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Published Papers (1988-1993)

on Fishing Vessels Design and Economics

by

Prof. Dr. M. A. Shama

1- "Factors Affecting Productivity of Coastal Fishing Vessel", AEJ, April, (Egypt-1988), Shama, M. A., (100%)

2- "Factors Affecting Fishing Voyage Expenses and Efficiency", AEJ, April, (Egypt-1988) , Shama, M. A., (100%)

3- "Operational Cost Analysis of Coastal Fishing Vessel", AEJ, July, (Egypt-988), Shama, M. A., (100%)

4- "An Economic Evaluation Model for the Egyptian Coastal Fishing Vessel", AEJ, July, (Egypt-1989), Shama, M. A., (100%)

5- "Investment Decisions on Coastal Long Liners", AEJ, October,. (Egypt-1989), Shama, M. A. (100%)

6- "Appraisal of Fishing Vessel Economics Using Risk Analysis", AEJ, Jan., (Egypt-1990), Shama, M. A., 100%)

7- "A Rational approach to the Determination of Principal Dimensions of Coastal Trawlers", AEJ, Jan., (Egypt-1993), Shama, M. A., Eliraki, A. M., and Atwa, K. I. (33%)

8- "A Computer Based design Model for Coastal Stern Trawlers", AEJ, Jan., (Egypt-1993), Shama, M. A., Eliraki, A. M., and Atwa, K. I. (33%)

9 - "Appraisal of Fishing Vessel Economics Using Risk Analysis", ISUMA93, April. (USA-1993), Shama, M. A., (100%)

10 - "An Integrated Rational Approach for Improving the Economics of Coastal Stern Trawlers", AEJ, April. (Egypt-1994), Shama, M. A., (100%)

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AN ECONOMIC EVALUATION MODEL FOR THE EGYPTIAN COASTAL FISHING VESSELS

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Abstract

A general outlook of the current Egyptian Coastal fishing industry is presented. The main featuresand characteristics of the coastal wooden fishing vessels are given. The main factors affecting the annual fish production and revenue are identified and examined. The elements of annual expenditure are outlined and investigated. Particular emphasis is placed on the cost of capital. An economic evaluation model is introduced and used for determining the highest ship price compatible with the current fish prices. The model cold be also used to determine the minimum acceptable fish price to give a required profit margin for a given investment.

It is concluded that the rationalisation of coastal fishing should be based on the optimisation of the investment capital and the minimisation of cost items independent of fish production. Investment loans may appear attractive, but may also impair the economics of the fishing vessel.

1. Introduction

The Egyptian aquatic coastal resources represent an essential element of the National Food Resources. The rational exploitation of these resources should solve part of the current acute problem of meat shortage, create badly needed job opportunities, establish new industries, develop present and new coastal fishing areas and finally improve the National Economy

The annual fish consumption in Egypt is about 250,000 tonnes of which about 120,000 tonnes produced locally and about 130,000 tonnes imported as frozen fish. A high proportion of the imported fish (about 95%) is of the Pelagic type (Sardine, Sardinella, etc.). It is hoped to increase our fish production by rationalising the exploitation of our coastal waters. Some of the coastal species are of the highest quality and could be exported at a high price. Efforts, therefore, should be directed to improve the coastal fishing industry.

The present Egyptian coastal fishing industry depends totally on Tradition and Family Business for both building (wooden vessels) and operation. However, these vessels are very poorly constructed and equipped, badly maintained and rather unscientifically operated. In general, this industry is based on art rather than science with regard to operation, navigation, fish detection, maintenance, etc. This situation reflects significantly on the productivity and economics of coastal fishing and discourages the new generations to join this important field of industry.

In order to rationalise the exploitation of our coastal waters, it is necessary to use modern fishing vessels, properly equipped and manned

for Trawling, Purse seining and Long lining. It is also necessary to explore new and potential fishing grounds.

This paper investigates the main factors affecting productivity and economics of coastal fishing both qualitatively and quantitatively.

2. A General Outlook To The Egyptian Coastal Fishing Industry

2.1 Fishing resources and methods

Coastal fishing in Egypt covers both the Mediterranean and Red Seas. The Mediterranean fishing grounds are covered by several centres of which Alexandria is the main centre. These centres are generally divided into Western and Eastern Fishing Grounds, see Fig. (1).

Trawling, purse seining and gill netting are the most popular methods adopted for coastal fishing, together with some very primitive long lining.

Since the building of the High Dam in Aswan, Mediterranean resources have been seriously deteriorated. This situation is made worse by the drastic increase in population and shortage of meat with the subsequent high demand for fish. Adding to that the inclination to favour fresh fish to frozen fish, some coastal fishing grounds have been seriously overfished and exhausted. The catch rate per hour has been almost halved within the last ten years.

Trawling in the Mediterranean sea is carried out all the year round, whereas purse seining is carried out over the period from March until October, see fig. (2). In the Red sea, bottom trawling is limited to certain areas only because of the nature of the fishing grounds.

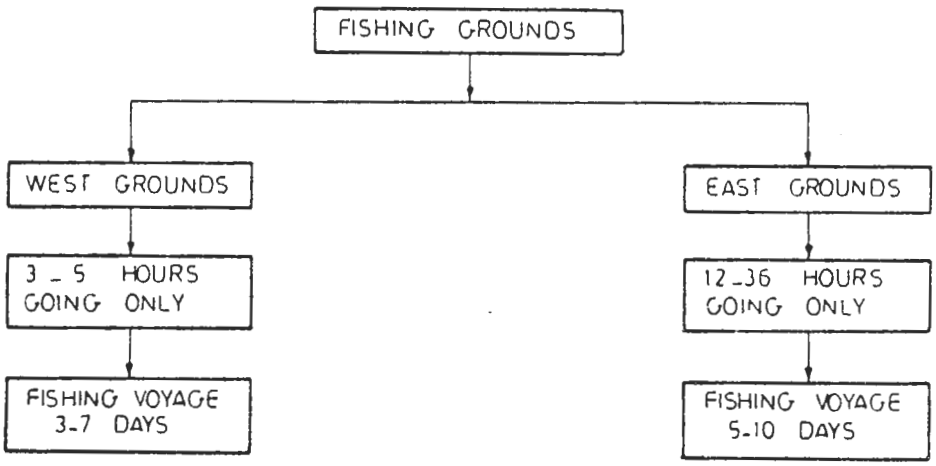

Fig.(1) FISHING GROUNDS .

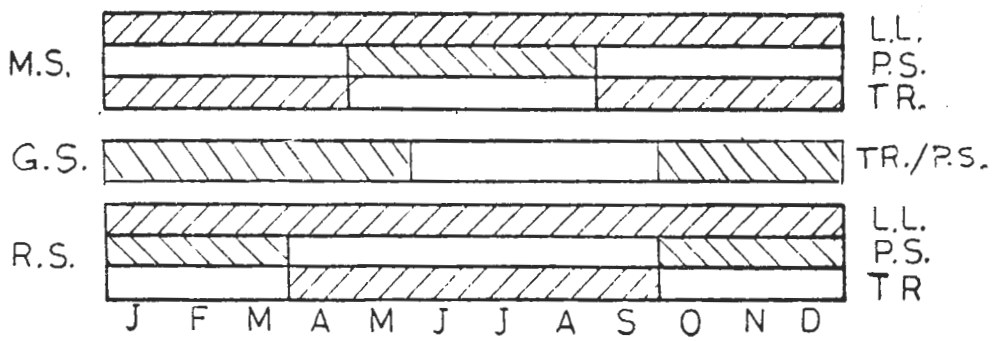

Fig.(2). Seasonal Fishing .

However, midwater trawling could be used in deep water areas unsuitable for bottom trawling.

Purse seining is carried out during the period from October until March. Because of its nature, gill netting and long lining could be used in both Mediterranean and Red Seas.

2.2 Fishing Profile

The main elements of a trawling fishing cycle is given in reference (1). Because of the closeness of the current fishing grounds to the main land, the Mediterranean fishing voyage varies between 3 to 7 days. The latter is the upper limit and is governed by fish preservation requirements as well as by the Coast Guard regulations. The Gulf of Suez fishing voyage varies between 3 to 10 days.

3. Characteristics of Coastal Fishing Vessels

These vessels are almost totally constructed of locally produced wood, except for imported Pitch Pine. Because Egypt is not a wood producing country, the available wood is not properly seasoned, contain high percentage of moisture, contain several types of defects and does not exist in large quantities. The fastening is almost totally made of iron bolts, not galvanised.

To overcome these shortcomings, the scantlings are always on the high side, producing a heavy lightweight and rather costly ship hull, see figs. (3, 4). The construction does not follow any rule requirements or design drawings but is based totally on the experience of the builder. The general arrangement of a typical wooden vessel is shown in Fig. (5).

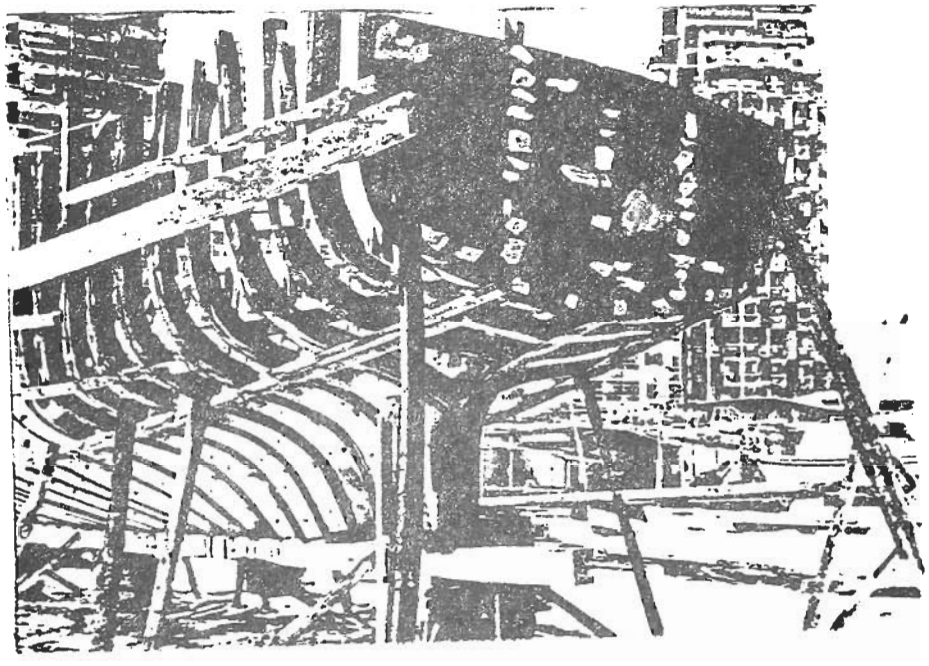

Fig. (3). Wooden Construction of The Aft End.

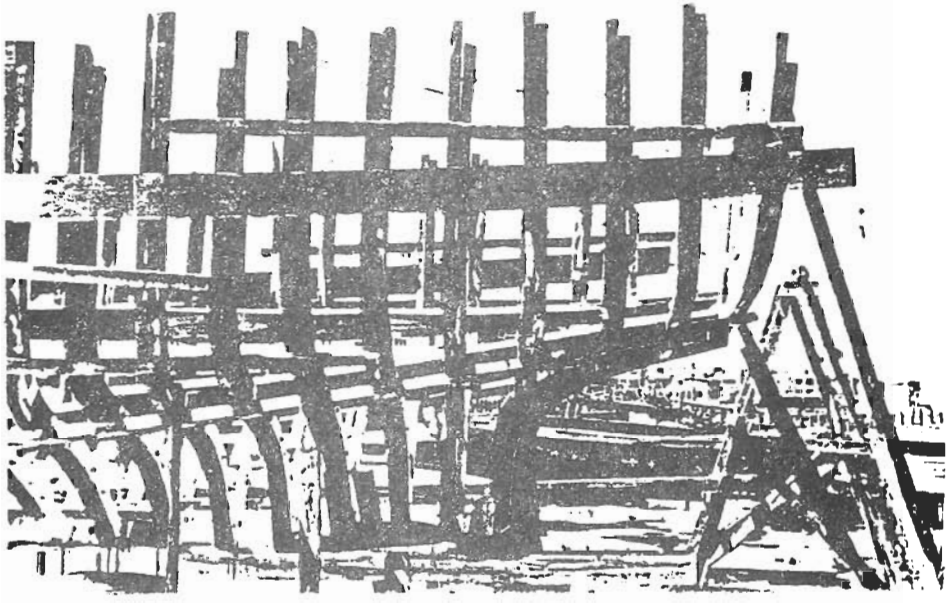

Fig. (4) . The Stern of a Wooden Construction

The fish hold is divided into a primary fish hold and a secondary fish hold (a fish handling room). The primary fish hold does not have a deck opening, but has an opening in the partition between the two fish holds. The entrance to the fish handling room is from the deck. This fish hold arrangement is adopted to cover the deficiency of insulation of the fish hold.

The length overall varies between 18 m and 21 m so as to have good seakeeping qualities. The breadth is about 6m and the depth is about 3.25m. The sheer forward is large and the vessel has a large deck area aft.

Coastal fishing vessels are powered by medium speed diesel engines, mostly naturally aspirated and developing about 200-450 HP. The trawling winch is mostly mechanically operated from the main engine. The minimum fittings are used so as to keep vessel price as low as possible to be compatible with fish catching rates.

4. The Economics of Coastal Fishing

In order to improve the present state of coastal fishing, it is necessary to introduce modern fishing vessels, properly equipped and fitted and also properly manned by well trained skipper and crew, see fig. (6). However, because of the limited resources of our coastal fishing grounds, it becomes necessary not to over invest in fishing vessels with limited productivity and revenue. Therefore, it is important to study the relevant factors affecting both revenue and expenditure so as to be able to make rational decisions with regard to new investments.

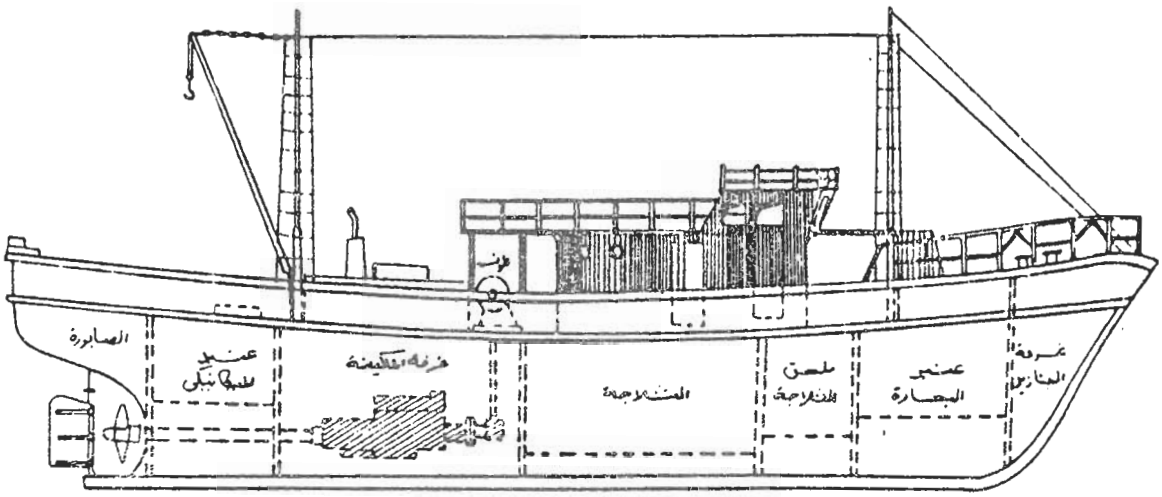

Fig. (5). An Egyptian Wooden Fishing Vessel

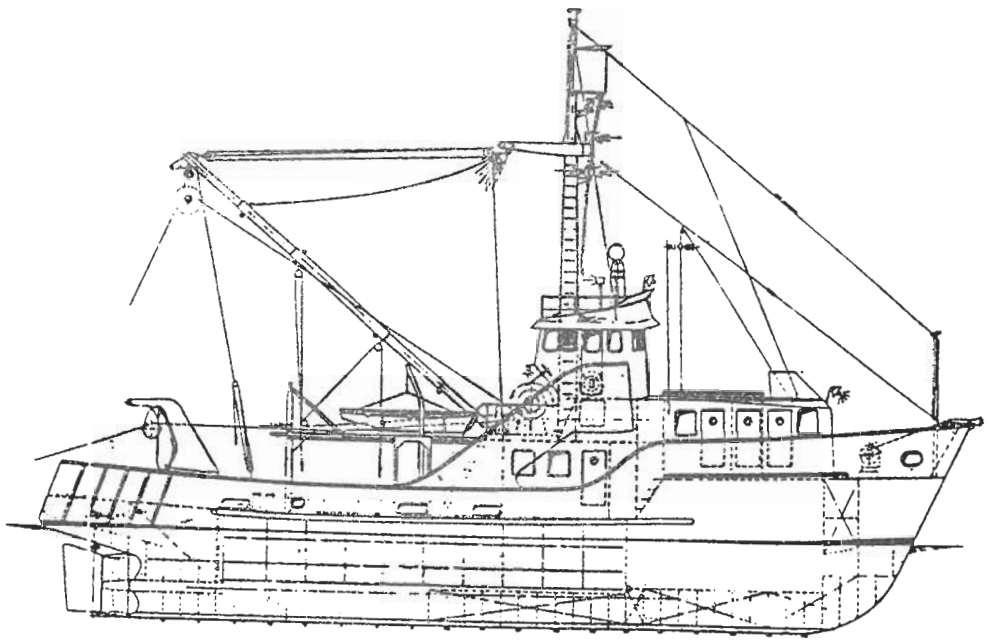

Fig. (6). A Modern Fishing Vessel

The economic evaluation of coastal fishing could be based on the evaluation model shown in fig. (7). This could be achieved by studying the main factors involved in the fishing system.

4.1 The Profit Equation

The simplest measure of profitability is given by the following equation.

Annual Profit (P) = Annual Revenue (R) - Annual Expenditure (E)

or $P = R - E$

In order to maximise P, it is necessary to maximise R and/or minimise E. This could be achieved by investigating the main factors affecting both R and E.

4.2 The Annual Revenue

The annual revenue R could be calculated as follows:

$$R = Q \times C$$

where:

c = mean price of fish, $/kg

Q = annual fish caught, kg

Maximising R requires the maximisation of both "Q" and "C".

4.3 Annual Production, Q:

The annual production, Q, of a fishing vessel depends on the following

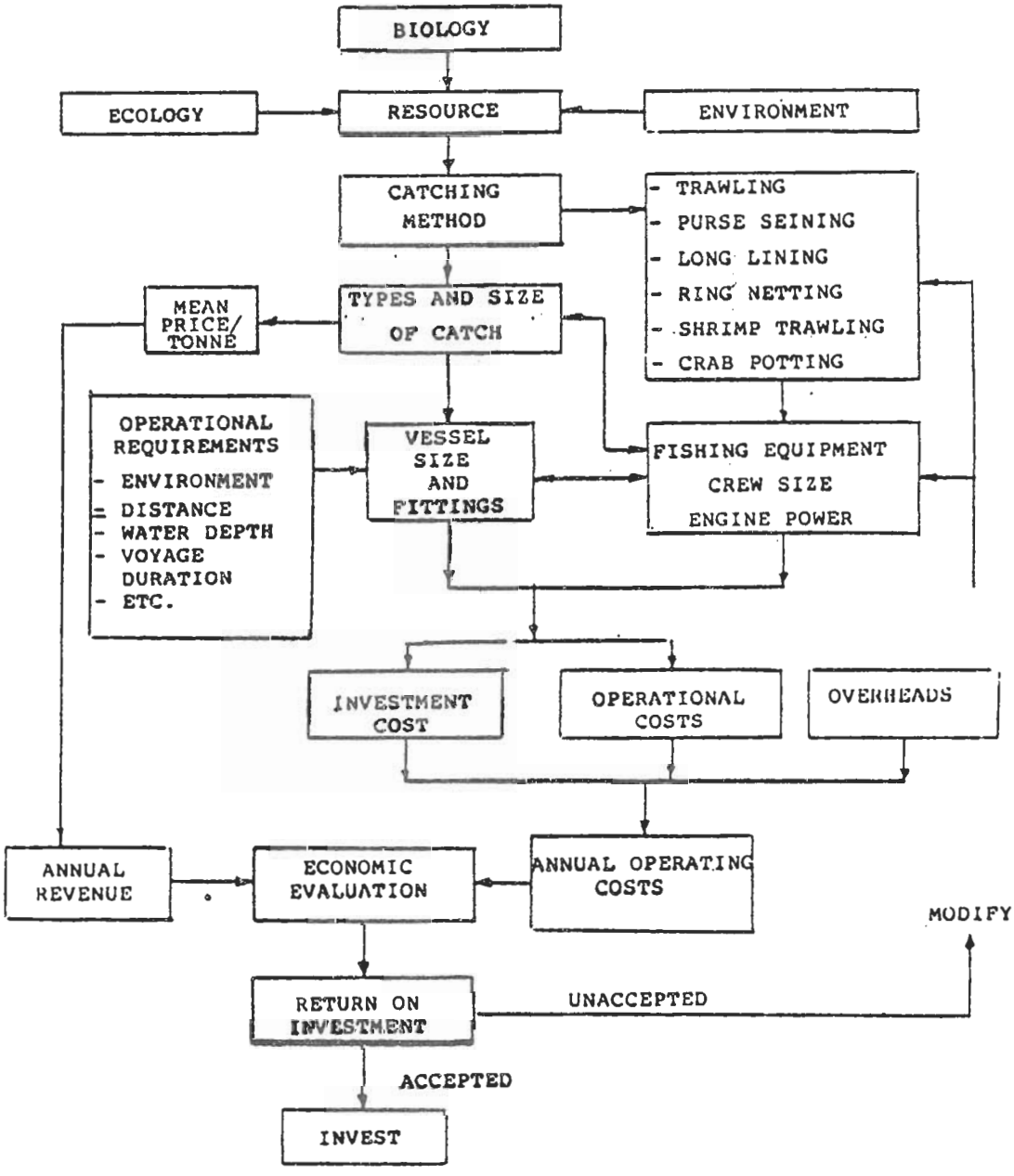

Fig.(7) ECONOMIC EVALUATION MODEL FOR COASTAL FISHING

main parameters:

- Potential of fishing grounds
- Environmental and climatic conditions
- Distance to fishing grounds
- Nature of fishing grounds
- Competancy of the fish master
- Competancy of the crew
- Mean price of catch
- Catch rate per hour
- Number of fishing hours per day
- Number of fishing days per voyage
- Number of voyages per year
- Composition of catch species
- Proportion of fish exported
- Effectiveness of fishing gear and equipment
- Degree of mechanisation and automation
- Effectiveness of the navigation and fish detection equipment

Some of these factors have direct effect on the annual production while others have indirect effects. However, annual production of a coastal fishing vessel could be related to the following main factors (1):

$$Q = f\ (h_c,\ t_e,\ t_j\ ,\ t_v\ ,\ \alpha,\ \gamma\ )$$

where:

t_e = exploitation time per year
t_v = voyage days
t_j = time for going to and coming back from fishing grounds
α = coefficient of prolongation of voyage

γ = a factor taking into account bad weather & non-catching time .

It is shown that annual production improves significantly by increasing mean catching rate and exploitation time (1).

4.4 The Mean Price, c:

The mean price of fish could be estimated from the following equation:

$$c = \sum_{i=1}^{k} n_i \cdot c_i \qquad \$/kg$$

where:

c_i = price/kg of fish species "i"

n_i = proportion of fish species "i"

k = number of species in the catch

Assuming, for simplicity, that the catch could be divided into two main categories only, namely: High quality species, and Low quality species, then the mean price/kg is given by:

$$c = \psi \cdot C_H + (1 - \psi) C_L$$

where:

C_H = price/kg of the high quality species

C_L = price/kg of the low quality species

Assuming further that: $C_H = \lambda \cdot C_L$

Then,

$$c = [1 + \psi (\lambda - 1)] \cdot C_L$$

The variation of c/C_L with "ψ" , for different values of "λ" is

shown in Fig. (8). Assuming that $\lambda = 8$ and $\psi = 0.2$, the average fish price = 2.4 C_L.

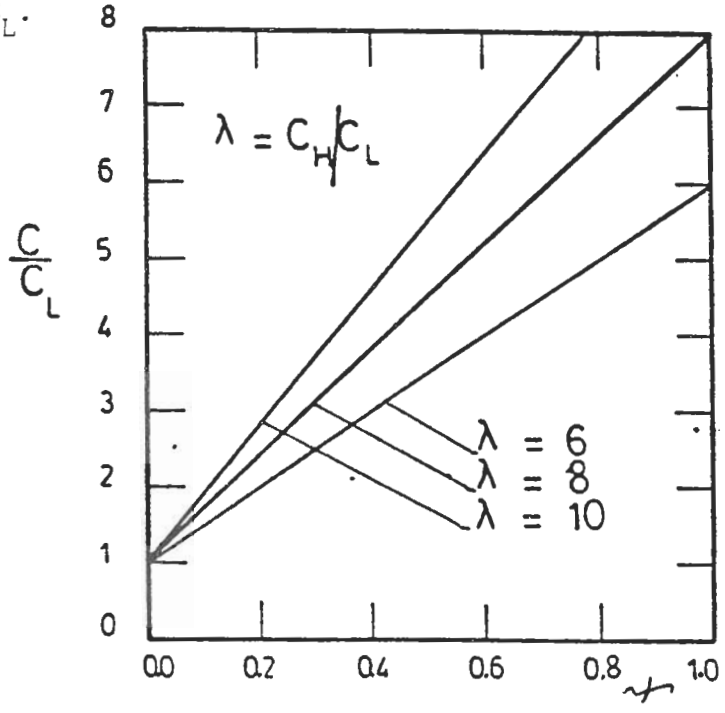

Fig. (8) VARIATION OF C/C_L WITH ψ

4.5 Annual Expenditure, E

The total annual expenditure, E, could be divided into its basic elements as follows (2):

E = Fixed Expenses + Variable Expenses

i.e.

$$E = E_F + E_V$$

The fixed expenses include depreciation, interest on capital, insurance, overheads, fees, routine maintenance, etc.

The variable expenses include:

i. consumable items such as fuel oil, lubricating oil, ice, fishing gear, provisions, etc.

ii. non-consumable items such as commission, crew share, major and accidental repairs, interest on operational expenses, etc.

These cost elements could be easily related to the basic cost items; initial ship cost C_s, annual revenue, R, number of fishing days, q, engine power, P_B and annual production, Q, as follows (2):

$$E = e_1.C_s + e_2.Q + e_3.q + e_4.R + e_5.P_B + e_6$$

The minimisation of E requires the minimisation of the initial ship cost, engine power and wear and tear of the fishing gear.

The minimisation of wear and tear of fishing gear requires competant skipper and crew, effective fish detection and fishing equipment.

The minimisation of engine power requires good hull design, proper selection of propeller, efficient fishing equipment and gear, proper hull maintenance, etc.

Initial ship cost is influenced by construction material, ship size, engine type, power and R.P.M., degree of mechanisation, degree of automation, type and effectiveness of outfit work, etc. (2).

Therefore, the minimisation of the cost of capital requires the smallest vessel compatible with the dominant operating conditions, smallest engine power satisfying the power demand for free running, trawling, etc, minimum of fittingsnecessary for the safe and efficient

operation of the vessed, lower degree of mechanisation and automation, etc. However, the minimisation of the cost of capital should be very carefully examined as the parameters affecting the cost of capital may also have a serious effect on annual production.

The evaluation of the cost of capital depends on whether the investment cost is paid as a lump sum at the beginning of ship operation or it is a borrowed capital. Consider the following two cases:

1. The investment cost is paid as a lump sum at the beginning of ship operation

In this case, the annual cost of capital is given by, see fig. (9)

$$E_C = (CR - i\% - N).\ C_s$$

where:

CR = capital recovery factor (4)

i = rate of interest

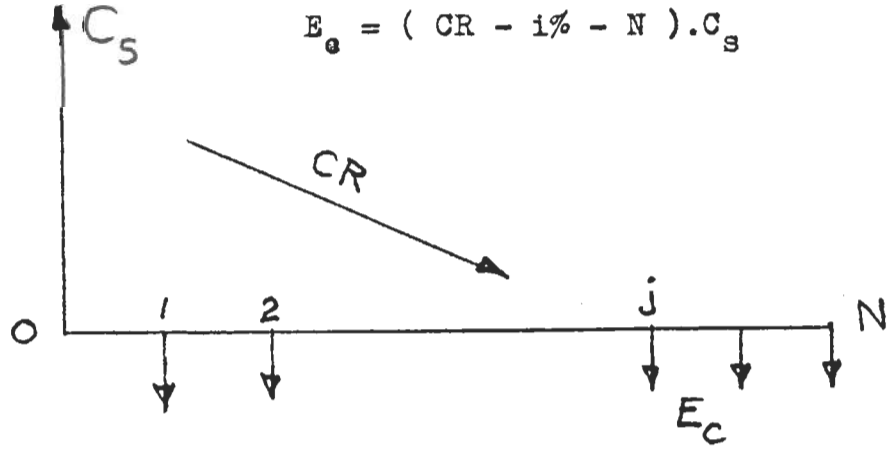

Fig. (9) Annual Cost of Capital

2. The investment cost is borrowed at an interest rate "r" over a period of "n" years with a grace period "g" years

In this case, the annual cost of capital is given by :

$$E_c = (CR - i\% - N) \{ [\sum_{i=1}^{n-g} \frac{C_s}{n-g} (1 + r(n - g - j)) \times (PW - i\% - j)]. (PW - i\% - g) \}$$

where:

PW = present worth factor (4)

Fig. (10) shows the variation of E_c/C_s with N, i,n, g and r. It is evident that the loan conditions may have a serious effect on the annual cost of capital. For the particular condition given by:

N = 16 years
i = 20 %
n = 12 years
g = 2 years
r = 3%

E_c/C_s = 0.135 , see fig. (11)

This value could be significantly increased if the loan condition is not favourable. Therefore, it is necessary to thoroughly examine the loan conditions so as not to unduely increase annual expenditures and impair the profitability of the fishing vessel.

5. Economic Evaluation

From the foregoing analysis, it is evident that initial ship cost and

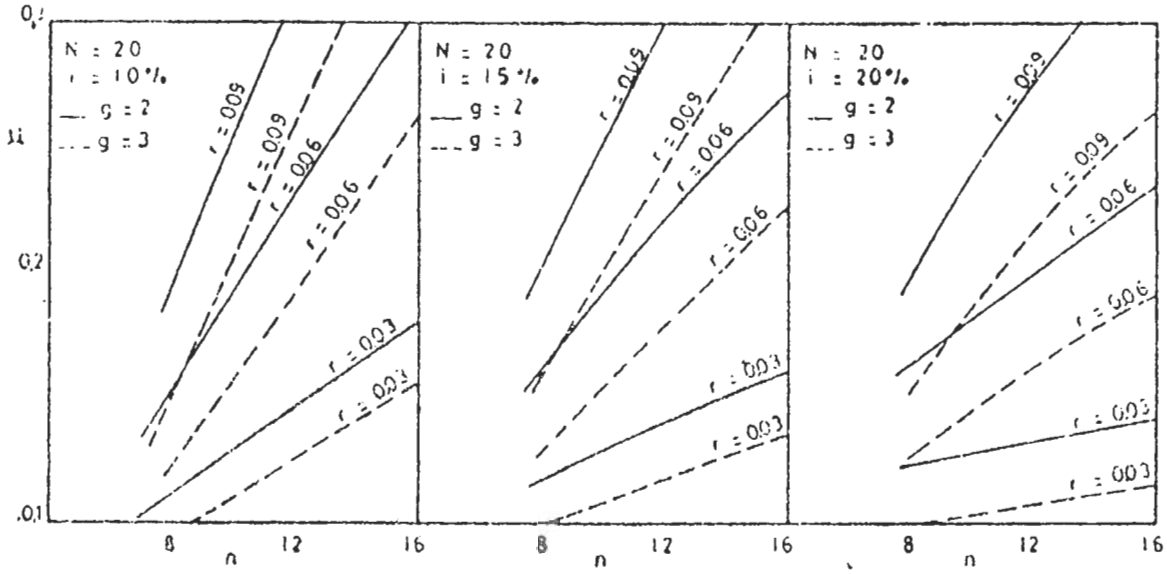

Fig (10) Variation of μ with N, i, n, g and r ($\mu = E_c / C_s$)

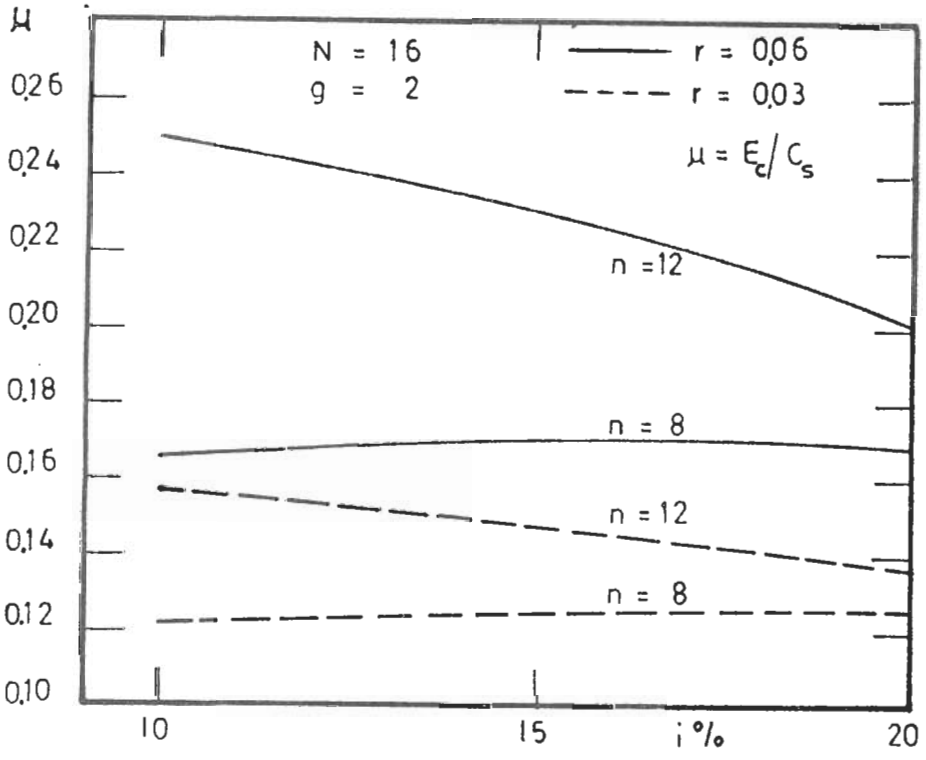

Fig.(11) : Variation of μ with "i, n" and "r".

revenues are indirectly interrelated. This makes the problem of maximisation of the profit margin a rather complex problem, since the minimisation of expenditure has an indirect adverse effect on annual revenues.

Therefore, the minimisation of expenditures should be directed totally to those cost items not affecting productivity and revenue.

It is also evident that the mean fish pice and initial ship cost are the most important factors affecting decision making for investment in a new fishing vessel.

The minimum value of the mean fish price could be evaluated as follows:

$$c \geq \frac{AAC}{Q}$$

where;

AAC = Average Annual Cost

Q = Annual fish production

The AAC could be estimated as follows:

$$AAC = E_C + (CR - i\% - N)\{\sum_{j=1}^{N} E_j\ (PW - i\% - j)\}$$

where:

E_j = annual operational costs in year "j"

Therefore, for a known value of the mean fish price, the maximum value

of the investment cost for a new ship could be estimated to satisfy a specified profit margin, see fig. (12). Alternatively, for a given ship price and profit margin, it is possible to determine the minimum value of the mean fish price.

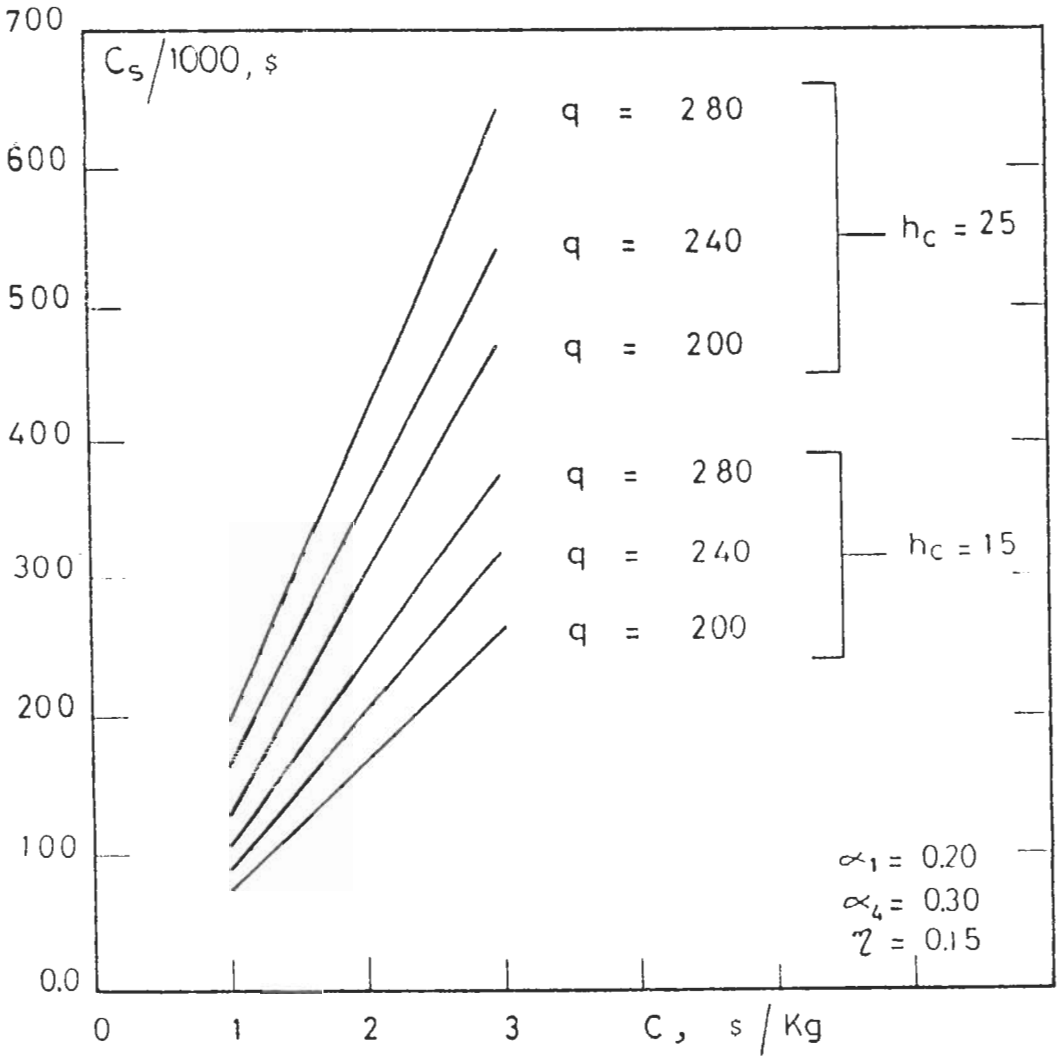

Fig (12) Variation of "C" with C_s .

Ex. It is required to determine the maximum investment cost for a coastal fishing vessel operating under the following conditions:

- Price of low quality fish/kg ($) = 0.8
- Price of high quality fish/kg ($) = 4.8
- Proportion of high quality fish = 30%
- Number of fishing days/year = 240
- Average fish catch rate (kg/h) = 25
- Crew share = 25 %
- Profit margin = 15 %

Then: mean fish price/kg = $ 2.0
maximum investment cost = $ 357,660

6. Concluding Remarks

The main conclusions drawn up from this investigation could be summarised as follows:

i. Annual revenue and expenditure are directly and indirectly interrelated as they both depend on initial ship price. The latter is greatly influenced by the degree of mechanisation, automation and the versatility and quality of fishing equipment and other fittings.

ii. Coastal fishing economics could be significantly improved by:
   - increasing the proportion of high quality species by the widespread use of long lining.
   - exporting part of the catch.
   - reducing the operational cost items that do not have an adverse effect on fish production and revenue.

iii. For new investments in coastal fishing, it is essential to relate

the mean fish price to the value of the investment cost.

iv. Investment loans for fishing vessels should be very carefully examined as the loan may appear to be very attractive but the cost of capital may be exceedingly high.

7. References

[1] M.A. Shama, "Factors Affecting Coastal Fishing Vessel Productivity", Alexandria Engineering Journal, vol. 28, No. 2, April, 1989.

[2] M.A. Shama, "Factors Affecting Fishing Voyage Expenses And Efficiency", Alexandria Engineering Journal, vol. 28. No.2, April, 1989.

[3] M.A. Shama, "Operational Cost Analysis of Coastal Fishing Vessels", Alexandria Engineering Journal, Vol. 28, No. 3, July, 1989.

[4] H. Brenford, "Fundamentals of Ship Design Economics", The University of Mishigan, August, 1965.