost by assumption, and thereby does not allow for loss of service potential related to wear and tear through usage. The question of materiality, especially in the case of depreciating nets, hooks and the short lived assets also arises.

It is worthwhile noting that the costs of operation differ with respect to the individual fisherman's technology. In this case both the explicit and implicit costs of production are important. The running costs are higher in the case of the users of engine boats, since they have to meet the fuel costs as well. This practice is more common on Port Victoria beach, in many of the other beaches however, paddles and sails are used as means of propulsion. In the same respect, while the costs of operation differ with respect to technology, yet it can be noted that these costs of capital limit the sort of technology adopted since the majority of fishermen lack sufficient funds. The quality of the available equipment (embodying technology) hampers the development of the fishing industry towards increased output.

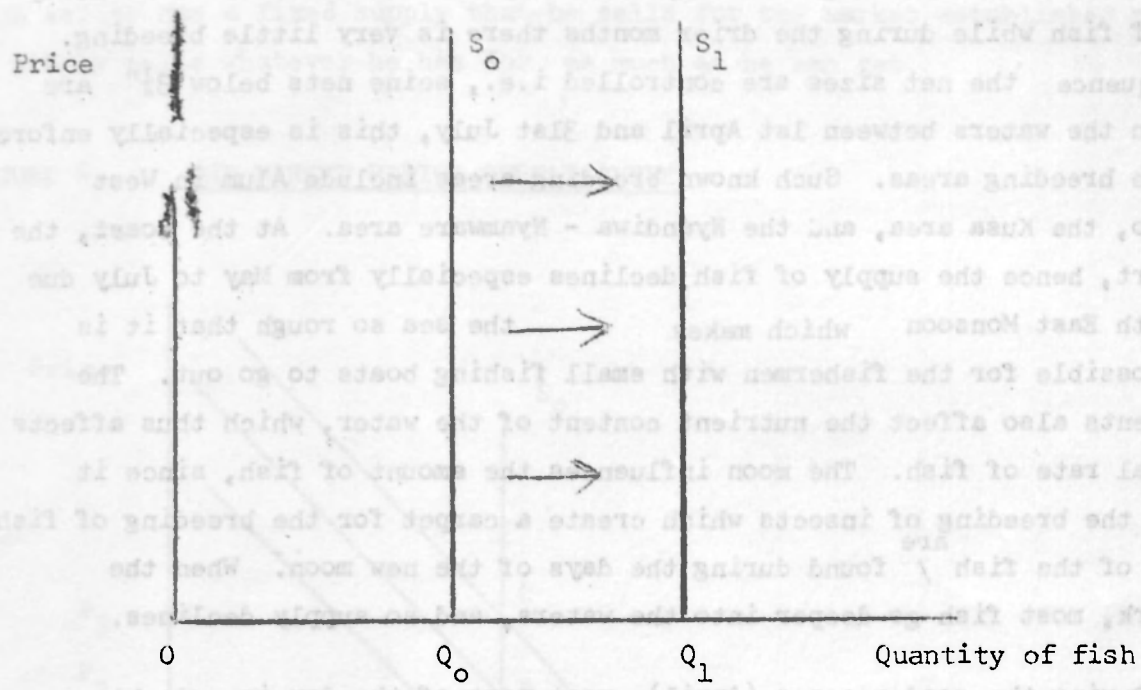
4.2. STATE OF TECHNOLOGY

Technology as defined as the "sum total of the society's pool of knowledge concerning the industrial and agricultural arts".[24] The technology existing at a given point in time sets limits on how much may be produced with a given amount of inputs, as was noted in our discussion of technical progress above. Given the level of technology there is generally a wide range of possible methods of producing a given good/service requiring different combinations of inputs, as was seen in the discussion of technical progress. The production function discussed previously shows for a given level of technology, the maximum rate of output that can be achieved from a given amount of inputs.

The technology found in the fishing industry differs from place to place, in some areas, the traditional fishing methods still exist, e.g. hooks, traps, spears, baskets etc. The most modern techniques/applied widely rank among what we would call intermediate technology, i.e. use of engine boats, different types of nets, e.g. seine, gill and shark nets, etc. The really modern technologies involving the use of trawlers / non-existant on the lake, but probably exists to a small extent on the ocean. Lack of sufficient funds and adequate knowledge of handling the higher technologies are constraints on the fishermen but we have no direct evidence that they would plan to use them despite / advantages of increased catch. (Fishermen indicated rather, that they would expand the scale of their operations with existing technology should funds be available.) The efficiency of modern, improved technology in expanding output is an obvious fact, and the fishermen know it. This is because the more advanced technology would enable the users to go further offshore in search of better fishing grounds,rather than remain perpetually in the already overfished grounds. Occurrance of overfishing is indisputable, especially along the shores as stated by most fishermen, who have migrated from their previous beaches as a result. The implication here therefore is that with improved technology the output will expand, and the supply curve, which is perfectly inelastic as will be seen later, will shift outwards to the right while retaining its original shape as shown below.

It is interesting to note that whereas changes in the price of fish do not evidently affect the supply function of fish, changes in prices of technology greatly affect it. As was noted earlier the technology is embodied in the forms of capital used. Assuming that a given technology persists, assume also that the fishermen also need to replace their equipment and suppose the prices now go up. The fishermen will either buy the equipment (if they have the money), or enter into some collective purchasing arrangement with others, or else quit.

FIGURE 5 . SHIFT IN SUPPLY CURVE DUE TO IMPROVED TECHNOLOGY.



While changes appear to be taking place in the sort of technology used by most fishermen, i.e. many are graduating from hooks, traps, etc. to the intermediate techniques as money becomes available, large scale mechanized fishing is not coming in very fast. The benefits of this mechanization aside, its welfare affects are:

(i) there would be economic competition between local fishermen and the trawler operators, and hence competition and conflict between the two groups for the use of the same bodies of water;

(ii) stocks of certain fish species would gradually be diminished because of the fishing activities of the trawlers.

In this case many fishermen would be affected by the imminent unemployment; commericial exploitation will be high, and overfishing will result. This view is supported by most fishermen including one, Alfred Okumu, of Dunga beach who says ".... it appears we are going to lose our self employment, since more people are beginning to join us and the fish population is decreasing." Another fisherman from Seme beach, George Omuke says, ".... trawling should not be allowed in the lake. It is also another menace apart from theft and floating islands."

4.3. TIMIMG VARIATION

Fishing activities follow a seasonal pattern - breeding, growth, movement and migration of fish all take place during given periods. Fishing however is done all the year round - the seasons only indicate the peak and slack periods.

In the connection it is worth noting that the supply of fish is influenced by climatic factors which influence the breeding rhythms and hence population densities of fish at various times. During the heavy rains (April - October) there is heavy breeding of fish while during the drier months there is very little breeding. In consequence the net sizes are controlled i.e., seine nets below 3½" are outlawed in the waters between 1st April and 31st July, this is especially enforced in the lake breeding areas. Such known breeding areas include Alum in West Karachuonyo, the Kusa area, and the Nyandiwa - Nyamware area. At the coast, the catch effort, hence the supply of fish declines especially from May to July due to the South East Monsoon which makes the sea so rough that it is almost impossible for the fishermen with small fishing boats to go out. The ocean currents also affect the nutrient content of the water, which thus affects the survival rate of fish. The moon influences the amount of fish, since it influences the breeding of insects which create a carpet for the breeding of fish, hence most of the fish are found during the days of the new moon. When the moon is dark, most fish go deeper into the waters, and so supply declines.

During the good seasons (April), most parts of the day is suitable for fishing. From the research, it was noted that those people with smaller boats spend more time in the Lake on average, i.e. 6-8 hours as they fish closer to the shores (where it is quite difficult to get good catches fast), while owners of larger boats go further offshore to fresher grounds and so spend less time before returning with their catch. Various arguments were advanced for day vs.night fishing. The proponents of night fishing said that fish mostly move and feed at night, and that it is more quiet and cool. Supporters of day fishing said that the water during daytime was clearer, fish are present, good winds prevail, lake is not very rough and that it is easier to locate fishing grounds. In addition to this they said they preferred daytime fishing since theft of nets was prevalent at night. There thus emerges a clear divisionbetween those who prefer day and those who prefer night fishing.

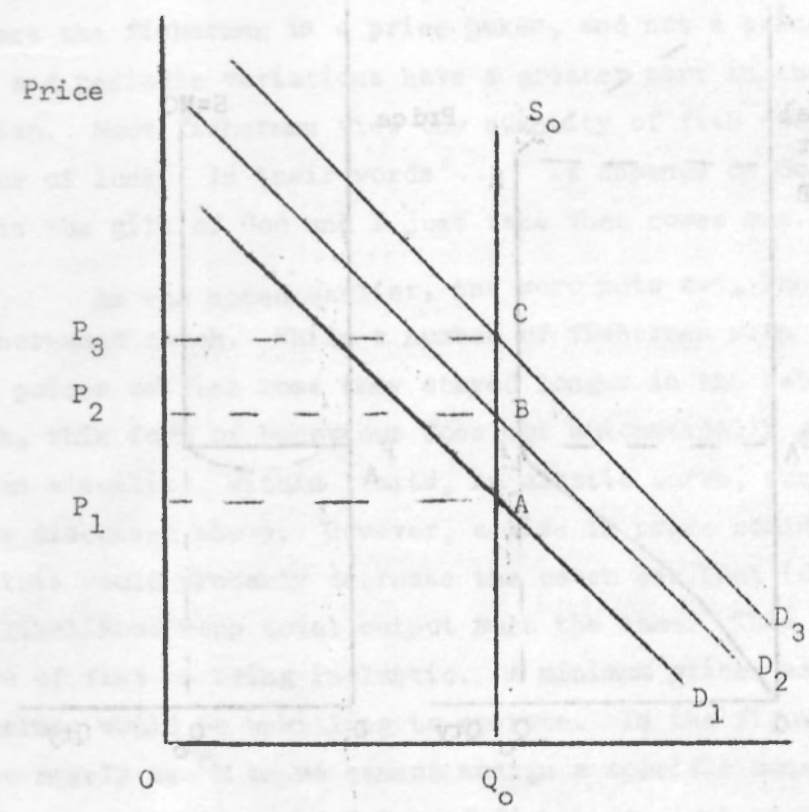
As was noted above, fishermen are aware of all these variations and consequently organize their activities in such a way as to utilize their knowledge regarding the timing variations.

4.4. TIME PERIOD

In classical economics, three time periods are usually noted: the market period, the short run and the long run. By definition, the market period is "the period during which the supply of a good is fixed."[25] In fishing, this is the period following the harvest of the catch, in which time the quality harvested may be fixed for some time after the harvest, hence, the supply curve, i.e. the curve that shows the quantity of output supplied at each price is a vertical straight line as shown in the figure below. Note that in this situation, since

each seller has a fixed supply that he sells for the market established price, he simply sells whatever he has for as much as he can get.

FIGURE 6. THE MARKET PERIOD SUPPLY CURVE

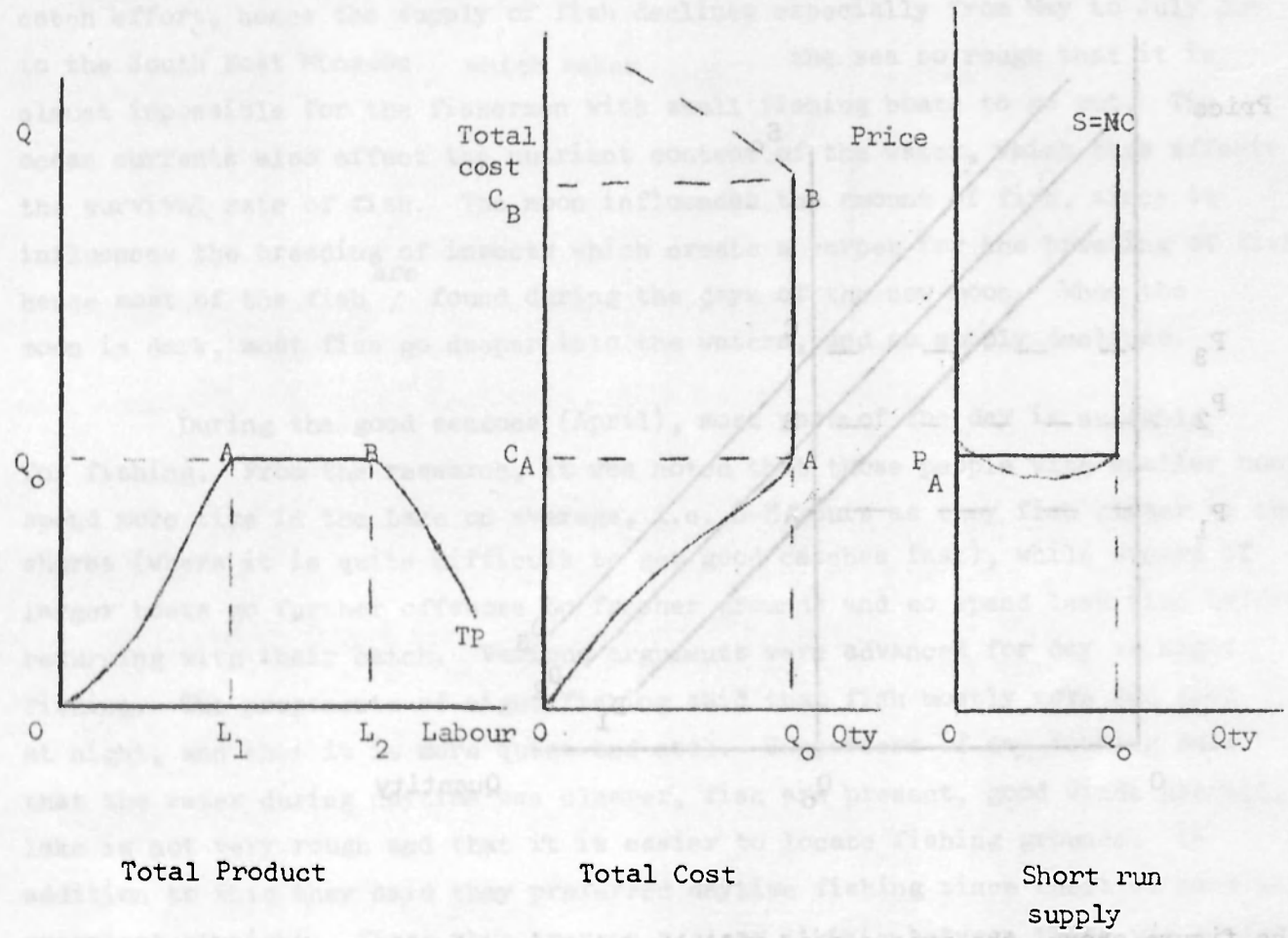


In the figure above, the prices paid will be determined by the nature of the demand as shown by the equilibrium points A,B and C.

The shortrun is defined as "that period of time in which some of the firm's inputs are fixed."[26] More specifically, it is the length of time during which the fishermen's equipment is fixed. A more elaborate definition gives the short run as "a planning period so short that the firm is unable to consider varying the quantities of some resources used."[27] The fisherman is unable to vary his equipment, i.e. boats, nets, etc due to the fact that since he has insufficient funds, it may take sometime to acquire additional quantities or to dispose of a part of the quantities already owned. Within the fishing industry as a whole, the length of the short run varies greatly, depending on the individual fisherman's ability to vary his equipment following availability of funds.

The short run supply curve can be derived from the total product curve in Figure 2 derived above. The flat portion of the total product curve represents a fixed supply, but increasing marginal costs. These marginal costs, mainly cost of employing additional labour, increase even when quantity starts falling as more labour is added. In the short run therefore, the supply curve is equal to the marginal cost curve. This can be seen in the three panel diagram below.

FIGURE 7. DERIVATION OF THE SHORT RUN SUPPLY CURVE



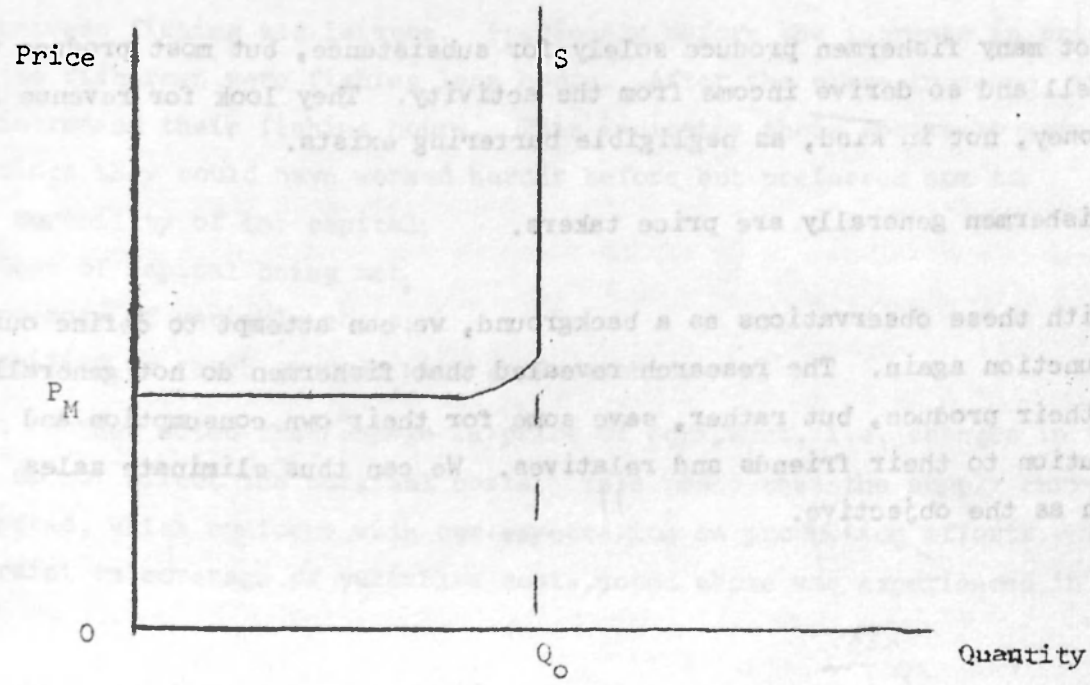
The long run is "the planning period long enough for the firm to be able to vary the quantities per unit of time of all resources used."[28] In the long run therefore, we are worried about the alternatives available for capital. The firm in this case can make a complete adjustment to any change in its environment. The flexibilities introduced into the picture in the long run enable fishermen, for example to opt out of fishing and put their capital to other uses, as happened in the Lamu case which was cited earlier. In this case, the long run supply curve will probably tend to NC_o in Figure 2 discussed earlier, and the highly elastic portion will be the supply curve. Note that it does not maintain its high elasticity indefinitely into the future, but will ~~truncate~~ [illegible] in the long run.

4.5. PRICE OF FISH

In the short run, some inputs are fixed, and so increases in the price of fish will have no notable effect or influence on the quantity of fish supplied. Unlike the other industries where a desired level of output can be predetermined and prices fixed accordingly thereby giving rise to the usual upward-to-the-right sloping supply curve, the fish industry is such that the fishermen cannot determine the desired quantity depending on the prevailing or expected prices. In fact the fisherman is a price taker, and not a price fixer. In this respect, luck and periodic variations have a greater part in the supply of fish than prices of fish. Most fishermen view the quantity of fish caught as being basically a matter of luck. In their words "... " it depends on God's will that day," or "... it is the gift of God and I just take what comes out."

As was noted earlier, the more nets set, the higher the probability of an increased catch. While a number of fishermen were reported as saying that when prices of fish rose they stayed longer in the water so as to increase their catch, this form of behaviour does not automatically guarantee increased catch. We can visualize, within limits, an elastic curve, such as the long run elastic curve discussed above. However, a rise in price could attract more fishermen, and this would probably decrease the catch per boat (due to overfishing), and in all likelihood keep total output much the same. This establishes the supply curve of fish as being inelastic. A minimum price exists, below which the fishermen would be unwilling to operate. In the figure below, we designate this price merely as P_M as we cannot assign a specific monetary value to it due to differences in sizes and types of fish. The price paid by the consumer will depend on the nature of his demand function.[29]

FIGURE 8. THE SUPPLY CURVE FOR FISH.



It is worth noting in conclusion that of the variables in the supply function: prices of factors of production, state of technology, time period and timing variation all affect the quantity supplied. The price of fish (in the short run) does not affect the supply, unless such price falls below the minimum price, P_M, at which point the fisherman will simply quit, since he cannot even meet his operating expenses, the goals of the producers are discussed under the objective function below.

5. THE OBJECTIVE FUNCTION

Briefly stated, this function defines the goals of the fishermen. It tells us what it is that the fisherman is trying to obtain or to maximize. Ordinarily, the fisherman may aim at one or a combination of several things - maximization of catch, of profits, of sales, a target income, or minimization of risk, among others. From the research, several observations can be made:

1. There is evidence that fishermen react favourably to things which increase output, e.g. increase in nets is desirable, fishermen request loans to purchase equipment to enable them increase their catch, they migrate to fresher grounds in search of larger catches, they seek information about availability of fish in other grounds, etc.
2. The fishermen are risk averse, i.e. they don't move far from their home areas, or even as far out into the water as they would consider their security endangered. This is particularly so with the Coast fishermen who thus fish close to the shore and together in groups as was noted above. At the Lake the risk of theft of nets is greater and fishermen in response to this do not fish at night as was noted earlier.
3. Not many fishermen produce solely for subsistence, but most produce to sell and so derive income from the activity. They look for revenue in money, not in kind, as negligible bartering exists.
4. Fishermen generally are price takers.

With these observations as a background, we can attempt to define our objective function again. The research revealed that fishermen do not generally market all their produce, but rather, save some for their own consumption and for distribution to their friends and relatives. We can thus eliminate sales maximization as the objective.

Maximization of revenue requires maximization of the product of price and quantity since total revenue is given as:

$$TR = PxQ.$$

Since the supply curve has been argued to be highly inelastic on various grounds, and since fishermen are price takers revenue is automatically maximised, but we cannot conclude that this is the dominant objective since as was pointed out earlier, some fish are not sold.

Maximization of profit requires the setting of the fisherman's marginal cost equal to his marginal revenue. Stated mathematically, profit is maximised when MC=MR. What is the marginal cost in this case? In the previous sections, we have argued throughout as though there were a clear functional relation between inputs and outputs. However, because of the fisherman's lack of effective control on the catch, we would need to work on expected catches and hence expected costs and expected revenues, rather than actual. We have noted above that fishermen are risk averse. On the Lake, they fish during the day to avoid the risk of net theft at night. At the coast, they fish in company rather than going out of competitative waters alone. Subject to this, the research revealed that at the coast, when prices of fish increased fishermen spent more time at sea, and some increased their equipment. On the lake, some increase in fishing hours was noted as a response to increased fish prices. This suggests that people do try and produce more fish when price rises. These forms of behaviour indicate an aim to increase profit subject to not increasing risk. It further indicates that the risk side is trying to control loss, and since loss minimization is the same thing as profit maximization, our evidence supports profit maximization as the objective, subject to:

(i) not increasing risk;

(ii) leisure constraint - this determines how the fisherman divides his time between fishing and leisure. Previously before the increase in price of fish the fishermen were fishing less hours. After the price increase, they increased their fishing hours. This indicates their desire to earn more profits since they could have worked harder before but preferred not to.

(iii) Durability of the capital;

(iv) Cost of capital being met;

(v) Coverage of variable costs;

(vi) Ability to reach grounds with good catches.

It was further noted that a change in the price of equipment, i.e. changes in the fixed costs do not affect the marginal costs. This means that the supply curve is unaffected, which conforms with our expectation on production efforts. The constraint on coverage of variables costs noted above was experienced in Lamu in

1977 when many fishermen left fishing due to inability to meet these costs, and instead joined the relatively less remunerative mangrove cutting industry.

There is no evidence to support target income as the objective of the fishermen. Minimization of risk of loss is further supported by the fact that once the fisherman has invested considerable capital in the boats, nets, etc.he is quite reluctant to quit. Based on this and other evidence discussed above, we therefore come to the conclusion that profit maximization (which is the same as loss minimization) is the objectives of the fishermen, subject to risk minimization.[30] Note that catch maximization is ruled out by the fact that if this were their objective, then they would have worked all hours previously, yet they didn't do this but rather preferred leisure to more working hours.

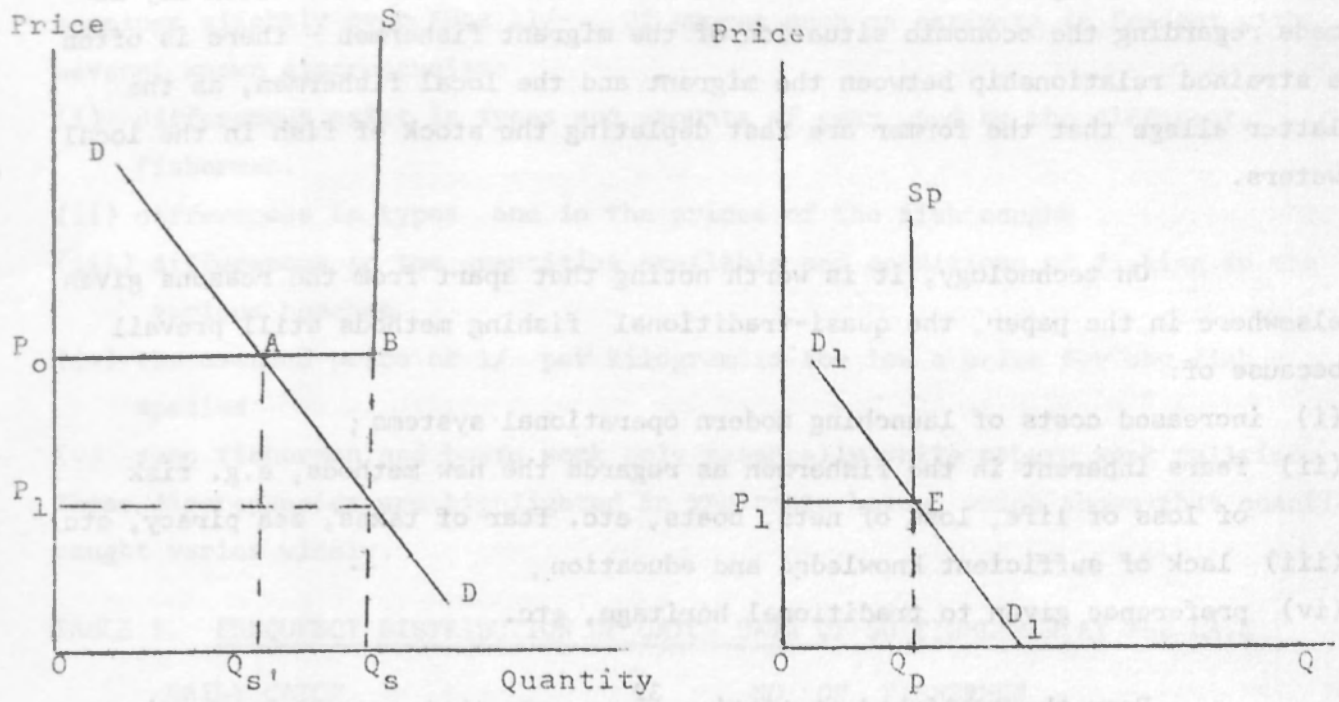
6. OBSERVATIONS

Much of the fish produced is meant for the market, although occasionally free distribution to friends and relatives occurs in anticipation of a similar action in return. The egalitarian values in Luo society in particular are such that a general feeling of sharing assets with relatives, neighbours and friends exists all through. As one fisherman noted, "... a fisherman coming back to his home area with a big catch is approached by many people asking for fish without intending to pay for it - at least not directly. If the fisherman wishes to maintain friendly relations and have a good reputation in his community he will have to give away part of his catch." One of the reasons why some fishermen go to fish in another area than their home place is to escape this constant demand upon them to share their fish and earnings from the Lake freely with others.

Few bartering activities occur on the Lake. At the Coast, bartering is non-existent.

As was noted earlier, the fishing industry is still very labour intensive. Fish are perishable goods and so deteriorate very fast. One aspect that is particularly striking in the Lake region is the flexibility of the marketing organization. When many fish are being landed, the number of fishmongers increase. If the nearby and local markets seem saturated, the fish can easily be smoked, or dried and then transported by fishmongers to the bigger markets elsewhere.[31] Generally, prices of the processed fish, i.e. smoked, dried or salted are less than those of fresh. Actual prices are difficult to determine since we are working with expected catches, and also since fishermen do not, generally, aim to produce for these inferior markets. A hypothetical situation may be illustrated, where fish that is not sold fresh is sold at a lower price. S is the supply curve, and D the demand curve for fish. Quantity Q_A is sold fresh. The rest of the supply, B - A is processed and sold in that state at a lower price P_1. After the processing, the supply of processed fish will also be fixed in the short run, in which case a set of curves illustrating the market for dried fish can be drawn as in Figure 9 below. An equilibruim is reached between the sellers and buyers at point E Unsold dried fish can be stored relatively costlessly.

FIGURE 9. PRICE DIFFERENTIALS BETWEEN FRESH AND PROCESSED FISH



The fishing industry in Nyanza is too large to allow a direct market between consumers and producers. Only on the smallest and most isolated beaches are there direct transactions between the fishermen and the consumers, hence the intervention of the fishmongers. The latter are mostly women. 60% to 70% of the total fish catch in the Lake is sold in a fresh state to the consumers. The rest is sold in processed form-smoked, dried or salted.

It was also noted previously that fishermen know that the supply of fish is relatively fixed in the short run, and that such supply is dependent on factors beyond their control. The response of the fishermen to changes in the price of fish, it was noted, is by increasing their fishing hours so as to maximize their profits. The profit maximization objective is further supported by the evidence that apart from fishermen migration due to fish movement, they also migrate to beaches where higher prices are offered for the fish. This latter form of migration presents some features worth noting. The migrations may be seasonal or permanent. The former kind of migration occurs when fish are scarce in one's own area. On the Lake, such migration may occur in March, May, June and July. The sort of people engaged in this form of migration are mostly fulltime fishermen who are not able to live comfortably off the crops from their land, and also unmarried fishermen who work as labourers or use the equipment of their older relatives.

The more permanent migrant fishermen are mostly those with almost or entirely no land in their home area, or those who had committed offences in their areas and so stay away, or those who want to accumulate enough capital away from

home due to the e galitarian values mentioned earlier. One observation may be made regarding the economic situation of the migrant fishermen - there is often a strained relationship between the migrant and the local fishermen, as the latter allege that the former are fast depleting the stock of fish in the local waters.

On technology, it is worth noting that apart from the reasons given elsewhere in the paper, the quasi-traditional fishing methods still prevail because of:

(i) increased costs of launching modern operational systems ;

(ii) fears inherent in the fishermen as regards the new methods, e.g. risk of loss of life, loss of nets, boats, etc. fear of taxes, sea piracy, etc.

(iii) lack of sufficient knowledge and education ,

(iv) preference given to traditional heritage, etc.

From the published statistics,[32] we note that overall production (output of fish) has declined greatly since the boom year of 1968 which recorded 108,400 tons of fish from the Lake valued at KShs 77.2 million to the fishermen and about KShs 220 million to the retailers. Today, catch around the Lake has stabilized at about 14,000 to 13,000 tons per annum. The catch figures for the Coast for 1976 were - Marine fish - 3889 million tonnes worth KSsh. 10.8 million, and Crustaceans (and others), 209 million tonnes worth KShs. 3.1 million.

A rough estimate of the Lake fishermen's average earnings could be calculated from these statistics, together with our catch data presented in Table 5 below.However, bearing in mind the differences in prices, types of fish, etc, our catch data is admittedly very crude. Apart from this, not all people responded to the catch question due to the fishermen's inherent suspicions with regard to such questions. Those who responded gave their figures in different units - some in tins, numbers, kilograms, etc. We have, in the table below tried to standardize these other units into kilograms - such standardization, we must admit may not be absolutely correct, but only an approximation.

Assuming a low price per kilo of KShs 1/- (irrespective of type of fish), if 16000 tonnes are harvested, then total earnings of fishermen on the lake = 16,000 x 1000 x 1 = KShs 16,000,000/- p.a. It was noted earlier that there are over 4000 boats plying the waters of the Lake

$$\longrightarrow \text{Catch per boat} = \frac{16,000,000}{4000} = 4000 \text{ kg}$$

At Kshs.1/= per kg, earnings per boat = 4000/- p.a. This implies daily earnings slightly over KShs 11/-. Of course such an estimate is fraught with several known discrepancies:

(i) differences exist in types and amounts of gear used by the different fishermen.

(ii) differences in types and in the prices of the fish caught

(iii) differences in the quantities available and conditions of fishing in the various beaches

(iv) the assumed price of 1/- per kilogram is too low a price for any fish species

(v) some fishermen and boats work only seasonally while others work fulltime.

These discrepancies are highlighted in the table below, which shows that quantities caught varies widely.

TABLE 5. FREQUENCY DISTRIBUTION OF CATCH DATA OF 50 FISHERMEN AT THE LAKE

DAILY CATCH (in Kg)	NO OF FISHERMEN
0 - 4	11
5 - 9	9
10 - 14	14
15 - 20	11
Over 20	5
TOTAL	50

On average however, our catch data seems to tally closely with the statistical averaging used in the above computations. Assuming an average boat crew size of 4 people, then we can similarly approximate earnings per head as 4000 ÷ 4 = 1000/- p.a. This of course is not entirely so since boat and gear owners are bound to get higher earnings than the labourers employed in the boat. However these computations give us a rough idea of what earnings in the fisheries are like on average. Note here also that while the catch remains stable at 14,000 to 18000 tonnes per annum, numbers of fishermen are continually increasing, implying a decline in catch per unit, and hence in the fishermen's earnings from his work.

Finally it is worth noting that apart from the fishermen and the fishmongers and consumers who are the direct beneficiaries of the fisheries, various service institutions have sprung up along the various beaches, and the owners of these have also come to derive benefits from the fishing industry:

(i) Repair and production of capital equipment is done along many beaches;

(ii) Carpentry tasks;

(iii) Small hotels have sprung up where fishermen can buy food and refreshments.

(iv) Jobs such as porterage of nets and sails to canoes, washing nets, carrying fish to where it is to be auctioned, etc. have arisen; and

(v) Transport services to fishing points have been operational.

7. FISHING AS A PUBLIC GOODS INDUSTRY

The classical definition gives a public good or service as one that is "equally available to all members of the relevant community."[33] This means that the good is accessible to all members of that community. In our situation, not only does the technological equipment at present used on the Lake and at the Coast allow many people to work there, but the ownership pattern also allows the majority of the people working in the Lake to possess their own equipment. The essence of a public good ties in the fact that there is a divergence between private and social marginal costs. Specifically, private marginal cost is less than social marginal cost. Freedom of accessibility leads to greater consideration by the fishermen of their own private marginal costs, without considering or reflecting the interests of the society as a whole, and such considerations inflict negative externalities on the other members of the society.

In our context, such private marginal cost considerations make it more difficult for others to enjoy such catch as they would be getting if societal considerations were reflected since overfishing occurs. We do not exclude fishermen, and therefore they only consider themselves when moving to a particular beach. But the evidence suggests that catches decrease as the number of fishermen increase. We have not been able to establish whether fish harvests have been such as to damage the breeding populations, nor do we know what the optimal harvest of fish as a renewable resource would be. Most fishermen remark rather mournfully that the fish population is fast declining. Shem Otiang' of Kusa beach echoes this as representative of most fishermen's feelings. In his case, he states that he "..... came to this beach because fish population decreased at my previous beach."

Private cost measures the opportunity cost to the individual of the resources he uses, such opportunity cost being based on the alternatives that are available to the entire society. Social cost measures the opportunity cost to the whole society of the resources the individual uses, such opportunity cost being based again on the alternatives available to the whole society.

It has been noted that private MC is less than social MC. It has also been noted that overfishing exists, and that the fishermen are aware of it. The existence of lower catches due to overfishing makes us conclude that fish are public goods.

The increasing cost nature of the fishing industry is basically due to the presence of external diseconomies in the long run for when individual fishermen increase in number, they bid up the prices of factors, thus inflicting higher costs on their colleagues. AV Cost curves thus shift upwards, rather than sliding up along the MC curve.

Apart from the present technology, other considerations like security, i.e. the risk averse nature of most fishermen who thus prefer to fish together in groups (especially at the Coast) give rise to the overfishing. Evidence from the Lake cites such species as Labeo (locally known as Ningu) and Schilbe (Sire) as gradually disappearing, while Alestes (soga) is practically non-existent today.[34]

8. CONCLUSION

Throughout the paper, effects of various variables on the supply function have been discussed. Because the supply function merely shows the relationship between the various factors and the amount of fish offered for sale, analysis of such variables have led us to the conclusion that the state of and changes in technology, goals of the fishermen, timing variation and prices of factors of production have the greatest influence on the output of fish. It is worth making a few general observations in conclusion:

1. That the existing technology in the industry today is such that it hampers full exploitation of the fisheries. The present canoes operate only in the shallow waters, 5 to 10 miles offshore as they are unsatisfactory for mid-lake fishing. The Coast fishermen, for example point out clearly that their Dugout boats are not for deep sea fishing. The result of this is the fishermen earn incomes just in the range of £50 to £75 p.a. This income, though better than the majority of earnings of the larger population of this country, is not particularly great. The best way to assist the fishing population would be to adopt technological ways of harvesting the fish which would have positive social results for them, and which at the same time would cater for their welfare situation. It is suggested here that one such technology would be one involving use of numerous vessels and types of gear allowing harvesting

of larger catches and at the same time purchasable at a price the local population could afford.

2. It is worth noting (with appreciation?) that the fishing industry becomes, mainly owing to the nature and small dimensions of the techological equipment involved, extremely labour intensive, a factor of significance in an age of rising unemployment.

3. Major problems which face the fishermen include;

   (a) Lack of proper security at sea, e.g no life jackets or even arms for protection against attacks by sea creatures. This is particularly notable from the Coast.

   (b) Problems caused by variations in weather.

   (c) Theft of equipment and even of fish from nets left in the water. This is particularly acute in the Lake.

   (d) Floating islands tearing away nets in the Lake.

   (e) Lack of enough money for further investment. All fishermen seek government assistance in the form of loans.

4. A final observation regards the role played by education in fishing. At the Lake, the feeling was that the level of education attained by a fisherman was not a major factor affecting his income, though it was of considerable consequence for earnings fron non-fishing employment. At the Coast, however, most fishermen felt that they needed to be educated in better fishing methods and modern equipment operations.[35]

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18. Jansen, "Fishing Population", p. 54.
19. Ibid, p. 76.
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21. Ibid, p. 6.
22. Ngalawa - Outrigger canoe, Ndema- basket trap, .Uzio -- rigid fish trap.

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24. Mansfield E., 1975, Micro-Economics: Theory and Applications (2nd Ed.) Norton, N.Y., p. 120.

25. Ibid. p. 236.

26. Ibid. p. 121.

27. Leftwich, Price System. p. 166.

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29. Throughout this paper we have made an oversimplification in talking of "fish" as an homogeneous product. The different types of fish command different prices but also require different net sizes to catch then.

30. Liebhafsky, H.H., 1963. The Nature of Price Theory, Dorsey Press, Illinois, p. 384. Following Knight, profit is considered as a payment for the performance of the function of assuming uninsurable risk.

31. There is a price differential between local and major markets which is covered by the transport and other incidental costs.

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35. We note that almost all fishermen on the Coast wanted more education. We see this as a desire to give themselves greater flexibility, raise their opportunity cost, rather than improve their ability to take advantage of improved technology.

9.2. OTHER SOURCES

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Ogada - Fish Market Supervisor, Kisumu
Odero - Director of Fisheries, Nairobi
J. Mumba - Assistant Fisheries Director, Mombasa
Some hundred interviews with fishermen and Beach leaders at the Coast and on the Lake.

9.3. ANNEX - SAMPLE QUESTIONNAIRES

SOURCE DOCUMENTS FOR 'A STUDY OF THE SUPPLY FUNCTION FOR FISH'

The Beach Leader.....Beach

I would be very grateful if you would be so kind as to complete for me these forms with the details required therein. From this questionnaire, I hope to obtain information concerning the fishermen in your Beach, and the importance of fishing to them. Your cooperation in completing the questionnaire with most accurate data obtainable will be very much appreciated.

Thanks in advance .....Research student.

1. ABOUT THE FISHERMAN

Fisherman's Name.....Tribe.....Age.....
Married or Single?.....Village.....
What is the Serial Number of your boat?.....
Type of boat.....Age of boat.....
How many people are usually in the boat when you go fishing.....
Are they male or female.....Their approximate Ages.....
Where do you fish? (Name).....Close inshore.....
Open water.....How far away do you paddle or sail.....
For how long.....hrs What part of the day do you find more convenient for fishing (time).....(Why?.....
.....
.....
.....
In addition to the boat, what other gears do you use in fishing (name them)
.....
What types of nets do you use.....What size of nets.....
What do you think is the approximate cost of your boat.....
How long do you think it can last.....What is the cost of the net.....
How long does it last.....
Do you also use hooks and lines.....If yes, how many long lines .....How many hooks.....Traps.....Others.....
(specify).....
Boat tenancy.....Check(X) Vessel owner..... Renter.....
Paid crew member..... Unpaid crew member.....
If renter of equipment, why dont you buy your own (ask for reasons).....
.....
.....
If paid crew member, are you paid in Money or in Fish?.....Why this particular method of payment?.....

How much approximately do you earn per month or per day?.....

How many persons (including self) are dependent on you.....

Highest level of education reached by the fisherman.....(specify)

Other courses or training attended (state).....

Occupation before joining fishing.....

Your fishing experience (state period) - In this beach.....Weeks/Months/Years.

Elsewhere (state where).....

Total number of weeks in a year during which you engaged in fishing and related activities.....

Do you have any Non-fishing, paid employment?.....For how long.....

State nature of this occupation.....

What is your average daily income from fishing?.....(Shs)

Has your income from fishing increased or decreased or remained constant over the last several years?.....Why do you think the change has occured?

.....

Does the amount of fish caught depend on the number of people in the boat?.....

What happens if there are less people?.....

More people?.....

Starting with one person in the boat, does the catch increase as more people are employed?.....Does it fall as more and more people are employed?..

.....If so, Why?.....

.....

After what number of people does it start falling?.....(state No)

Do you know of the existence of other forms of fishing equipment - better or worse than yours?.....Which ones?.....

Why have you not started using any of these?.....

What advantages do you see in your type of equipment?.....

.....

.....

If you have fished in other beaches as well, why did you move to this particular one?.....

Do you think all beaches have the same number of fish?.....Why?.....

.....

When you move from one beach to another, do you move with all your equipment?.....

.....Why or Why not?.....

Do you think all the type of equipment used is the same in terms of amount of fish caught?.....Why or Why not?.....

.....

State your Aim in fishing (check X) As much Sales as possible.....

As much profit as possible.....As much Catch as possible.....

Subsistence only.....Planned(target) Income.....Any other aim(state).....

Does your aim change from season to season or is it fixed?.....Explain.....

.....

On average, how many fish do you catch per day?.....

Do you sell all the fish you catch or do you keep some for your subsistence?.....

If you keep, how much do you keep?.....Is this amount kept, constant or does it vary?.....What does it vary with?.....

Do you exchange(Barter) fish for some other commodities apart from money?.....

If so what commodities?.....Why?.....

.....

What fraction of your fish do you exchange? All.....Most.....Half.....

Just a little.....None.....If none, why none?.....

Have the prices of your equipment increased over the last several years?.....

If yes, how did you react?.....

Why did you not leave fishing?.....

Did the amount of fish you caught increase/decrease or stay constant as a result of this change in price?.....Why?.....

Is there any way in which you can increase or decrease the number of fish you catch .....Explain.....

Do you always plan the quantity of fish you intend to catch in advance?.....

Why or why not?.....

If you plan, then what do you do if you catch more or less than you planned to catch.....Do you then change your plans for the next season?.....

How long do you take between setting your traps and drawing the fish?.....

How can this duration be shortened?.....

What do you do with fish that is not sold fresh?.....

Do you pay any taxes on the fish?.....If so how much?.....

Do you get any help from the Government?.....If so, what help?.....

Do you belong to the Cooperative?.....If so name it.....

What benefits do you get from the cooperative?.....

Have prices of fish increased over the last several years?.....When this happened, did you produce more fish, or less?.....Why?.....

.....

Do you intend to continue fishing as a major occupation?.....As a supplementary occupation?.....Do you intend to cease fishing and enter another whole time occupation as opportunity occurs?.....If so state the nature of this other employment.....Why do you want to change?.....

What inconveniences do you experience in your fishing life?. Theft of equipment?.....
Fights.....Storage problems?.....Others (name them).....
I would now welcome any comments on the fishing industry and its prospects you may care to make.....
.....
.....

2. FROM THE BEACH LEADER.

Name of Recorder..... Date.....
Fishing Site.....Time.....
How many fishermen are there in your beach?.....How many boats?.....
About how much time does each fisherman spend in the Lake daily?.....hrs
Are most of them full time fishermen or part time? .....Can you give any figures of those who operate full and part time?.....(figure)
Are there some people owning more than one boat?.....How many people?...
How do they operate them?.....
Who produce more fish? those operating on owned boats or those operating on hired boats?.....Explain.
What is the average lifetime of the boats, nets, and other gears (name them) used?..
.....
Can you estimate their average costs?.....
Has overfishing ever occurred in your beach?..... When?..... How did the fishermen know that it had occurred?.....
How did they react?.....
What do you think caused the overfishing?.....
Do you expect it to occur again in the future?..... Why?.....
What measures are being taken to prevent its occurrence?.....
.....
Do most fishermen leave fishing during the poor seasons?.....Why?.....
.....
Do you think the level of Education attained by the fisherman exercises any significant influence on his fishing income?.....Why?.....
.....
What advantages do you see result from (i) Overfishing.....
.....
(ii) Underfishing?.....
.....
What about disadvantages?.....
.....
.....
.....

I would now welcome any comments on any aspect of fishing either in your beach here or elsewhere that you may like to talk about.....

.....

.....

.....

.....

.....

Now, thank you very much for your help.

Sincerely,

Oduor M. K'Otieno
Research Student, University of Nairobi.
June/July, 1978.

SOURCE DOCUMENTS FOR A STUDY OF THE SUPPLY FUNCTION FOR FISH

Name of Beach Leader.....
Date of interview.....
Name of Beach.....

I would be very grateful if you would be so kind as to complete for me these forms with the details required there in. From this questionnaire, I hope to obtain information concerning the fishermen in your beach and the importance of fishing to them. Your cooperation in completing the questionnaire with most accurate data obtainable will be very much appreciated.

Thanks in advance,

Rosalia S. Karisa
Research Student.

BEACH LEADER:

How many fishermen are there on your beach?
How many own boats?
How many rent?
How many are paid crews?
How many are unpaid crews?
What is the average time spent at sea by the Fishermen?.....
.....
How much time is spent repairing equipments?.....
Estimate the life of boats.....Cost.....
Nets.....Cost.....
Hooks.....Cost.....
Lines.....Cost.....
Other specify.....Cost.....
Has overfishing occurred on your beach?.....
How did the fishermen react?.....
What did you do yourself?.....
Do most fishermen leave fishing during the unfavourable fishing periods?.....
.....
If they do what do they occupy their time with?.....
.....
What is the average level of education attained by the fishermen?.....
.....

Do you fish yourself?.....

Do you think the level of education influences the method of fishing?

.....

How?.....

Any comments about fishing on your beach or any other beach?.....

.....

.....

.....

ABOUT THE FISHERMAN:

(i) Name of fisherman .....

Level of education reached .....

Age .....

Type of boat used (a) Traditional /__/ (b) other specify .....

.....

(If traditional put ✓ in the box or else specify.)

How long have you been fishing? .....

Do you own the boat? .....

If yes how many boats altogether do you have? .....

If more than one do you rent some of them? .....

How are you paid? in money /__/ or in fish /__/

If in money why? .....

If in fish why? .....

Do you fish yourself .....

How many people are usually in the boat including yourself when you go out fishing .....

What happens if there are more people in the boat? .....

.....

Apart from the boat what other equipment do you use in fishing

(1)	Cost Shs.	(4)	Cost Shs.
(2)	Cost Shs.	(5)	Cost Shs.
(3)	Cost Shs.	(6)	Cost Shs.

What is the cost of the boat? .....

How long do boats last? .....

How long does the other equipment last? .....

(Specify the equipment and its service life .....

.....

.....

.....

.....

When do you usually go out fishing (time).....why.....

.....

Are you a fulltime fisherman.....

Do you have another occupations (specify the occupation) .....

.....

.....

Are there other fishing boats at your fishing ground.....

Why don't you look for another fishing ground where you will be alone (if the answer to the previous question is yes) .....

.....

Do you always fish at the same ground.....

Why or why not? .....

Have you ever been fishing at whether beach before .....

.....

Why did you move to the present fishing ground.....

.....

Do you always have the same amount of fish whenever you go out fishing?.....

.....

Why or why not.....

What are your best fishing seasons.....

Why are they best?.....

.....

Do you know other methods of fishing.....

Specify them .....

Why don't you use them .....

What do you do when you are not out fishing.....

Had you another job before? ..... If answer is yes why did you then join fishing? .....

(ii) If you don't own the boat are you paid .....

.....

Or do you rent the boat and give rent to the owner of the boat?

.....

How do you pay the owner of the boat - Do you give him some fish or some money (specify) .....

.....

.....

Why don't you buy your own boat? .....

.....

Do you always rent or hire the same boat? .....

.....

Why or why not? .....

Have you ever owned your own boat? .....

If yes what happened to it .....

Do you go out fishing alone .....

Why or why not .....

(2) Does the number of people in the boat affect the amount of fish caught? .....

.....

How does it affect it .....

Do you sell all the fish you catch or do you keep some for your own use? ....

.....

Is the amount kept fixed or does it vary with the amount caught? .....

.....

Do you exchange fish for some other commodities apart from money? .....

.....

Have the prices of your equipment increased over the last years?.....

..... can you give me any details? .....

.....

What was your reaction towards the increase .....

.....

Is there anyway you can increase or decrease the number of fish you catch with the existing equipment and the present method of fishing you are using? .....

.....

.....

Are you in the co-operative? .....

If not how do you sell your fish .....

Have the prices of fish increased over the last few years .....

.....can you tell me roughly by how much and when? .....

.....

Did you try to get more fish .....

Did this change your income? .....

Did you change the amount of time you spent fishing? .....

If so how? .....

Is there any theft of fishing equipment along the shoreline? .....

.....

If so what has the Government done towards such a problem? .....

.....

What do you do to the fish that is not sold fresh? .....

.....

Give any comment on the fishing industry in Kenya .....

.....

.....

.....

.....