THE FISHING INDUSTRY IN KERALA
PROBLEMS AND POTENTIALS

Thesis submitted to the
Cochin University of Science and Technology
for the award of the Degree of Doctor of Philosophy
in Economics under the Faculty of Social Sciences

By

RAJASENAN D.

Under the Supervision of

Dr. K. C. SANKARANARAYANAN

DEPARTMENT OF APPLIED ECONOMICS
COCHIN UNIVERSITY OF SCIENCE AND TECHNOLOGY
COCHIN - 682 022

MARCH 1987

SANKARANARAYANAN
PROFESSOR

HEAD OF THE DEPARTMENT
DEPARTMENT OF APPLIED ECONOMICS
COCHIN UNIVERSITY OF
SCIENCE AND TECHNOLOGY
COCHIN-682 022

PHONE: OFF. 85-6030
RES. 85-6394

March 2, 1987.

C E R T I F I C A T E

Certified that the tesis "The Fishing Industry in Kerala - Problem and Potentials" is the record of bona fide reserch carried out by Mr.Rajasenan,D., under my guilance. The theis is worth submitting for the degree of Doctor of Philosophy in Economics.

(Dr.I.C.Sankaranarayanan).

D E C L A R A T IN

I declare that this thesis the record of bona fide research carried oby me under the supervision of Dr.K.C.Sankaranyanan, Professor and Head of the Department ofplied Economics, Cochin University of Science Technology. I further declare that this has npreviously formed the basis of the award of ar degree, diploma, associateship, fellowship or otr similar title of recognition.

Cochin 682 Ø22,
March 2, 1987.

Rajasenan, D.

A C K N O W L E D G E M E N T

The idea of this study was conceived during my tenure in the College of Fisheries, Kerala Agricultural University. But it took the present form after my joining the Department of Applied Economics, University of Cochin (Now Cochin University of Science & Technology) in March 1983.

I take this opportunity to place on record my sincere gratitude to Dr.K.C.Sankaranarayanan, Professor and Head of the Department of Applied Economics, Cochin University of Science & Technology for his encouragement and meticulous guidance. I deem it a great privilege to have been associated with him.

A host of others including officers of the Fisheries Research Institutes and Department of Fisheries, Government of Kerala helped me with data and relevant information for this study. Dr.M.J.Sebastian, Dean, Faculty of Fisheries, Kerala Agricultural University, Panangad, Cochin who provided data on experimental fish culture activities conducted at Vytilla Fisheries Research Station deserves special mention. I also extend my gratitude to the large number of fishermen and boat owners for extending their sincere co-operation during my field visits and sample surveys in the selected scheme areas.

I am indebted to Dr.Jose T. Payyappilly, Professor, School of Management Studies and Dr.M.K.Sukumaran Nair, Reader, Department of Applied Economics, Cochin University of Science & Technology, for their timely advice and suggestions throughout this study. I am especially grateful to Dr.Jessy John, C.,Lecturer, Department of Applied Economics, for her help in analysing the data.

My thanks are also due to my colleagues in the School of Management Studies, especially, Dr.P.Sudarsanan Pillai, Dr.T.Mary Joseph and Mr.James Manalel for their sincere and invaluable help.

CONTENTS

Pages

Pages

Pages

LIST OF TABLES

LIST OF FIGURES

Figure No. Page

LIST OF APPENDICES

Chapter I

INTRODUCTION

1.1 With its 590 km coastline, fisheries provide one of the richest renewable natural resources in Kerala. The development in fisheries--marine fisheries in particular--encompasses a wide spectrum of functions such as handling, processing, transportation and marketing.

1.2 Resource base

1.2.1 Geographically Kerala forms a distinct region, lying between 8°- 18' and 12°- 48' north and 75°- 52' and 72°- 22' east. It is a narrow strip of land marked off from the neighbouring areas with the Karnataka state in the north, the Tamil Nadu state in the east and south east and the Arabian Sea in the west. The state is divided into three natural sub-divisions: the high land, the mid land, and the low land. The coastal line of Kerala is fringed with stretches of sand.

1.2.2 Kerala's 590 km coastline constitutes about 10 per cent of the country's total coastline. Along the coast line there are river mouths and sheltered bays suitable for development as fishing harbours. The continental shelf sprawls over nearly 40,000 km^2 and the overlying waters are considered to be the most productive in the Indian Ocean. The sea within the 10 km fm (18m) depth range accounts for 5,000 km^2 and between 40 - 100 fm (73 - 182m) 10,000 km^2. The shelf upto 60m depth area is muddy from south-west of Alleppey towards north (Government of India Fishery Survey, 1976). The south-west region manifests certain unique features which influence the fluctuations of the important commercial species. During the south-west monsoon a southernly drift is noticed. The upwelling of the sea during the monsoon formulates the occurrence of mud banks (Chākara). This is a storehouse of many nutrients which attracts large amount of prawn and fish. The sea between the chākaras and coast will be calm in spite of the monsoon. This facilitates fishing operations even by traditional craft (William, 1980).

1.2.3 Marine fishing is a highly skilled activity and fishermen in Kerala are well versed in the vast body of knowledge it requires: seasonal variation in availability, location of fish in different conditions of tide, weather and current, navigation and depth estimation etc. Such knowledge is also specific to different species of fish, craft and gear combinations, and techniques are also accordingly specialised.

1.3 History of the fishing industry

1.3.1 Fishing industry in Kerala had a long and varied history. From time immemorial fishing has been a traditional occupation for a large segment of the population, inhabiting in the sea coast. Scattered evidences of the Sangam Age (1st century A.D.) and the writings of the travellers Pliny and the anonymous author of "Periplus of the Erythrean Sea" in the first century A.D. give evidence to the immensity of fisheries, the abundance of fish trade and the importance of fishing community as its social structure (Day, 1865).

1.3.2 Pre-historic fishermen were the first to initiate research in fishery development. They developed small screens with weeds and palm leaves when they found that their hands alone were insufficient. They found suitable time, particularly morning hours, for fishing; storing his catch in pit with water until he finished the days catch; floating with a log of wood on water; getting assistance from companions etc.

1.3.3 Fisheries in those periods developed in rivers and lakes and in marine waters close to shore, where fishes were easily available and could be taken by hand, or with the simplest artificial devices. As local supplies become insufficient fishing activity spreads geographically, first up and down the shores of the sea, then out to sea as crude crafts and canoes were developed.

1.3.4 To exploit more and more fishery wealth the fishermen used many indigenous methods. The present day craft and gear technology are just improvements of the indigenous methods with those of many foreign nations' design and methods (Day, 1865). The crafts like the high board dugout formed with stiched planks are of Arab influence. The present day cattāmaran was of Egyptian origin. The gears like shore-seines (Kampavala) was of Portuguese import. The boat seine like the 'ōdamvala' and 'kollivala' were the results of Spanish influence. The Chinese dip nets were imported and infused into Kerala fishing methods.

1.3.5 Kerala has made substantial contribution to the world fisheries. The wide dispersal of the design of the net and the blow gun was Kerala's contribution to the outside fishing world. Stitching coir rope with boat construction and the use of fish oil as preservative of boat timber were also Kerala's contribution to the world fisheries (Day, 1865).

1.3.6 The colonial administration in India was one of the reasons for the underdevelopment of the fishing industry in Kerala. Because of lack of attention on fisheries, the boat building industry for which Kerala was once famous for dwindled very much. Until the enactment of 'Indian Fisheries Act' of 1897 the fishing industry in Kerala received little attention.

The Act empowered the state for the development and conservation of fishery resources in the inland and territorial waters.

1.4 Stature of the industry after Independence

1.4.1 After independence the fisheries sector in Kerala witnessed rapid development. Kerala's five year plans were milestones in the state's economic progress for intensive and extensive use of the state's natural resources. The decade 1950s was noted for the fisheries improvement effort as a result of the introduction of Indo-Norwegian Project (INP) in 1953 (Galtung, 1969). The move to construct larger boats with powerful engines (mechanised boats) using completely new fishing techniques (trawling) was well on the way. The joint marine survey (INP, CMFRI) in 1956 helped to discover the vast potential of untapped prawn resources available both in the shallower inshore waters and in deep-sea made Kerala waters the richest prawn grounds in the world (Kurien, 1985). This paved the way for large scale introduction of trawling boats for bottom trawling to capture demersal specie of prawn. Another revolutionary effect in Kerala fisheries was the shift from using cotton to nylon nets (Kurien and Mathew, 1982).

1.4.2 The fisheries activity during the first plan was untouched by the Indo-Norwegian Fishery Development Project. The plan investment (a meagre sum of Rs.2.7 lakhs) was wholly spent for the development of fishery in the private sector.

The major economic species caught during the plan period were oil-sardine and mackeral. The fish production of 1,81,000 tonnes during this period was wholly contributed by the traditional sector.

1.4.3 During the second plan, the main emphasis was on increased productivity and general welfare of the fishermen. A sum of Rs.21.6 lakhs was spent on production-oriented schemes and Rs.33.8 lakhs on processing and marketing schemes. During this period the fish production in the state reached 2,37,000 tonnes and the entire production was contributed by the traditional sector.

1.4.4 The beginning of 1960s marked a shift in the developmental process. This was largely owing to the financial resources and the new technology provided during the two five year plans and the INP. In the eyes of the planners the panacea for poverty was to increase production and productivity. So they suggested adoption of modern mechanised crafts in place of the traditional crafts. Export of prawn showed enormaus increase during these periods. Demand for prawn in the United States and Japan led to the introduction of more and more catch efficient methods of bottom trawling (Asari, 1969). All these created a new class of non-operating capitalists who owned the means of production. This also helped for the migration of large labour force into this sector. The entry of the big merchant capitalists forced the stagnant fish economy plunge well within the tentacles of the world market forces (Kurien, 1978b).

1.4.5 Kerala fish economy suddenly transformed into an area of increased internal investment and involvement. This led to the formation of a 'modern sector' in the fisheries sector with ample help from the Governmental side with the export-oriented thrust to foreign exchange earnings (Kurien, 1985). Most of the investments of the five year plans in the fisheries sector (more than 80%) were diverted for the development of mechanised boats and equipments and supporting infrastructure for facilitating export drive.

1.4.6 The greatest rise and fall of the fish production witnessed in Kerala during 1970s. The record production of 4,48,000 tonnes of fish and 84,700 tonnes of prawn occurred in 1973. But after 1973 production showed a sudden decline and stagnation. The economic species of oil-sardine and mackeral of the traditional sector and prawn in the mechanised sector showed wide variations of declining trend. Fish production reached the lowest mark of 2,79,000 tonnes in 1980.

1.4.7 The increase in the price of prawns resulted in very high investment in the modern sector, which led to unprecedented growth in the number of mechanised boats. A concomitant sudden increase in the labour force employed in this sector led to a reduction in physical output.

1.4.8 By and large, fisheries development under the five year plans in Kerala favoured mechanised fishing and supporting facilities for augmenting fish production and fishermen's income. Over the years 1951-52 to 1982-83 a total investment of Rs.41.76 crores was invested in this sector for fisheries development. Even though the traditional fisheries employs about 70 per cent of the fishermen and accounts for more than 55 per cent of the marine landings, the development allocations to this sector has been marginal. The samll scale sector was given an allocation of Rs.72.98 lakhs only. This resulted in the abandoning of the low cost technology to exploit the in-shore fisheries resources without endangering the eco-system and the resources (SIFFS, 1984). The over-emphasis on mechanised fisheries and linkage sectors really led to the use of unsuitable western technology without taking into account its impacts on local fisheries.

1.4.9 The technological polarisation which the fish economy has undergone for three decades with the initiative of the Norwegians and the market forces resulted in both stagnation and ecological imbalance.

1.4.10 The declining production trend led to certain apprehensions on the part of the artisanal fishermen. They were also of opinion that shrimp trawling during the breeding monsoon season is detrimental to the shrimp stocks. This was aggravated when the purse-seiners entered the fishing field in 1979. The subsequent competition for space, resources and fish price led to the pauperisation of the traditional fishermen. So the artisanal fishermen clamoured for effective measures to check resource depletion and saving the fishery economy from the present doldrums.

1.5 Significance of the study

1.5.1 The importance of fishing and other allied industries in the economy was realised only very recently. Consequently only very few studies are available on the subject. Here an attempt is made to survey the available literature on the subject.

1.5.2 Day was probably the first person who attempted to highlight the development of the fishing industry compiling information from the pre-historic to the second half of the 19th century (Day, 1865). It was Klausen (1968) who highlighted the need for a comprehensive project for fisheries development. Asari's work related to a critical analysis of the impact of Indo-Norwegian Project on the artisanal sector in Kerala (Asari, 1969).

1.5.3 In 1978 four studies were published regarding the fishery economy in Kerala. The first was that of Mathur in

1.5.8 Clucas analysed the methods relating to the fish handling and processing for the maximum utilisation of the marine resources (Clucas, 1981). Marine Products Export Development Authority's (MPEDA) study on the marine products processing industry presented the anarchic growth of the processing plants. The study also critically examined the defects found in the technology employed in the production process and suggested ways and means to rectify them (Status Report, 1981). Krishna Iyer et. (1982b) showed on the other hand the presence of idle capacity on the basis of certain case studies with reference to the fish processing industry in Kerala. They also analysed causes for the underutilisation and suggested remedial measures.

1.5.9 National Traffic Planning and Automation Centre (NATPAC) in a study analysed transportation time and marketing aspects of fish resources with a view to minimise waste from spoilage and movement of fish from landing centres to processing centres and market places (NATPAC, 1982). Chaston also made a comparative study of different transporting methods and their importance to fish marketing (Chaston, 1983). It was Platteau who revealed the rise and development of market economy in the marine fishing village of Sakthikulangara-Neendakara belt (Platteau, 1984).

1.5.10 Chidambaram (1975) viewed the need for diversification of the product for encouraging seafood export. An indepth analysis was done by Subramanian with regard to packaging cost of the marine products (Subramanian, 1982). A scientific analysis was done by Rao to explain the market concentration, the need for quality control and product development for the smooth flow of fishery trade (Rao, 1983).

1.5.11 Shang with the aid of statistical and econometric techniques evaluated the importance of aquacultural investments (Shang, 1981). Kee and Manru based on Cobb Douglas production function developed a model for aiding decision making with reference to milk fish culture operation in Phillippines. (Kee and Manru, 1981). Sarun and Theodore, on the other hand, used input-output analysis and production function approach for estimating the economics of catfish culture in Thailand (Sarun and Theodore, 1981). Purushan presented the conditions determining scientific fish culture in comparison with the traditional fish culture based on productivity and income (Purushan, 1985). Dwivedi based on case study showed that polyculture of fish is the most suitable method with reference to India (Dwivedi, 1985).

1.5.12 Three case studies were conducted in different periods to analyse the economics of mechanised fishing in Kerala (Krishna Iyer et.al.). The first highlighted the most economically efficient vessel size (Krishna Iyer et.al., 1968). The second study showed the minimum quantity of fish and prawn per trip for breaking even (Krishna Iyer et.al., 1982a). The third study showed that the profit and loss of the fishing trawler depended upon the number of fishing trips per year (Krishna Iyer et.al., 1983). In 1983 two more studies appeared in this field. Both showed that catch per unit effort and operational costs are the major determinants of the economic efficiency of mechanised vessels (Rao, 1983 and Bhaskaran Pilla 1983).

1.5.13 Gopalan analysed the manifold reasons for the sickness of mechanised fishing industry. He identified the following as causes of sickness: dwindling catches, restriction imposed by the Government on mechanised fishing boats from operating within 5 km from the shore, mounting operational cost due to increased taxes on oil, diesel and spares, high investment and diesel scarcity (Gopalan, 1980). George, on the other hand, showed dwindling trend of the catch with reference to the mechanised boats on account of concentration of mechanised boats in certain centres, the species composition and size of prawn as the causes of sickness (George, 1980). Bhaskaran Pillai, in his study, forcibly argued that if trawlin is prohibited during monsoon months the mechanised sector will not make any profit (Bhaskaran Pillai, 1981). Krishnakumar examined in his study the reasons for the failure of mechanised fishing. He also suggested some measures to solve the problems faced by the mechanised sector (Krishnakumar, 1981).

1.5.14 Swaminath emphasised the need for new types of hull materials for the profitable operation of the mechanised boats (Swaminath, 1983). Fibre glass and aluminium alloy were the two boat-building materials found to be economical in constructing mechanised fishing boats (Bay of Bengal News, 1984).

1.5.15 Kurien argued that the agitations to safeguard the traditional fishermen were not something novel. He stressed the need for proper management and regulation for recouping fishery (Kurien, 1984a). Kurien highlighted the impact of Norwegian technical assistance project on the socio-economic fabric of Kerala's fish economy (Kurien, 1985). Two studies of Mr.Choudhury are significant with reference to the managemen control and regulation of fishing. The first one stressed the need for management regulations to conserve fishery in the light of stagnating marine production (Choudhury, 1986a). The second study examined the interlinkage of fishery sector with the various economic systems and the importance of the alternat source of resources (Choudhury, 1986b).

1.5.16 Schaefer emphasised Total Allowable Catch (TAC) based on permitted number of trawlers as the basic idea of managing marine fisheries (Schaefer, 1957). Turvey's study examined the importance of mesh regulation as a major factor needed for the management of fishery resources in the coastal waters (Turvey, 1964). Anderson pointed out the regulation of fisheries based on Maximum Economic Yield (Anderson, 1977). AMCRR showed Maximum Sustainable Yield (MSY) as the guiding principle for fishery management (AMCRR, 1980).

1.5.17 Madhupratap et.al. argued that industrial effluents and the resulting water pollution were the major reasons for the destruction of the fish breeding structures of the shrimp resources in Kerala (Madhupratap et.al., 1979). FAO's study explained marine pollution (organic and inorganic) as responsibl for the depletion of fish resources in the shore fisheries (FAO, 1971).

1.5.18 The Babu Paul Committee made a fair attempt to cross-check the marine management conservation methods with the experiences and considered opinions of the fishermen and fishery scientists in suggesting the various needs for conservation of marine resources and allied matters (Babu Paul Commission Report, 1982). Kalwar Commission, a second in the series on Kerala's marine fisheries conservation, showed that Kerala's present level of exploitation of inshore resources was near the allowable level and any further effort will lead to overfishing (Kalwar Commission Report, 1985).

1.5.19 Joseph examined the type and size of trawlers needed for deep-sea fishing based on oceanographic conditions of fishing ground (Joseph, 1982). Dixitulu has made an effort to outline the background of the present stage of deep-sea fishing and its potential (Dixitulu, 1985).

1.5.20 Krishnakumar presented 28 developmental issues as a strategy for a three year massive thrust and action programme for fisheries development and welfare (1980-83) with the object of carrying the sector to a take off stage of orderly development, so that full potential of the sector is realised within a further perspective 10 year (1983-1993) plan period (Krishnakumar, 1980).

1.5.21 In short, the literature survey shows that the fishing industry faces problems of resource stagnation and uneconomic operation of the fishing units. Before depleting the fish resources, management conservation methods are to be implemented on an urgent basis. Alternative sources of resources, other than coastal fisheries, are to be explored.

1.5.22 In the light of the above problems, it is felt that seasonality analysis and fish production forecasts are to be carried out for managing the marine resources. An adaptive method of fish culture activity is developed to solve the resource problem. Moreover, indepth case studies of the cost and earnings of the mechanised fishing units in the highly concentrated centres are to be carried out. These are to be conducted and supplemented with the earlier studies, so as to formulate an effective planning in the stagnant fishery economy.

1.5.23 The succeeding study is designed to include the above-mentioned works, which have been neglected so far to provide investigations, analysis and solutions for planning and management of the fast-depleting near shore fishery resources. To help further understanding and practical application of the solution a general analysis of the sector from harvest to post-harvest area is looked into.

1.6 Problems

1.6.1 The problems posed in this study are:

1) Has the fishing industry made any significant contribution to the development of the state?

2) What are the reasons for the stagnation in the marine production?

3) Is there any possibility to increase inland fish production and fish culture?

4) What are the reasons for the uneconomic operation of the mechanised fishing industry?

5) Has it been possible to introduce some management regulations to safeguard the depleting prawn resources and to expand the catch and production capacity of the artisanal sector?

6) How to rehabilitate the mechanised sector and resume its development?

7) How far the present transportation system is effective in minimising the economic waste from spoilage?

1.7 Hypotheses

1) Fishing industry recorded high degree of productivity in the 1960s and 1970s. But this has not contributed anything to the development of the traditional fishermen who form the majority in the fishery economy.

2) Mechanised fishing is unprofitable in terms of cost and yield.

3) Concentration of mechanised vessels in certain centres has resulted in overfishing of certain commercially important species. If these mechanised vessels are deployed for diversified fishing, the mechanised fishing industry can be saved from the present crisis.

4) Fish catch levels have remained stagnant in spite of large scale investment and development programmes under the five year plan.

5) Very high fluctuations are noticed in most of the marine species. Peak and lean seasons are important for management regulation.

6) Large number of processing plants set up in the state exhibit low levels of capacity utilisation.

7) Fish culture industry can be developed for generating income, employment and foreign exchange earnings to the state.

1.8 Methodology

1.8.1 This is an empirical study based on data collected from two sources--primary and secondary. The data for the study were collected in the following way:

1) Primary data for analysing the economics of mechanised fishing were collected for six quarters from the maximum concentrated mechanised fishing centre of Sakthikulangara - Neendakara belt.

2) To study the importance and potential of fish culture activities data were collected from the experimental fish farms of the Kerala Agricultural University (Fisheries

3) Secondary data were collected from various Fisheries Research Institutes and the Fisheries Department, Government of Kerala to measure income trends for mechanised, non-mechanised and for various gear types in Kerala.

4) Secondary data regarding the fish production trends with reference to 28 quarters were collected to find out the seasonal variation based on time series forecasting models.

5) Secondary data from CMFRI were collected to analyse the transportation and marketing of marine fish.

6) Secondary data from MPEDA were also used to analyse the importance of marine products exports in the econom of Kerala.

1.8.2 Data collected from different sources were supplemented by holding discussions with the fishery experts of different research institutions.

1.9 Limitations

1.9.1 The study has some limitations. The major limitatio results from the non-availability of reliable and accurate data with reference to the techno-economic performance of the indust The mechanised boat owners invariably try to understate the cat and value of the products and overstate their economic problems. There is wide variation in the catch data of the artisanal sector from one source to another.

1.10 Plan of the study

1.10.1 For the purpose of analysis the thesis is divided into ten chapters:

1.10.2 Chapter I presents the genesis, growth and development of fishing industry in Kerala. It also presents the present position and problems faced by the industry. Importance of the study, hypotheses, objectives and methodology also form part of this chapter.

1.10.3 Chapter II examines the various production methods and technology in the artisanal and mechanised sectors. The results of economic analysis of various craft-gear combinations based on the technological developments in the fishing industry is also presented in this chapter.

1.10.4 Chapter III presents the production trends in the marine and the inland sector. The iterative behaviour of fish production is estimated based on harmonic analysis of time series model. A seasonal forecasting model of Auto Regressive Moving Average (ARMA) is used to forecast the landing pattern of the major species. The gearwise income trends in the Kerala fisheries is also estimated and presented in this chapter.

1.10.5 Chapter IV discusses the various aspects of mechanisation.

1.10.6 Chapter V examines the development and growth of the fish processing industry. It also examines the causes of sickness of the fish processing industry.

1.10.7 Chapter VI presents the role of transportation and marketing in minimising spoilage and waste of fish resources. Intervention of intermediaries and its effect on the fishery economy is also analysed.

1.10.8 Chapter VII highlights the problems of the fishing industry, i.e., conservation and management regulation. It also includes the estimated results based on Schaefer model, the Maximum Sustainable Yield (MSY), Total Allowable Catch (TAC) and the number of trawlers required to exploit the Maximum Economic Yield (MEY) of the prawn resources of the major fishing centres.

1.10.9 Chapter VIII makes an analysis of the structural and changing pattern of the Kerala Seafood export trade. Measures needed for the smooth flow of marine products trade are also analvsed here.

1.10.10 Chapter IX presents a case study and an evaluation study. The case study is undertaken with a view to assess the economic performance of the mechanised fishing industry. The study is based on benefit-cost analysis, discounting method and statistical coefficients of seasonal fishing ability. The evaluation study based on Cobb-Douglas production function is done to suggest an alternative method of fish production in the stagnant fish economy. A comparative analysis of the different types of fish culture operation is also made to suggest the type of fish culture activity which is more economic in the present condition.

1.10.11 Chapter X presents the findings of the study.

Chapter II

PRODUCTION METHODS AND TECHNOLOGY

2.1.1 The total complex of fishing units, comprising a variety of composite systems of two factors--craft and gear--constitutes the means of production. There are a variety of craft and gear. The craft is an important instrument as it is used to take the fisherman to the fishing ground. Gear is used to catch fish.

2.1.2 The place to place change in the types of equipments and their operations depend upon factors such as nature of coastal region, climatic conditions, species of fish available, capital at the command of fisherfolk and local traditions (Kurien, 1978a). Any technological change in fisheries means change in the craft and gear combination for any substantial increase in the output. Mechanisation of fishing craft, introduction of mechanised boats of new designs, use of improved gear materials and gear designs, adoption of modern techniques--all contribute towards the development of the industry on scientific lines and thus effect increased catch.

2.2 Fishing crafts

2.2.1 Depending upon the distance of the operation the craft is broadly divided into three categories. They are:

1) Craft for small distance or coastal fisheries: The crafts belonging to this category are of 12 metres length. They may be mechanised or non-mechanised depending upon the type of operation. They generally make daily trips.

2) Crafts for middle distance or off-shore fisheries: The length of these crafts vary between 12 to 30 metres. These fishing crafts have to operate usually for more than a week. Hence all the preservation facilities will be available on board of these crafts.

3) Crafts for distant fisheries or high sea fisheries: This category of crafts is very large--generally above 30 metres in length. They have all amenities of modern fishing including processing. Since these vessels remain in the sea for about 3 to 4 months at a time, they are sea-worthy to undertake fishing all the year around, under all sea conditions.

2.2.2 The crafts are also classified into indigenous or non-mechanised crafts and mechanised crafts. Based on the operation ,the non-mechanised crafts are again divided into three categories; viz., (1) cattamarans, (2) dugout canoes and (3) plank-built canoes.

2.3 Indigenous crafts

2.3.1 Cattamaran

2.3.1.1 Cattamaran is a keeless craft formed by lashing together several logs, carved and shaped like a canoe. It was of Egyptian origin. The word cattamaran is derived from the Tamil word 'Cattumaram' which means tree or wood together (Kurien, 1978a). The logs are held together either by ropes or by pegging with wooden pieces. These types of traditional crafts are mostly used by the latin catholic fishermen of Quilon and Trivandrum districts in Kerala. Cattamarans are formed either with three logs of soft wood tied at the two ends with coir ropes or with five logs tied with coir ropes at both ends with a cross piece cut of woods. The craft is rowed with the help of a bamboo pole.

2.3.1.2 The size of the cattamaran depends on the number of logs used. Generally the length ranges from 7 to 8.5 metres and width from 1.5 to 1.11 metres. The big cattamarans can carry more than two persons, but they are usually paddled by two men. In a 3 log craft only one man goes for fishing. The fishermen in Quilon and Trivandrum generally use the cattamaran only once a day, i.e., they go in the evening and return in the early morning. But in certain seasons owing to the easy availability of a particular specie of fish they use cattamaran more than once. Gillnetts and hook-and-line fishing are the two important types of gears used for fishing by those who use cattamarans. In addition, they also use drift net. Sometimes cattamarans are used in pairs to operate boat-seines, drift nets and hook-and-line sets. For storing fish they carry a small net and keep it at one end of the craft and this gives only very little protection from waves and winds.

2.3.1.3 The district-wise distribution of cattamarans in Kerala, according to the different census, is given in table 2.1. This table indicates variation in the number of the cattamaran during the different census periods. This is mostly noticed in the quinquennial live stock census of 1972 and 1977 as the census included some traditional craft in the category of others. It is interesting to note that Trivandrum is the only district which uses this crude and rudimentary traditional craft at an increasing scale. Next comes Quilon. Other districts have totally stopped the use of this craft by 1980. In 1980 there were 11,480 cattamarans, of which 10,302 were in Trivandrum district and the rest in Quilon district. The interesting feature is that cattamaran is the most fascinating vessel for sport sailing and the most inconvenient as a fishing boat.

2.3.2 Dugout canoe

2.3.2.1 The most predominant type of traditional craft of the indigenous origin is the dugout canoe. Dugout canoes are employed all over Kerala for catching various species of fish near the shore and in deep waters. A dugout canoe is made by scooping out a large log of wood, making the keel portion thicker than the sides. In Kerala the size of the dugout

Table 2.1 Districtwise distribution of cattamarans in Kerala

District	Year				
	1966	1972	1977	1979	1980
Trivandrum	5500	1094	1231	5812	10302
Quilon	174	1478	937	1402	1178
Alleppey	49	1597	1529	64	--
Ernakulam	199	2055	1142	--	--
Trichur	41	562	373	--	--
Palghat	2	--	--	--	--
Malappuram	--	613	596	--	--
Kozhikode	12	1126	490	--	--
Cannanore	79	1194	1103	--	--
Total	6056	9719	7401	7278	11480

Source: 1) Government of Kerala, Department of Animal Husbandry, Kerala State <u>Live Stock Census Reports</u> , 1966, 1972 and 1977.

2) Central Marine Fisheries Research Institute, Government of India, <u>Census of Fishermen-Fishing Craft</u>, 1980.

canoes varies between 8 to 13 metres and middle size 9 to 10 metres and the smallest 8 to 9 metres. They use gears like boat seines, drift nets and long lines. The largest dugout canoes are called 'odam' or 'vanchi', the middle ones 'thonies' and the small ones 'beputhonie' (Mathur, 1978).

2.3.2.2 Dugout canoes are used for fishing generally October through May when the weather is clear. They use big paddles for propulsion as well as for control. Mats are also used for the movement of the dugouts to the favourable direction. Small dugouts called the 'beputhonie' are mostly used for hook and line fishing. They are also used for gill netting. Two big dugouts are employed for operating boat seines for different species coming in shawls.

2.3.2.3 The width and depth of these canoes and the purpose for which they are used vary according to locality. A dugout canoe of 12 to 13 metres long and one metre wide with a crew of 15 is used for operating 'thangu vala'. This vala (net) is 90 metres long, 24 metres wide but is narrow at the middle with 7.5 metres width at the ends. It has a mesh size of 2 cm. A smaller dugout canoe, with a capacity to carry only five people, is used for operation of 'ayila vala' which is 220 metres long and 8 metres wide (Kurien et.al., 1962). It has a mesh size of 5 cm, described as the 'chala vala', the encircling gill net for sardine and mackeral. The method and design used for operating the chala vala and ayila vala are one and the same, but the mesh size of the ayila vala is larger than that of the chala vala (Noble, 1974).

2.3.2.4 From table 2.2 it can be seen that dugout canoes were used mostly in the districts of Quilon, Alleppey and Ernakulam. This is seen only in the State Department of Fisheries Census data of 1979. But CMFRI census data show that the dugout canoes have reduced phenomenally in 1980. In this, Kozhikode and Cannanore were the two districts using this kind of canoe for traditional fishing operation. At present about 15,000 dugout canoes are operated in Kerala by 18,188 fishermen households. Of these, 11,437 are owned and operated by fishermen households. In Trivandrum dugout canoes are used comparatively low.

2.3.3 Plank-built canoe

2.3.3.1 The dugout canoes are enlarged by placing wooden planks with or without ribs inside. Depending upon the size and methods of planks used plank-built canoes are grouped under two classes (Mathur, 1978). Both of these are called 'kettu vallam'. The first type has 7 to 12 metres length, 1 to 1.5 metres width and 0.5 to 1.2 metres depth. The other type plank-built canoe has 7 to 16 metres length, 1 to 2 metres width and 0.7 to 1.5 metres depth.

Table 2.2 Districtwise distribution of dugout canoes in Kerala

Districts	Years				
	1966	1972	1977	1979	1980
Trivandrum	1030	1242	1281	584	1282
Quilon	1378	1556	1967	2694	680
Alleppey	2048	1369	1785	2267	735
Kottayam	715	730	745	891	--
Ernakulam	1166	1527	1672	3031	1198
Trichur	502	353	791	1933	1411
Palghat	346	312	56	--	--
Malappuram	--	557	545	1178	1416
Kozhikode	1130	1022	911	1745	1907
Cannanore	649	1197	1337	1686	1786
Total	8964	9865	11090	16009	10416

Source: (1) Government of Kerala, Department of Animal Husbandry; Kerala State Live Stock Census Reports, 1966, 1972 and 1977.
(2) Central Marine Fisheries Research Institute, Government of India, Census of Fishermen-Fishing Craft 1980.

2.3.3.2 The size of the crew varies between 4 to 15 depending upon the size of the canoe. The plank canoe uses only paddles for steering and propulsion. The big plank-built canoes are meant for using in moderate surf, while the small plank canoes are used only in calmer seas. All boat seines, gill nets, drift nets and hook and lines are launched from the plank-built canoe. The plank-built canoe has a carrying capacity of 1 to 4 tonnes depending upon the size. The cost of a plank-built canoe varies between Rs.5,000 to 20,000 depending upon the size. The expected life span of this type of a canoe is about 5 to 7 years.

2.3.3.3 The distribution pattern of the plank-built canoes (table 2.3) shows that Alleppey district has the maximum number. A recent analysis shows that the total plank-built canoe in the state comes to about 5,000.

2.3.3.4 The distribution of various types of traditional crafts is not uniform in Kerala. This is largely owing to the concentration of a particular type of production technique in a particular area, and to some extent owing to the inequailties in the possession of capital for investment and definite local references (Mathur, 1978). A considerable variety of traditional crafts in the Kerala coasts performs various kinds of specialised function. The gears used for fishing by the indigenous fishing units of Cochin and Quilon are boat

Table 2.3 Districtwise distribution of plank-built canoes in Kerala

Districts	Years				
	1966	1972	1977	1979	1980
Trivandrum	627	264	377	573	911
Quilon	1344	361	915	1766	760
Alleppey	3192	334	1008	2668	1442
Kottayam	675	102	112	408	--
Ernakulam	2054	1094	997	2168	265
Trichur	923	114	402	505	112
Palghat	329	--	--	--	--
Malappuram	--	222	605	667	597
Kozhikode	2293	744	1026	980	287
Cannanore	1039	889	1072	1090	2
Total	12476	4124	6511	10825	4371

Source: (1) Government of Kerala, Department of Animal Husbandry; Kerala State <u>Live Stock Census Reports</u>, 1966, 1972 and 1977.
(2) Central Marine Fisheries Research Institute, Government of India, <u>Census of Fishermen-Fishing Craft</u> 1980.

seine, the large net or 'thangu vala' and gill net 'ayila vala' etc. (Kurien et.al., 1962). The fishing units in these areas are called 'Tanguvallam' as they are specialised in tangu vala.

2.3.4 Mechanised craft

2.3.4.1 Mechanisation of the crafts in the fishing sector was first started in the early 1950s as a part of the national development programme for increased fish production. The concept of mechanisation in the initial period in the country was confined to motorisation of the traditional craft. But owing to various reasons the idea of motorisation was not welcomed in the state. Hence the idea of mechanising beach-fishing has been abandoned and has turned to constructing a boat type, which is dependent on small natural harbours (Klausen, 1968).

2.3.4.2 Motorised craft

2.3.4.2.1 An interesting feature of the Kerala fisheries is that, the state is now increasingly going for motorisation of the traditional crafts which was abandoned in the early 1950s as the traditional crafts of cattamaran, dugout canoes and plank-built canoes were unsuitable for motorisation.

2.3.4.2.2 Upto 1985 about 3,500 traditional crafts were motorised. Motorisation is done in the traditional fisheries by installing an out board or an inboard engine. Motorisation

2.3.4.2.3 The motorisation is expected to increase employment opportunities to the fishermen working in the traditional sectors. The motorised cattamaran requires 3 to 5 persons instead of only 2 for the non-mechanised units. The increased mobility and easy accessability of the fishing ground for the motorised cattamarans resulted in higher returns than that of the non-mechanised crafts.

2.3.4.3 Mechanised boats

2.3.4.3.1 At present there are about four types of mechanised boats in Kerala, viz., 1) trawlers (2496), 2) gill netters (382) 3) purse seiners (53) and 4) others (50).

2.3.4.3.2 Table 2.4 shows the district-wise distribution of mechanised boats in the state. As per the XII quinquinnial livestock census the total number of mechanised boats in the state was 2,984 with maximum concentration in Quilon district (693). But according to fisheries census of 1982 conducted by the Department of Fisheries, the maximum concentration of mechanised vessel is in Ernakulam district. But actually the maximum concentration of mechanised boats is found in Sakthikulangara - Neendakara belt. The discrepancy is perhaps due to the fact that since the census period was during February, a lean season for the mechanised fishing in Neendakara, majority of the vessels might have gone for fishing in other districts especially to Ernakulam and Calicut.

Table 2.4 Districtwise distribution of mechanised craft in Kerala

Districts	Years	
	1977 (1)	1982 (2)
Trivandrum	358	13
Quilon	633	607
Alleppey	593	218
Ernakulam	498	836
Trichur	25	145
Malappuram	193	162
Kozhikode	205	591
Cannanore	479	389
Total	2984	2961

Source: (1) 12th Quinquennial Livestock Census-1977, Department of Animal Husbandry, Government of Kerala, Trivandrum.
(2) Census of Mechanised Boats in Kerala-1982, The Statistical Cell, Directorate of Fisheries, Government of Kerala, Trivandrum.

2.3.4.3.3 From table 2.5, it is clear that trawling is the major activity of the mechanised fishing industry in Kerala. Prawn is the mainstay of the mechanised sector. The other species landed by the mechanised fisheries are perches, scianeids and cat fishes. This sector basically caters to the needs of the fish export industry. This sector of the industry also gives the maximum employment opportunities to the marine fishermen, i.e., more than 2 lakh workers in fishing and other subsidiary units.

2.3.4.3.4 The lengthwise distribution of the trawlers (see table 2.6) in the state shows that about 90 per cent have between 30' to 32'. The rest ranges between 31.5 and 32'. 32' boats are seen mostly in Quilon (310) and 31.5' in Ernakulam (247) district.

2.3.4.3.5 With the advent of mechanisation of the fisheries sector, development of diversified fishing methods in the coastal fishing sector has gathered momentum. In recent years the drift gill net fishery has become one of the fast growing fishing methods in the mechanised fishing sector because of its economic viability for catching larger pelagics which find ready acceptance and consumer demand in the market. The area of operation of the drift gillnetters is generally in the 20-25m depth zone. The total number of fishing units engaged

Table 2.5 Districtwise distribution of mechanised boats in Kerala by type

District	No. of mechanised boats				
	Gill-netter	Trawler	Purse-seiner	Others	Total
Trivandrum	10	3	--	--	13
Quilon	40	567	--	--	607
Alleppey	13	205	--	--	218
Ernakulam	139	594	53	50	836
Trichur	63	82	--	--	145
Malappuram	38	124	--	--	162
Kozhikode	38	553	--	--	591
Cannanore	41	348	--	--	389
Total	382	2476	53	50	2961

Source: (1) 12th Quinquennial Livestock Census-1977, Department of Animal Husbandry, Government of Kerala, Trivandrum.
(2) Census of Mechanised Boats in Kerala-1982, The Statistical Cell, Directorate of Fisheries, Government of Kerala, Trivandrum.

Table 2.6 Districtwise distribution of trawler by length

Length of boats (in ft)	No.of mechanised boats (districtwise)								
	Tri-vandrum	Quilon	Alleppey	Ernakulam	Trichur	Malappuram	Kozhi-kode	Canna-nore	Total
24	--	1	--	--	--	--	--	--	1
25	--	25	--	4	5	--	18	--	52
28	2	14	1	4	1	1	11	5	39
30	1	29	7	88	45	40	244	179	633
30.5	--	2	--	--	--	1	--	--	3
31	--	34	5	10	2	--	5	2	58
31.5	--	148	70	247	5	4	2	9	485
32	--	310	117	230	23	67	216	145	1108
32.5	--	1	--	--	--	--	--	--	1
33	--	--	--	--	--	1	--	--	1
34	--	--	--	1	--	--	--	--	1
36	--	3	1	7	1	10	57	6	85
38	--	--	4	--	--	--	--	--	4
41.5	--	--	--	--	--	--	--	1	1
42	--	--	--	3	--	--	--	1	4
Total	3	567	205	594	82	124	553	348	2476

Source: (1) 12th Quinquennial Live Stock Census-1977, Dept.of Animal Husbandry, Government of Kerala.

(2) Census of Mechanical Boats in Kerala-1982 . The Statistical Cell, Directorate of Fisheries, Trivandrum, Government of Kerala.

in this type of fishing is 382 with maximum concentration of 40 per cent, i.e., 139 in Ernakulam district itself.

2.3.4.3.6 The purse-seiners have started operations in Cochin area during the latter half of 1979 with about 10 units. This increased to about 53 in 1982. Almost the same number exists at present also. The purse-seiners operated in this area are about 13 m in length with nets measuring 500-600 m in length and 50-60 m in depth with the meshes ranging from 13-20 m in size. Oil-sardine and mackeral landing are the two principal species of the purse-seine fishery.

2.3.4.3.7 Marine diesel engines operating in Kerala have upto 100 Brake Horse Power (BHP). Most of them are manufactured in India. Fishing crafts of different size, or of the same size but undertaking different types of fishing methods, would require engines of varying capacities depending upon the distance of the fishing grounds, speed desired, towing of gears as in the case of trawlers, driving fishing gear handling accessories such as trawl winch or power blocks, and driving auxiliaries. Table 2.7 gives the appropriate range of engine capacity for different types of trawlers alongwith respective displacement tonnage.

Table 2.7 Range of engine capacity and displacement tonnage

Size of thebboat overall length(m)	9.1	9.7	11.0	12.2	15.2
Displace-ment tonnage	5.5-6.0	8.1-9.1	15.0-16.0	17-18	30-32
Power of main engine (BHP)	30-45	40-45	60-70	80-90	150-160

Source: Government of India, Ministry of Agriculture and Irrigation, New Delhi; Report of National Commission on Agriculture, Part VIII--Fisheries, 1976, p.133.

2.3.4.3.8 The programme of mechanisation in the 1950s was initiated with imported engines. But imports were stopped when engines were manufactured indigenously. Now the economic efficiency of the mechanised fishing craft largely depends on the reliability, performance and price of the indigenously manufactured engines.

2.4 Need for technological change in craft and hull materials

2.4.1 The existing design of mechanised boats in Kerala is almost 30 years old. Originally the boats were of 24' 7" size, but later boat design upto 57' were built. This change in craft technology shows that there is further scope for improving the design of the existing boats. It also shows that we can positively design bigger size boats as in the case of some fishery developed countries, who are operating wooden boats of more than 100 feet size.

2.4.2 A comparison of our boats with that of the Eastern countries shows that our boats are fitted with less HP engines. Consequently these boats are unsuitable for operating bigger nets and also in distant and deep waters (Kirby and Szezepanik, 1957). This adversely affects the efficiency of operation. But it seems that the efficiency of these boats can be increased simply by increasing the horse power of the engines. Alongwith increasing the engine power work has to be taken up to improve the propeller efficiency for better performance and less fuel consumption. For certain fishing methods, the engine-cum-sail-boats can be thought of to minimise the cost of fuel consumption.

2.4.3 Our mechanised boats are designed for the purpose of stern trawling. Hence we do not have any specific design for diversified fishing activities or for distant, deep water fishing and purse-seine fishing. A slight modification in deck arrangement was made recently for converting them to purse-seiner. Since the fish hold arrangements could not be provided in these purse-seine boats, they had to make use of separate transport vessels as carrier boats which again were not designed for this purpose. All these show that we have even to go in for new designs of purse-seine boats.

2.4.4 At present we have mainly wooden boats operating in our coast. Since wood is becoming very costly and scarce, we have to think of alternative materials like fibre glass or ferrocement for the construction of smaller fishing boats (Bay of Bengal News, 1984). Experts who developed designs for our fishing vessels in 1950s were of the opinion that the existing design of the mechanised vessels are outmoded and hence need modification and improvement. If we want to extend our fisheries especially to long line tuna fishing or pole and line fishing for skipjack tuna we have to think of new designs of fishing boats. Besides we need to develop new designs for different types of fishing methods for coastal as well as for deep sea fishing operations.

2.4.5 It is, therefore, imperative to plan afresh for developing new crafts for the future. To develop new fisheries one needs to:

1) Compile existing facts, record existing problems and needs of the fishermen.

2) Design new boats to fit the parameters.

3) Build and test the prototype to assess technological and economic viability over a sufficiently long period of time.

4) Work at a scheme to introduce successful prototype.

2.5 Comparative analysis of different hull materials

2.5.1 The two important components of the fishing boats are hull and engine. The cost of hull is an important economic determinant of the economic efficiency of fishing. So a comparative analysis of the different hull materials for the small mechanised boats and larger fishing vessels are important to know the technical viability of the industry.

2.5.2 The price of almost all the hull materials used for the construction of the mechanised fishing has increased several fold. The price of good boat building timber log of the size Rs.4,500 R/m^3 has doubled since 1980. The price of marine plywood too has doubled since 1980. A 12 mm sheet costs Rs.130.00 R/m^2. The price of cement used in ferrocement construction has increased five times since 1980 to Rs.1,500/tonne. The only two materials which have shown marginal increases since 1980 are fibre glass (FRP) and aluminium and this is mainly due to the reduction of excise duty (Bay of Bengal News, 1984).

2.5.3 The cost of a gillnet fishing boat in wood, plywood sheathed with FRP, aluminium and ferrocement based on the accepted boat building practice is given in table 2.8.

Table 2.8 Cost of a 10m gillnet boat of different materials

(Amount in Rs.)

	Wood	Plywood seathed with FRP	FRP	Aluminium	Ferrocement
Shell weight including framing (kg/m^2)	34	27	17.5	15	62.5
Displacement (kg)	6,000	5,200	3,700	3,500	7,500
Shell cost ($Rs./m^2$)	475	540	825	620	325
Hull material cost	50,000	53,000	69,000	53,000	28,000
Labour cost	20,000	17,000	8,000	15,000	30,000
Outfit, overheads profit	35,000	35,000	40,000	40,000	35,000
Cost without engine	1,05,000	1,05,000	1,17,000	1,08,000	93,000

Source: Bay of Bengal News, Issue No.13, March 1984.

2.5.4 The figures given for labour cost overheads and profits are mere estimates. Table 2.8 also does not consider service life and maintenance cost. Aluminium, FRP, and ferrocement hulls are impervious to borer attack. Damage due to impact and change with the quay side and with the other boat largely depend upon boat care.

2.5.5 Table 2.9 presents cost of hull of small size mechanised boats made of different materials. The cost relates to the year 1976. As the actual cost of ferrocement is not available, an appropriate estimate was considered.

Table 2.9 Cost of hull of small mechanised boats

	Wood	FRP	Ferro-cement
Size of hull (m)	9.7	9.9	9.7
Cost of hull (Rs.)	51,000	95,000	60,000
Normal life (years)	10	20	20
Per annum depreciation cost (Rs.)	5,100	4,750	3,000

Source: Government of India, Ministry of Agriculture and Irrigation, New Delhi; Report of National Commission on Agriculture, Part VIII--Fisheries, 1976, p.131.

2.5.6 The price of the wooden hull of a boat has more than doubled in 1984 compared to 1976. But in the case of FRP the price of the hull has increased only about 18.91 per cent and that of the ferrocement hull 35.48 per cent during the same perio

For both the periods steel is considered as an uneconomic material for the construction of hull for the small category fishing vessels. Aluminium is the only material (see table 2.8) which can fetch a scrap value upto 40 per cent of the original material cost if sold. But the life span of the FRP and ferro-cement is double that of the life span of wood. Annual depreciation is also more in the case of wooden boats. Again, lighte hulls need less power than the heavier hulls for the same speed. So taking into consideration fuel efficiency and material cost, it is all the more attractive to build hull with lighter materials.

2.6 Energy crisis and its impact on the mechanised fishing industry

2.6.1 The cost of energy has a touching effect on the economic efficiency of mechanised fishing boats. Fuel cost as a percentage of total operating cost for mechanised fishing vessels has more than doubled during the last 5 years (Gopalan, 1980). The catch data, on the other hand, show that catch has declined during the reference period. So it is feared that any further increase in the fuel prices will make mechanised fishing an uneconomic proposition.

2.6.2 To come to grip with this problem and to identity remedies--which could be either technical or changes in operational pattern to reduce fuel use--a fuel conservation survey should be undertaken immediately in areas where there is heavy concentration of mechanised boats like Neendakara and Cochin.

2.6.3 Any introduction of technological hardware or operational changes has to be carefully evaluated from the economic standpoint to ensure that it reduces overall operational cost. It is unlikely that any fisherman will adopt a technological solution that entails high investment unless it results in handsome dividents and better profits. The only feasible way to achieve this is cutting fuel cost by less fuel consumption.

2.7 System sharing and pattern of ownership

2.7.1 The small scale fishermen use a wide variety of production means, each of which represents different levels of investment. But one important factor responsible for the economics of fishing is the ownership of means of production. Marine fishing is generally undertaken not by an individual, but by a group of persons operating jointly, each having a specified role and with minimum hierarchy in the work organisation (Kurien, 1984c). Even though fishing activity is a joint venture, two types of ownership pattern exist in the means of production--individual ownership and collective ownership. Ownership pattern is generally based on the share of capital invested for forming a craft and gear. Under joint ownership, joint owners need not always invest in an equitable manner. This often creates problems in sharing the proceeds from the catch.

2.7.2 Based on the participation in production and the nature of production relations the nature of ownership has three dimensions (Kurien, 1978a). Each dimension has two aspects:

Dimension	Aspects I	Aspects II
1. Nature of ownership:	Individual (IO)	Collective (CO)
2. Status of owner :	Owner-Worker (OW)	Owner-nonworker (ONW)
3. Status of non-owner :	Non-owner partner (NOP)	Non-owner labou (NOL)

2.7.3 If we consider these three dimensions together we will get a six-fold relationship based on the nature of sharing patter. They are:

1. Individual ownership (IO)
   Owner pattern (OP)
   Non-owner pattern (NOP)

2. Collective ownership (CO)
   Owner workers (OW)

3. Individual ownership (IO)
   Owner worker (OW)
   Non-owner labourers (NOL)

4. Collective ownership (CO)
   Owner workers (OW)
   Non-worker labourers (NOL)

5. Individual ownership (IO)
   Owner non-workers (ONW)
   Non-owner labourers (NOL)

6. Collective ownership (CO)
   Owners non-workers (ONW)
   Non-owners labourers (NOL)

2.7.4 There is wide variation in the nature of relationship between the owners and non-owners even in the non-mechanised sector. Out of the six relationships mentioned above, the cattamaran unit is considered to be the most egalitarian relation ship in the traditional sector. As capital investment increases even in this traditional sector itself, the egalitarian relationship breaks down. This is because of the concentration of economic power in the hands of a few. This is more visible in the case of canoe shore-seine units. But a clear-cut capitalisti form of ownership is prevailing in the mechanised sector because of its investment need and operational cost.

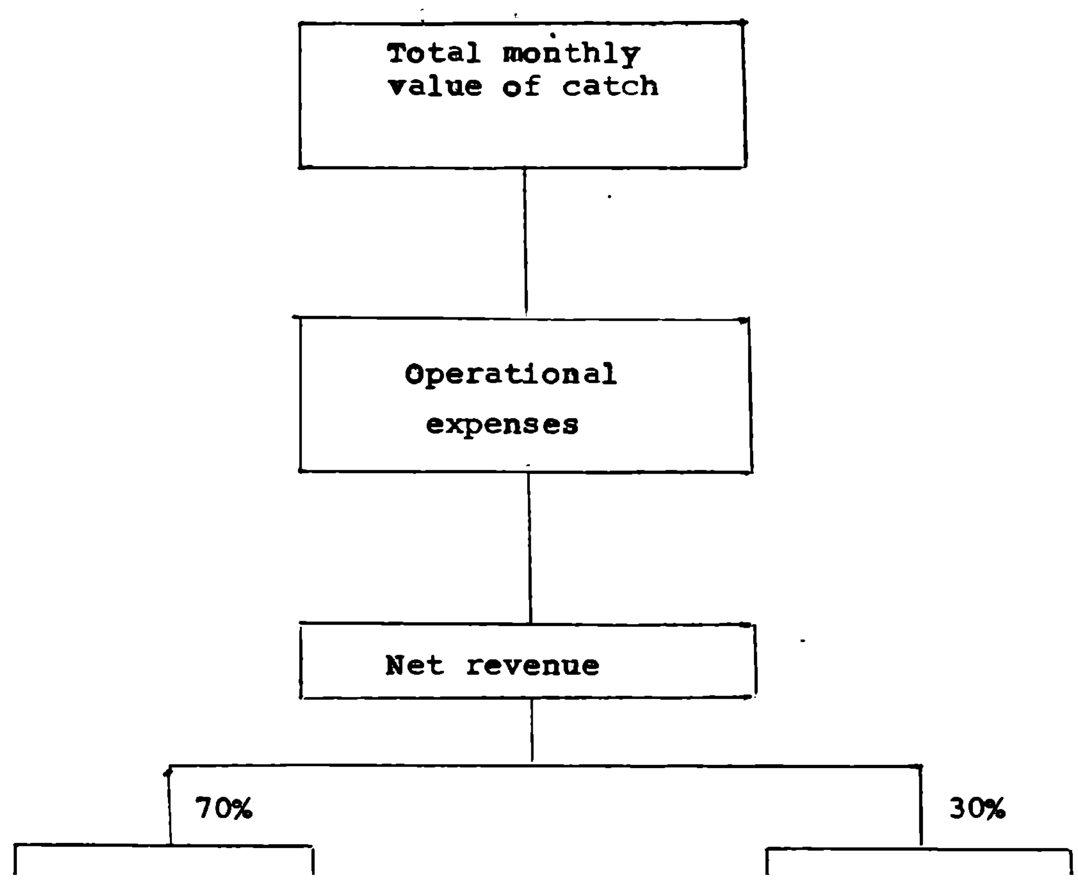
2.7.5 There are different systems of sharing between owners essence of sharing system is the meshing of capital and labour in a hopefully efficient and equitable manner, one which encourages maximum utilisation of existing productive assets and provides all concerned with an adequate return to their respective controbution. Systems of sharing and patterns of ownership reflect the relative values based on labour and invested capital and provide insight regarding broader socio-economic relationships (Kurien, 1978a).

2.7.6 Based on the labour requirements of the particular type of gear used and the available manpower of each households owner-operator may or may not need to recruit additional crew members. Seasonal nature of fisheries demands for diversity of gear to enable year-round operations. It also gives pressure to the owner operators to work as crewmen or share operators.

2.7.7 Those who enter the industry as workers are mostly young fishermen. They own neither boat nor gear. The basic constraint is lack of capital. But employment as a crewman is not restricted to those with no investment in craft and gear. In some seasons the fishermen who owned boat and gear also work as crewmen with other fishermen.

2.7.8 The system of sharing determines the distribution of proceeds from the catch to labour and capital. The division of proceeds between the owner and crew is done only after deducting the operational expenses. The operational expenses vary from gear to gear and also from craft to craft, as do the particular demand of the work involved. For some types of craft and gear specialised skills and responsibilities involve an extra share to certain crew members. A general pattern of sharing system in the mechanised fishing sector of Kerala is given in Figure 2.1.

Fig.2.1 Sharing pattern in the mechanised sector



2.7.9 The relationship between the distribution of output and value for the mechanised and non-mechanised fishing sector in Kerala fisheries for the years 1969-1980 is given in table 2.10 Different systems of sharing pattern prevail in the mechanised and non-mechanised sectors. The general sharing pattern in the mechanised sector is that the owners get 70 per cent of the gross earnings. But a major portion of the income will have to be spent in the form of fuel cost and others.

2.7.10 It is assumed that in non-mechanised sector the owners get 40 per cent share of the gross earnings. This is because the operational expenses are very low in this sector. The total number of workers and total volume and value of output are higher in the non-mechanised sector throughout the year. But output per worker and per capita income of workers are very high in the mechanised sector. In 1979-80 the total value of output of the mechanised sector was Rs.468.4 million for an output of 115 thousand tonnes. But for a higher 190 thousand tonnes of fish in the non-mechanised sector, the value was only 271.4 million rupees. This is due to the economic value of the species of the mechanised sector, especially of the export variety prawn. The output per worker of the mechanised sector for the year 1979-80 was 3,880 kg and his per capita income (at current prices) was Rs.8,029. In comparison with this, in the non-mechanised sector the output per fisherman was 1,780 kg and per capita

Table 2.10 Distribution of volume and value of output in Kerala Fisheries between sectors and classes (1969-1980)

Year	Volume (in lakh tonnes)	Value of output (in Rs.lakhs[1])			No.of workers	Output per worker (kgs)	Per capita income of workers (Rs)	Output per worker (Rs)
		Total	To owners	To workers				
				MECHANISED SECTOR				
1969-70	0.40	415	290	125	7765	5150	1610	5344
1974-75	1.43	3228	2260	968	11260	12700	8597	28668
1979-80	1.15	4684	3279	1405	17500	3880	8029	18737
				NON-MECHANISED SECTOR				
1969-70	3.03	1655	662	993	90660	3340	1095	1826
1974-75	2.77	3118	1247	1871	99105	2800	1888	3146
1979-80	1.90	2714	1086	1628	106625	1780	1527	2545

Note: 1. Two-year simple average in current prices.

Source: Kurien, J. (1984)"Marine Fish Production in Kerala: Past Trends Perspectives for the Future"(mimeo), Centre for Development Studies, Trivandrum.

income (at current prices) was Rs.1,527. These two figures are 45.88 per cent and 61.99 per cent less than what his fellowmen earn in the mechanised sector.

2.8 Technological aspect of different craft gear combination and its economic analysis

2.8.1 Only very few studies have been conducted: (i) on the comparative economics of different types of fishing methods, (ii) on economic status of the fishermen in different productive sectors of the industry, and (iii) on the economic impact of fishermen by changes in industry particularly in the introduction of mechanised fishing. The overall performance of the fishing industry with varying fishing techniques can be evaluated only if we know the operation of the different production methods, similarity in economic characteristics, catch composition, cost and return functions etc.

2.8.2 As indicated in Figure 2.2, each craft gear combination has specialised operation and seasonal character. Unlike the mechanised fishing operation, the non-mechanised fishing operatio is not possible throughout the year. Moreover, each craft-gear combination has special production technology for catching particular species of fish depending upon the season. The total possible fishing days vary from different craft-gear combinations and, in general, is a function of the fisherman's experience

Figure 2.2 Expectations about seasons of operation and main species of fish caught by type of craf gear combination

Sl. No.	Craft-gear combination	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Main species caught
1.	Encircling net-canoe	—	—	—	—	—	—	—	—	—	—	—	—	Sardines, Mackerals, Prawns
2.	Boat seine-dugout canoe					—	—	—	—	—	—			Sardines, Mackerels
3.	Boat seine-kattumaram	—	—	—	—	—	—	—	—					Ribbon fish, Anchovies, Caranx
4.	Cotton shore seines-canoe	—	—				—	—	—	—	—	—	—	Anchovies, Ribbon fish, Scads, Tunnies
5.	Nylon shore seines-plank canoe	—	—							—	—	—	—	Sardines, Anchovies; Scads
6.	Small mesh driftnet-plank canoe	—	—		—	—	—	—	—	—				Sardines, Mackerels
7.	Large mesh driftnet-dugout canoe	—	—			—	—	—	—	—				Tunnies, Seer fish
8.	Large mesh driftnet-kattumaram	—	—	—	—	—	—	—	—	—	—	—	—	Tunnies, Seer fish, Caranx
9.	Anchovies net-kattumaram	—	—			—	—	—	—					Anchovies
10.	Prawn net-kattumaram	—	—	—	—	—	—	—	—	—	—	—	—	Prawns, Sciaenids, Lactarius
11.	Sardine net-kattumaram	—	—				—	—	—	—				Sardines
12.	Prawn net-dugout canoe	—							—	—	—	—	—	Prawns, Sciaenids, Lactarius
13.	Sardine net-dugout canoe					—	—	—	—	—	—			Sardines
14.	Cast net-dugout canoe				—	—	—	—	—	—	—			Sardines, Mackerels
15.	Lobster net-dugout canoe			—	—	—	—	—	—	—	—			Lobsters
16.	Hook & Line-plank canoe	—	—			—	—	—	—	—	—	—	—	Sharks, Rays, Perches,
17.	Hook & Line-dugout canoe	—	—				—	—	—	—	—	—	—	Sharks, Rays, Perches, Cat fish, Rock Cod
18.	Hook & Line-kattumaram	—	—			—	—	—	—	—	—	—	—	Tunnies, Shark, Seer fi: Cuttle fish
19.	Trawl net-mechanized boat	—	—	—	—	—	—	—	—	—	—	—	—	Prawns, Perches, Sciaen: Cat fish
20.	Large mesh driftnet-mechanized boat	—	—	—	—	—	—	—	—	—	—	—	—	Tunnies, Seer fish, Pom: Shark, Caranx

Source: Kurien and William (1982) 'Economics of Artisanal and Mechanised Fisheries in Kerala--A S on Cost and Earnings of Fishing Units', A regional FAO/UNDP Project. Working Paper No.34, Madras. p 21 and expectation (Kurien and William, 1982). Encircling net canoes, large mesh drift-cattamarans and prawn net cattamarans, have the maximum number of fishing months which anchovies net cattamarams and the sardine net cattamarans have the lowest possible fishing months. But the emechanised boat-gear combinations have year round operations.

2.8.3 The catch data of the various craft-gear combinations and the economic importance of different fishing units are given in Table 2.11. This table indicates that the rate of return and investment turnover ratio are very high for the 'thanguvala' and 'ayilavala' units of the traditional canoe fisheries. In comparison with the pusse-seiners and mechanised trawlers, the GRP gillnetters set very high percentage rate of return over investment. Net profit is more in the case of purse-seiners and trawlers, but these fishing units also need very high capital investment. The payback period is very low in the case of canoe 'thanguvala', 'ayilavala' units and GRP gillnetters. The payback period is comparatively high for mechanised units. Decision on investment is largely based on the ability to cover the fixed cost at an early period compared to the high profit rate of the indigenous units like 'thanguvala' and 'ayilavala'. The gain on investment on mechanised unit is poor.

Table 2.11 Comparative financial projection of various fishing units (value in rupees)

Type of unit	Thanguvala[1]	Ayilavala[1]	GRP Gillnetters[2]			36' Purse-seine cum trawler[3]	65' Demersal trawling cum single boat pelagic trawling[4]	78' Trawler for deep-sea fish and deep-sea lobster[4]
			15'	16'	20'			
Initial investment	21150	5375	41950	47500	58950	330000	3100000	5140000
Gross income from sales	177044	31594	45000	48000	60000	400000	3350400	5624640
Expenditure	140729	27796	28200	30400	34710	283300	2437166	4214425
Net profit	36315	3798	16800	17600	25290	116700	913240	1410215
Profitability (%)	20.51	12.02	37.33	36.67	42.15	29.18	27.26	25.07
Rate of return (%)	171.70	70.66	40.05	37.05	42.90	35.36	29.46	27.44
Investment: Turnover ratio	1:8.37	1:5.88	1:1.07	1:1.01	1:1.02	1:1.21	1:1.08	1:1.09
Pay back period (years)	0.58	1.42	2.50	2.70	2.33	2.83	3.39	3.65

Source: 1. CMFRI Special Publication No.4 (1979).
2. Seafood Export Journal, 10(6): (1978).
3. Seafood Export Journal, 8(11): (1976).
4. Souvenir, Integrated Fisheries Project, Cochin : (1977).

2.8.4 A comparative analysis of information given in tables 2.11 and 2.12 show that the gross value added to total investment, percentage net return on investment and profit on investment is higher than traditional sector craft-gear combinations. One important aspect of the non-mechanised sector is the very low labour productivity in this sector compared to the mechanised sector on an average. The mechanised sector's labour productivity is more than nine-fold compared to that of the non-mechanised. The share of the labourers in the non-mechanised sector is higher than that of the mechanised sector, which reflects a more egalitarian nature of distribution of the proceeds of the catch in the non-mechanised sector. The gross profit per unit is more in the case of encircling net and canoe (12,586) than the trawl net mechanised boat (3,562). Net return on investment of the mechanised sector is negative (-9.8), but four out of five non-mechanised units show very high net return on invemtment (about 44.3 per cent in the case of encircling net and canoe). This shows that mechanised sector is unprofitable.

2.8.5 The craft has to be designed based on the distance to the fishing grounds, nature of fishery etc. Based on extensive trials, a fairly good idea of a standard design could be framed. The design is to be such that any capsizing of the

Table 2.12 Data pertaining to costs and earnings of certain craft-gear combinations in Kerala's Fisheries (1980-81)

	Encircling net & canoe	Boat-seine and katta-maran	Small drift net & plank canoe	Sardine net and dugout canoe	Hook line and katta-maran	Trawl net and mecha-nised boat
1. Investment per unit (at cost)					1260	128500
i) Craft	9550	2760	2745	2060	1260	128500
ii) Gear	11850	2085	4840	2465	330	3975
2. Nature of ownership	Collective	Individual	Collective	Individual	Individual	Individual
3. Average crew size	15	5	7	4	2	5
4. Average no.of fishing trips/year	102	28	99	89	101	157
5. Extent of owner involvement in fishing (% trips)	94	45	72	100	82	0
6. Water depth in area of fishing (mts)	8	19	15	13	38	34
7. Total effort/trip (person-hours)	81	40	45	25	19	56
8. Catch landed/trip (kgs)	233	62	91	28	16	124
9. Catch landed/unit/year (kg)	23785	1749	9073	2525	1653	19397
10. Gross earnings/trip (Rs.)	436	138	158	72	49	588
11. Gross earnings/unit/year (Rs.)	44491	3863	15598	6396	4926	92331
12. Total operating costs/year	7788	606	2435	753	818	60759
- of which owners cost	546	76	520	233	192	7065
- of which common cost	7242	530	1915	520	626	53694
13. Catch landed per Rs.100 operating costs (kg)	305	286	371	334	201	32
14. Total divisible earnings/year	34943	2975	12543	5522	3786	37837
of which crew share	21376	2296	8271	3989	2783	11932
15. Labour productivity (Rs.)	2998	646	2356	1729	2357	18578
16. Per capital crew earnings (Rs.)	1505	427	1161	1188	1547	3406
17. Gross profit/unit (Rs.)	12586	604	3557	1300	826	3562
18. Capital productivity (Rs.)	2.00	0.83	2.00	1.43	3.3	0.71
19. Net returns on Investment (%)	44.30	-2.0	28.4	16.3	32.2	-9.8
20. Capital intensity	1442	886	1146	7231	759	26655
21. Gross value added/Gross earnings	0.92	0.90	0.93	0.93	0.90	0.23
22. Gross value added/total investment	1.91	0.72	1.91	1.31	2.78	0.15

Source: Kurien and William (1982) "Economics of Artisanal and Mechanised Fisheries in Kerala--A Study on Cost and Earnings of Fishing Units", A regional FAO/UNDP Project. Working Paper No.34, Madras.

boat in the surf should not cause any damage to the boat. A solution for this calls for a boat big enough to be handled by a few men on shore. With the increase in the cost of construction material of conventional fishing craft, methods are to be taken for constructing cheap ferrocement and FRP hulls. Similarly the use of Aluminium Alloy sheet in place of costly copper sheet should be used as sheathing material for wooden boats. This would help to bring about substantial savings in cost and foreign exchange. For higher annual return, the operational cost, notably fuel cost is to be reduced.

2.9 Fishing gear

2.9.1.1 Side by side with the designing of suitable types of boats, efforts were made for the development of more efficient fishing gear and introduction of modern fishing techniques for the economic exploitation of different species of fish. For exploiting different types of fisheries a large number of indigenously developed traditional gears are used by the fishermen. There are also numerous types of gears used in different places for exploiting the same type of fishery. This kind of variation in the operation of the gear is most noticeable in the exploitation of mackeral and sardine. Even though there is marked difference in the operation of the gear, some regional homogeneit in the operation of traditional gears is noticed. The type and nature of fish caught depend on mesh size, type and thickness of thread used and also the shape of the net. In addition to various kinds of nets some other methods of gear, especially hook and line, have also been introduced by fishermen from time immemorial to catch special types of fishes.

2.9.1.2 The most important gears that are used for catching various species may be grouped into: seine nets, gillnets, hook and lines, chinese nets and cast nets.

2.9.2 Shore seines

2.9.2.1 Shore seine is a traditional type of gear used in the artisanal fisheries to fish oil-sardine, mackeral, anchovies etc. In South Kerala this kind of gear is popularly known as 'kambuvala' (Kurien et.al., 1962). This is a bag shaped net having coir wings of about 1500 metres long on both sides. With the help of a canoe, one rope end is taken to the sea paying out that wing until bag shaped net is reached and brings the other end of the rope to another point of the shore. These two points are separated from each other with a distance of about 100 to 200 metres depending upon the size of the net. After the seine has been deposited in the sea two ends are then dragged together on the shore by two parties, each of 10-20 fishermen. As operation advances both the closer end bag is pulled to the beach for completing the operation.

2.9.3 Boat seines

2.9.3.1 Boat seines are also widely used gears. Unlike the shore seine, it is operated from a boat. These are conical bag shaped nets made of cotton or nylon yarns with or without wings. This is used to fish pelagic and mid-water schooling fishes. The traditional boat seines used widely are called 'ayilavala', 'mathikollivala' etc. (Kurien et.al., 1962). They are used to catch mackerals and sardines. The boat seines are operated with the help of two canoes, so that the mouth of the mesh is widely opened for getting more fishes into it. These two canoes pull the net into a particular direction and help the fishes to swim to the narrower opposite end. To drive more fishes into the net some scaring devices such as beating on the sides of the boat, beating on the water with the help of coconut leaf etc. are used. The net is operated with the help of 5 to 20 persons from two boats depending upon the type of craft and gear used and also for the type of fish to be caught. It is usually operated at a depth range of 10 to 15 fathoms.

2.9.4 Gill nets

2.9.4.1 The gill nets are those by which the fishes are caught by hooking the gills. When the fish swims vigorously to spit out the net they become entangled in its meshes. These are single walled nets which may be the set, the float or the drift type. The set gill nets are wall nets used for a stationary craft for bottom set nets. The floating gill nets are fixed between floats on the upper end and anchors on the lower end. The drift nets are of considerable importance for catching most of the shoaling varieties of marine fishes (Mathur, 1978). The gill nets used in Kerala generally are: 1) Ayilavala to catch mackeral, 2) Ozhukkuvala for catching seers and cat fish, 3) Terandivala for catching skates and rays and 4) Nettolvala for catching white baits.

2.9.4.2 Standardisation of important commercial gill nets for seer, pomfret, hilsa and lobster with respect to material mesh size, colour of webbing, hanging coefficient and fishing height of net has been achieved by CIFT (CIFT Special Bulletin, 1979). Another type of gill net which is found to be most suitable and effective for coastal gill nets is multimeshed gill nets. Attempt has to be made for the development of high sea gillnetting as it is totally absent today.

2.9.5 Hook and line

2.9.5.1 Hook and lines are different from net fishing. It is a fishing method making use of hook and lines to fish particular species of fish and also to fish in deeper waters. There are four types of hooks fishing--headlines, long lines, pole and line and trolling lines. In head line the gear simply consists of a single vertical line, sinker and few bailed hooks in series. At present hand line fishing is widely practised by small boats for rock cod. Improved lobster traps with long life and two-fold catch efficiency were introduced by the CIFT, Cochin for the benefit of traditional fishermen (CIFT Special Bulletin, 1979).

2.9.5.2 Longlining is a fishing method making use of lines as fishing gear. The lines are set at particular depth in the sea. Longline fishing may be classified into three major groups: surface longline, mid-water longline and bottom longline. These three are presumed to be the transformation of hand line fishing. In this case, the boats are very essential which is a distinctive feature of longline fishing. This method is widely used for catching deep sea fishes (Haruta, 1983). This method is not commonly used in Kerala for commerci fishing. At present some private entrepreneurs have ventured for commercial tuna longlining. Another field which is having immense potential for long line fishing is longlining for sharks and other predatory fishes of the deeper waters.

2.9.5.3 Pole and line fishing operations are carried out to catch tuna fishes. The gear is a bamboo pole or fibre glass pole 4.5 to 6.0 m in length with a line having barbless tuna hook. The material used for the line is hemp, cotton or nylon and always the line must be shorter than the pole. The hooks used are barbless, but artificial and baited hooks are also used. The success of this method mainly depends on the availability of the shoal, bait fish and the suitable tuna hooks. The trolling lines are single lines having baited hooks or artificial hooks used for catching seer fish, tunnies and other big fishes.

2.9.6 Chinese nets

2.9.6.1 The chinese nets are employed for fishing in the backwaters. It is a kind of dip net or a stationary lift net and mostly found in the backwaters of Cochin. It consists of a square dip net having 9 to 11 metres operating by raising and lowering the net with a particular framework. Mostly fishing operation is done at night. Light is also used to attract fish and it is arranged to lie just above the water.

2.9.7 Cast nets

2.9.7.1 The cast nets are used all over Kerala for riverine fishing. Two types of cast nets are found--cast nets with a string and without a string. The operation of the cast net and its catching capacity is based on experience and ability of the fishermen. It is mainly used for catching small fishes like 'kanambu', 'tirutha' etc. When the cast net is operated the bottom part of it is closed together by the weight and the fish entangled in it will not be able to escape. This net is mainly made of cotton or nylon yarn and is having a length of 5-9' and width of 4-5'.

2.9.8 Trawl net

2.9.8.1 Trawling, a method of fishing, was introduced for commer cial exploitation of the prawn resources of Kerala. Trawl net is bag-shaped net with varying arrangements to keep the mouth open with a pair of other boards, floats and sinkers. According to the method of operation, construction of the net and device used for opening the mouth of the net, trawl nets have been classified as in table 2.13.

Table 2.13 Classification of trawl nets according to different aspects

According to the device used for opening the mouth of the net			According to the depth of operat-ion of the net			According to the method of constr ction of the net		
Beam trawl	Other trawl	Bull trawl	Bottom trawl	Mid-water trawl	Surface trawl	Four seam trawl		Two sea trawl
						Over-hang	Non-over-hang	Over-hang

Source: Nair, R.S., "General Principles of the Design of Trawl Net," <u>Fishery Technology</u>, Vol.VI, No.1 (1976).

The principle in all these methods is to drag a bag net provided with wings, along the sea floor on the support of two traps of wir ropes payed out from a winch worked generally by the main engine of the vessel. Trawl net was first introduced only for bottom trawling, now it is used for mid-water trawl and also for surface trawl.

2.9.8.2 Recent technological change in trawl techniques as a result of the involvement of various agencies has resulted in the introduction of trawls of appropriate specification to meet the requirement of particular area and fishery (Appukuttan et.al., 1965). A specialised trawl called the long wing trawl has been introduced with vertical height for catching shrimps. In table 2.14 a comparison between the conventional trawl and long-wing trawl is given. It shows that the longwing trawl prawn catch is almost double that of the conventional trawl.

Table 2.14 Catch per hour of prawn and fish in longwing and conventional trawl

Catch/hr (in kg)	Longwing trawl	Conventional trawl
Prawn	14.69	7.87
Fish	43.85	41.87

Source: Satyanarayana et.al. (1976):'Studies on High Ope Trawl: Relative Efficiency with Bulged-Belly Trawl', Fish.Tech.13(2), Cochin.

2.9.8.3 Another type of trawl called the six seam trawl with better vertical opening, is capable of fishing prawns and more bottom fishes (Vijayan & Remani, 1982). Table 2.15 presents a comparative position of different seam trawls.

Table 2.15 Catch per hour of prawn and fish in different seam trawls

Specification of net	Catch/hr (in kg)
13.7 m Four seam trawl	99.0
18.2 m Four seam trawl	217.0
15.8 m Six beam trawl	234.0

Source: Vijayan V. and Rama Rao,S.V.S. (1982),'Bulged Belly Trawl', Fish.Tech. 19(2), Cochin.

2.9.8.4 It can be seen from table 2.15 that the catch per hour of 15.8 m six beam trawl is two and a half times more than 13.7 m four seam trawl. The catch per hour percentage of 15.8 m six beam trawl is more by 6 per cent than 18.2 m four seam trawl.

Even though there is a wide technological innovation in the case of trawl nets, the availability of trawl nets for exploiting the midwater resources and also trawl nets for larger class of vessels are very inadequate.

2.9.9 Purse-seines

2.9.9.1 Purse-seine is a large-sized wall net used to encircl a school of fish. This kind of fishing was started in Kerala only in the beginning of 1980s. At present this fishing technique has been well established for the coastal pelagic fishery. A pursing cable passing through the wings under the net is used to pouch the bottom of the net for trapping the fish Initially purse-seining was done with the help of two boats, but with the help of power block for hauling the net till all the fishes are concentrated in a small pauch can be operated with single boat. Recent technological development of purse-seining is the formation of mini purse seines suitable for operation from country crafts and successful operation of purse-seine for large class of vessels. However, commercial exploitation of the potential resources of tuna, cat fishes etc. by this technique is yet to be developed.

2.10 Inventory of fishing gear

2.10.1 Inventory relating to fishing gear have been collected by various agencies for different time periods. The first census of fisherman's gear was available from the Department of Fisheries Administration Report 1957-58. Next available source of data was from the Kerala Livestock Census for the period 1966,1972 and 1977. The latest of it was done by the Directorate of Fisheries'Census of Fisherfolk of Kerala 1982! These are shown in table 2.16. The different census

Table 2.16 Fishing gear in Kerala State

Type of gear	1957-58[1]	1966[2]	1972[2]	1977[2]	1982[3]
Shore seine	4501	6617	8224	5168	5166
Boat seine	21281	2909	--	--	6437
Gill net	--	--	35919	20732	12060
Drift net	35778	--	--	--	--
Drift & Gillnet	--	30907	--	--	--
Drag nets	--	--	19988	26119	17995
Trawlnnets	--	7555	16500	9771	3326
Cast nets	--	99271	11273	14175	17696
Scoop nets	--	18246	--	--	--
Spawn collecting nets	--	--	977	1483	--
Fixed & stationary nets	--	1918	--	--	--
Traps	--	--	--	13540	7407
Hook & line sets	16312	--	--	--	179041
Bag & purse nets	--	12484	--	--	--
Others	--	17416	23554	17410	23327
Total	77872	197323	134853	98627	272455

Source: (1) Government of Kerala, Department of Animal Husbandry, Livestock Census Reports, 1966, 1972 and 1977.
(2) Central Marine Fisheries Research Institute, Census of Fishermen--Fishing Craft 1980.
(3) Census of Fisherfolk in Kerala, Directorate of Fisheries, Government of Kerala, Trivandrum, 1982.

show wide variations regarding the availability of various types of gears. This is because of the fact that the same census included marine as well as inland gears, while others marine only.

2.10.2 According to 1957-58 census the total gears available in both the sectors were 77,872. This was increased phenomenally to 1,97,323 in 1966 and then decreased to 1,34,853 in 1972. A further increase of the number of gears was noticed, 98,627 in the 1977 census. A very high increase in the availability of the number of gears was found (2,72,455) in the year 1982. This was mainly due to the abnormal increase in the number of hooks of about 1,79,041 in 1982.

2.10.3 A districtwise item-wise fishing gear data is given in table 2.17 as per the 1982 census. The maximum availability of the most traditional types of gear like hooks was found in Malappuram (68,117) and Alleppey (43,832). The most frequently used gears like seines and caste nets were found in the districts of Trivandrum, Alleppey, Quilon and Ernakulam. The mechanised trawl gear of 1,820 were found in Quilon district, out of the total of 3,326 in the State.

2.11 Technological change in gear materials

2.11.1 Before 1950s most of the fishing nets were made of natural fibres, mainly cotton and hemp. Owing to the absorption

Table 2.17 Districtwise distribution of fishing gears

District	No.of caste nets	No.of drag nets	No.of Gill nets	No.of Trawl nets	No.of boat seines	No.of shore seines	No.of Stake nets	No.of Chinese dip nets	No.of traps	No.of hooks	No.of other gears
Trivandrum	753	1076	2188	54	1512	3561	5	3	1624	26119	504
Quilon	2087	2337	709	1820	387	530	942	198	1563	12961	3376
Alleppey	4908	9084	3144	402	3275	435	1980	362	521	43832	3951
Kottayam	728	1487	8	--	10	27	816	141	133	1072	1054
Ernakulam	4703	1658	201	55	--	2	3428	1286	119	1367	1730
Trichur	2185	596	3666	216	917	531	446	59	2083	7470	1020
Malappuram	844	354	268	211	151	45	53	--	312	68117	92
Kozhikode	930	431	1013	326	171	32	187	4	1021	16270	428
Cannanore	558	972	863	242	14	3	802	7	31	1833	453
State Total	17696	17995	12060	3326	6437	5166	8659	2060	7407	179041	12608

Source: Census of Fisherfolk in Kerala, Directorate of Fisheries, Trivandrum, Government of Kerala, 1982.

of moisture these nets are prone to decay by bacteria and fungi and also heavy to carry for fishing. So various gear preservation methods were followed, like coal tar treatment, tarin fixation treat etc. for catching durability and susceptibility of the gears.

2.11.2 The introduction of synthetic fibres like nylon for the fabrication of gear is a major technological breakthrough in Kerala fisheries recently (Kurien, 1985). The synthetic fibres have several advantages over the natural fibres. Besides improved catching capacity, they are easy to handle. New synthetic materials like, nylon, vinylons, polyster and vinylidene and the evolution of different designs of fishing gear and operational techniques are some of the technological advances for the exploitation of the known as well as potential resources (George, 1986).

2.11.3 Recent technological advances in different gear materials like HDFE fibrillated tape twisted twines, multifilament nylon (PA) and terylene (PES) and its comparative catch details are given in table 2.18.

2.11.4 The HDPE fibrillated tape twisted twines is an effective substitute for large meshed gill net twines of multifilament nylon (PA). The cost of material per kilogram is more in the case of nylon 210/8/3 145 mm mesh compared with HDPE fibrillated

Table 2.18 Catch data of nylon and HDPE fibrillated tape twine gill nets

Specification	Nylon 210/8/3 145 mm mesh	HDPE fibrillated tape twine 145 mm mesh
No. of fishes		
Seer	20	1
Tuna	63	48
Shark	16	19
Others	53	147
Cost of material/kg	Rs.90.00	Rs.45.00

Source: Radhakrishnan & Gopalan Nayar, 'Fishing Experiments with Newer Materials', Proc.Symp. Harvest and Post Harvest Technology of Fish , Cochin, November (1982).

tape twine. The catch rate of seer and tuna are more in the case of nylon mesh, while the catch rate of shark and others are more in HDPE fibrillated mesh.

2.11.5 It is evident from the return of the local seine nets that the substitution of knotted webbing of nylon with knotless webbing of nylon for small meshed seine nets has increased the catch and earning capacity. The details are shown in table 2.19.

Table 2.19 Catch efficiency of seine nets of knotted and knotless webbing

Net	Knotted webbing	Knotless webbing
Mesh size-bar in mm	9-10	9-10
Material of webbing	Nylon 210/2/2-210/2/3	Nylon knotless 2518 and 2520
Weight of webbing in kg per net	100-115	100-115
Cost of net in Rs.	18,000-1,85,000	17,500-18,000
Catch per day in kg	583	729

Source: George V.C., 'Fishing Technology for Increased Marine Production', International Seminar on Training and Education for Marine Fisheries Management and Development, CIFNET, Cochin, January (1986).

2.11.6 The cost of net of the knotless webbing is less (Rs.17,500-18,000) in comparison with that of the knotted webbing (Rs.18,000-1,85,000). The catch per day shows that knotless webbing seine nets are 25 per cent more efficient than the knotted webbing seine nets.

2.11.7 In spite of the ever-increasing importance of modern fishing techniques the majority of the Kerala fishermen still practise age-old methods of fishing like 'thanguvala', gill nets and hook and lines etc. The advances in observing fish reactions in fishing gear and modes of escape and herding reactions should be studied to analyse the changing conditions. Two things in particular marked the early period, the steady increase in the technique of fish findings and the introduction of synthetic twines. Mechanisation of fishing vessels has resulted in bottom trawling as a major method of fishing. Consequent use of different methods of trawls shows that bulged belly trawl is more efficient for shrimp, whereas six seam and high opening trawls are proved to be very efficient for fish. A new crisis for the harvesting technology is that fuel has become so expensive. There is a new emphasis on trying to modernise passive gears. So depending upon the size and the nature one method is to be changed for the other for a better and enhanced landing of fish and prawn.

Chapter III

PRODUCTION TRENDS

3.1.1 Being dynamic and self renewing in nature, fisheries resources are subject to fluctuations, which can be classified under dependent and independent factors. Over 510 different species of fish have been identified in Kerala, but most of them are quantitatively insignificant and commercially unimportant. Moreover, the economic importance of various species differs from place to place. So the information regarding the trends on the total landings and specie-wise landings is an essential prerequisite for proper planning of development strategies with regard to the fish economy of Kerala.

3.2 Marine fish production

3.2.1 Kerala has been the largest producer of marine fish among the maritime states. The marine fish production in the state continues to be predominantly in the hands of the traditional and small scale mechanised sector. In this sector effort is still concentrated in the narrow coastal belt. This situation has been continuing despite the development input such as increase in mechanised fleet comprising 3,000 small trawlers and establishment of infrastructural facilities such as fishing harbours.

3.2.2 Kerala's marine production touched 448 lakh tonnes in 1973 for the first time and thereafter for nearly 12 years the production has stabilised around 3.25 lakh tonnes (see appendix I). The index of marine fish production with base 1960 reached 130 in 1973 for Kerala and 139 for India. After 1973 Kerala's production index has been declining and reached to a very low index of 80 in 1981, but for India the production index showed an increasing trend and reached from 139 in 1973 to 204 in 1984.

3.2.3 The compound rates of growth of marine fish production are presented in table 3.1. The seafish production during the years 1951-84 registered an annual growth rate of 6.20 per cent in respect of Kerala compared to 5.17 per cent for the country as a whole. However, Kerala had a lower growth rate since 1966, even though it showed an increasing trend during 1966-75. The overall higher rate of growth for Kerala for the years 1951-84 was due to the stupendous increase in production visualised in 1956-60, prior to the impact of mechanisation. Marine fish landings showed increases of 44 per cent in 1956, 104 per cent in 1957 and 80 per cent in 1960 over the immediately preceding years. Peak landings of oil-sardine (1957 and 1960) and caranx (1956) contributed to the sudden increase in production in some of the years.

3.2.4 Fish production during the years 1976-80 declined heavily registering a negative growth rate of 7.19 per cent per

Table 3.1 Compound rates of growth of sea fish production (Kerala and India)

Years	KERALA		INDIA		Share of Kerala to India
	Average annual production (tonnes)	Compound rate of growth annum (%)	Average annual production (tonnes)	Compound rate of growth annum (%)	
1951-55	130903	-11.31	565542	+0.70	23.15
1956-60	258555	+37.61	762911	+11.33	33.89
1961-65	263688	+ 3.74	735131	+ 0.34	35.87
1966-70	348768	+ 4.16	931035	+ 5.69	37.46
1971-75	406065	+ 5.05	1200434	+ 6.50	33.83
1976-80	331791	- 7.19	1329175	- 0.50	24.96
1981-84	377036	+13.57	1632582	+12.27	23.09
1951-84		+ 6.20		+ 5.17	

Source: Compiled from Central Marine Fisheries Research Institute Published Data.

annum for Kerala. But this declining trend in Kerala has also been responsible for the reverse trend of national fish productio However, the declining rate in the case of India is only 0.5 per cent per annum. During 1980-84 the fish production again registe an annual growth rate of 11.34 per cent, a greater average percentage growth rate after 1961. This is due to the increased production of oil-sardine, mackeral and many of the species other than shrimp.

3.2.5 The peak and lean landings of seafish have been progressively increasing till 1973. An exception to this phenomenon is manifested since then when production in 1980 and 1981 slumped to lower rates than that prevailed in 1969. This is given in table 3.2. A regular cyclical variation in production experienced upto 1973, but after that production trend has not been at regular intervals.

Table 3.2 Peak and lean marine landings

('000 tonnes)

Peak landings		Lean landings	
Year	Quantity	Year	Quantity
1950	202	1955	105
1957	310	1959	191
1960	345	1962	191
1967	364	1969	295
1971	445	1972	296
1973	448	1980	279
1983	385	1981	274
1984	424		

3.2.6 The specie-wise average marine fish production for the period 1969 to 1984 is given in table 3.3. The average annual fish production during the years 1980-84 declined to 3.21 lakhs from 3.53 lakhs tonnes in 1975-79 registering a fall of 3 per cent The demersal species suffered more with seven per cent decline compared with one per cent by the pelagic species. The 18 major species enlisted together account for over 90 per cent of the total marine fish production.

3.2.7 The pelagic species fish landings in 1980-84 registered only 1 per cent decrease over 1975-79 and this is because of the 7 per cent increase of oil-sardine, 114 per cent increase of anchoviella and 4 per cent increase in seer fish. But the species such as lesser sardine, ribbon fish, carnax and tunnies actually suffered a fall in production. The largest fall of 57 per cent is noticed in the case of ribbon fish. Among the 10 major species in the demersal group lactarius showed the largest increase (48%) followed by soles (46%), leiognathus (32%), pomfrets (10%) and caphalapods (2%). The species which suffered growth in the demersal groups are sciaenids (51%), perches (36%), prawns (27%), elasmobranches (21%) and cat fish (16%). The remarkable fall of the demersal species of 20 per cent could be attributed to the increased mechanised fishing in the coastal waters beyond the Total Allowable Catch (TAC).

3.2.8 Since oil-sardine, mackeral and prawn are considered to be the most important species, their fluctuation and trend

Table 3.3 Species-wise marine fish landings--Kerala average annual catches (1975-84)

Species	1975-79 (tonnes)	1980-84 (tonnes)	Increase/Decrease in 1980-84 over 1975-79 Tonnes	%
I. Pelagic fishes				
i) Oil-sardine	115049	123314	+8265	+7
ii) Lesser sardine	23267	20745	-2522	-11
iii) Anchoviella	11856	25381	+13525	+114
iv) Ribbon fish	16038	6919	-9119	-57
v) Caranx	10092	6277	-3815	-38
vi) Mackeral	19876	15792	-4084	-21
vii) Seer fish	4575	4740	+165	+4
viii) Tunnies	9474	6773	-2701	-29
Total I	210227	209941	-286	-1
II. Demersal fishes				
i) Elasmobranches	7908	6292	-1616	-21
ii) Cat fishes	14698	12417	-2281	-16
iii) Perches	15411	9910	-5501	-36
iv) Seiaenids	10802	5223	-5579	-51
v) Lactarious	793	1172	+379	+48
vi) Pomfrets	1808	1987	+179	+10
vii) Soles	5607	8161	+2554	+46
viii) Leiognuthus	4454	5875	+1421	+32
ix) Prawns	45365	33114	-12251	-27
x) Cephalopods	3874	3950	+71	+2
Total II	110725	88101	-22624	-20
Total I & II	320952	298042	-22910	-7
All species including miscellaneous	352924	344291	-8633	-3

Source: Compiled from Central Marine Fisheries Research Institute Published Data.

are of special significance in Kerala's marine fishery (Kurien, 1978a). So these species are termed as the economic species. The oil-sardine and mackeral are the mainstay of the non-mechanise artisanal sector and fluctuations of these two species show considerable effect to the livelihood of a major segment of the poorest among the population in the state. The other, prawn, which is the sole dependent species of the mechanised export sector and its fluctuation has greater impact for the foreign exchange earnings to the state.

3.2.9 The annual landings of the selected marine fishes in Kerala during 1979-84 is given in table 3.4. The oil-sardine output during the period is marked by wide fluctuations. The

Table 3.4 Annual landings of selected marine fishes in Kerala during 1979-84

('000 tonnes)

Species	1979	1980	1981	1982	1983	1984
Oil sardine	116.8 (35.3)	69.7 (25.0)	147.0 (53.6)	143.2 (44.0)	154.9 (40.2)	101.8 (24.0)
Mackeral	18.5 (5.6)	18.4 (6.6)	16.2 (5.9)	10.7 (3.3)	12.7 (3.3)	20.9 (4.9)
Prawn	29.5 (8.9)	52.6 (7.0)	22.3 (8.1)	26.7 (8.2)	29.7 (7.7)	31.1 (7.3)
Rest of the species	165.7 (50.2)	138.3 (49.5)	88.9 (22.4)	144.8 (44.5)	188.0 (48.8)	270.9 (63.8)
Total	330.5 (100.0)	270.0 (100.0)	274.4 (100.0)	325.4 (100.0)	385.3 (100.0)	424.7 (100.0)

Note: Figures in the parentheses indicate percentage to total.

The output reduced to 69,700 tonnes in 1980 recording only 25 per cent of the catch. But again it shows an increasing trend and reached to the peak level of 1,54,900 tonnes in 1983. In 1984 production again declined to 1,01,800 tonnes constituting only 24 per cent of the total production. But in 1984 the similar specie of lesser sardine increased considerably leading to an increased total production. Except in 1982 and 1983 the mackeral production was ranging between 16 to 21 thousand tonnes. The highest landing of 20,900 was recorded during these periods with a 4.9 per cent of the total landings. With a higher production of 52,600 tonnes in 1980 the prawn in all other years in this period ranged between 22 to 31 thousand tonnes. Compared to the last three years the prawn production in 1984 showed a marginal increase. The rest of the species also showed a fluctuation between 138 and 271 thousand tonnes except in 1981. The maximum landing of this is recorded in 1984 with 2,70,400 tonnes with a higher 63.8 per cent landing.

3.2.10 The production of the major species based on the quantity of landing is given in table 3.5 on a three-year-moving-average. The moving average value of oil-sardine shows that it is susceptible to a long cyclical phenomenon. The period 1951-53 to 1966-68 can be considered as a period of upswing. The production reached the maximum of 2,28,000 tonnes

Table 3.5 Production of principal species (Three year moving average

('000 tonnes)

Year	Oil sardine	Lesser sardine	Ribbon fish	Macke-ral	Cat fish	Leiog-nathus	Pena-eid prawns	Al sp ci
1951-53	21	13	12	23	4	6	6	14
52-54	26	9	11	15	6	6	4	12
53-55	31	8	10	9	6	5	5	11
54-56	18	11	7	7	8	7	9	12
55-57	67	18	10	10	8	6	14	18
56-58	100	21	9	30	10	6	16	25
57-59	119	23	10	35	8	5	17	26
58-60	122	19	5	39	9	6	14	27
59-61	138	13	4	27	7	6	16	26
1960-62	148	8	2	22	5	6	21	26
61-63	105	6	2	27	2	5	24	22
62-64	114	9	1	24	2	6	29	23
63-65	156	14	5	25	3	8	24	28
64-66	204	14	12	13	4	11	26	33
65-67	219	12	14	11	6	12	23	35
66-68	228	8	10	6	6	11	27	35
67-69	207	9	7	13	6	11	29	33
68-70	193	8	4	29	9	12	32	34
69-71	176	9	10	60	13	13	34	37
1970-72	164	8	11	61	15	10	35	37
71-73	141	27	17	50	15	11	51	39
72-74	110	34	22	22	21	14	60	38
73-75	107	42	23	15	28	14	74	43
74-76	108	33	18	15	26	8	57	39
75-77	113	30	10	18	18	5	51	36
76-78	120	22	13	22	10	5	40	35
77-79	118	16	19	21	9	5	38	34
78-80	102	13	21	21	11	4	43	32
79-81	110	11	15	18	11	3	35	29
1980-82	119	9	10	15	10	5	34	29
81-83	148	7	10	13	11	7	26	32
82-84	133	28	8	15	13	7	29	37

Source: Calculated from Central Marine Fisheries Research Institute Published Data.

in 1960-68, thereafter a clear downswing in the production of oil-sardine. Between 1972-74 and 1980-82 the annual production of oil-sardine, based on a three-year-moving-average varied between 1,00,000 and 1,20,000 tonnes, remaining some of the years in 1950s and 1960s. But it has showed a slight improvement in the period between 1981-83 and 1982-84.

3.2.11 In the case of lesser sardine, short term cyclical fluctuation appears to be more clear. From 23,000 in 1957-59 the production declined to 6,000 tonnes in 1961-63. This was followed by slight recovery from 1963-65 to 1964-66, stagnation upto 1970-72 and a further improvement in 1975-77. The production witnessed rapid strides in 1973-75 reaching 43,000 tonnes and steadily declined upto 1981-83. But 1982-84 showed a remarkable increase to 28,000 tonnes.

3.2.12 The production of ribbon fish, moving in a short cyclic manner, has picked up over the years, reaching the maximum of 23,000 tonnes in 1973-75. The production declined to 1,000 tonnes in 1962-64 and regained appreciably in 1978-80 and then showed a slight decline.

3.2.13 Mackeral is subject to heavy fluctuations, but the fluctuations are of short intervals. The maximum average production was 61,000 tonnes in 1970-72. Between 1972-74 and 1982-84 the production of mackeral ranged between 15,000 and 22,000 tonnes. Cat fish, which contributed less than 10,000 tonnes until 1968-70, moved up accounting for 28,000 tonnes in 1973-75. In the succeeding years production declined to 9,000 tonnes in 1977-79 and thereafter stagnating to that level. Leiognathus also fared peak production during the years 1972-74 and 1973-75 at 10,000 tonnes and then the production fell to the lowest level of 4,000 to 7,000 tonnes between 1975-77 to 1982-84.

3.2.14 As a result of mechanisation the landing of penaeid prawns showed almost a steady increase. From 6,000 tonnes in 1951-53 it increased to 74,000 tonnes in 1973-75, and thereafter it stabilised around 26,000 and 43,000 tonnes.

3.2.15 By taking all marine species together, it declined to 3,78,000 tonnes in 1982-84 from 4,30,000 tonnes in 1973-75. In the record production period of 1973-75, the share of oil-sardine was only 1,07,000 tonnes, less than 50 per cent obtained during the years 1965-68. The production of mackeral in 1973-75 was also only one-fourth of that existed during 1969-72.

3.3 Geographical distribution of marine fish landings

3.3.1 The districtwise landings of marine fish during the period 1980-84 are given in table 3.6. The Quilon district accounting for 6 per cent of the coast line of Kerala, stood foremost in seafish production sharing as high as 24 per cent

Table 3.6 Districtwise landings of marine fish

('000 tonnes)

District	Cost length km	%	1980 Qty	%	1981 Qty	%	1982 Qty	%	1983 Qty	%	1984 Qty	%	Average Qty	%
Trivandrum	78	13	50	18	29	10	54	17	46	12	36	9	43	12
Quilon	37	6	105	38	47	17	92	28	85	22	83	20	82	24
Alleppey	82	14	24	8	38	14	34	10	49	13	77	18	44	13
Ernakulam	46	8	38	14	35	13	36	11	61	16	75	17	49	15
Trichur	54	9	12	4	20	7	25	8	21	5	18	4	19	6
Malappuram	70	12	11	4	10	4	10	3	37	9	42	9	22	7
Kozhikode	71	12	23	8	33	12	31	10	41	11	51	12	36	11
Cannanore	152	26	16	6	63	23	43	13	46	12	43	11	42	12
Total	590	100	279	100	275	100	325	100	385	100	425	100	337	100

Source:

(1) Central Marine Fisheries Research Institute. Mar.Fish.Infor.**Serv. T&E. Ser.** **No.52**, 1983.

(2) Department of Fisheries, Government of Kerala, Survey of Marine Fish Landings, Numbers I to VI, 1984-85.

in 1980-84. The four southern districts, viz., Trivandrum, Quilon, Alleppey and Ernakulam, contributed 64 per cent of the aggregate production. On the other hand, the northern districts, viz., Trichur, Malappuram, Kozhikode and Cannanore, sharing 59 per cent of the sea coast subscribed only 36 per cent of the production. The high productivity of the south szone suggests the presence of the 'wadge bank', 'chākara' and the predominance of mechanised fishing in this region (William, 1980).

3.3.2 The districtwise quarterwise landings of pelagic and demersal group of fishes for 1984 are given in table 3.7. The maximum landing of the pelagic species in the first quarter of 1984 was from Cannanore (20,386 tonnes) out of 1,01,511 tonnes, and in the landings of demersal species also Cannanore stood first with 9,044 tonnes out of 22,248 tonnes. This is because of the migration of many of the mechanised boats from Quilon and Cochin to this area for fishing. During the second quarter Alleppey contributed the largest landing of pelagic species (13,242)tonnes) out of 49,767 tonnes. But in the case of demersal species the maximum landing was from Quilon district, and this is because of the increased mechanised fishing during the months of June-August, i.e., 12,679 tonnes out of 24,873 tonnes in the second quarter.

3.3.3 The third quarter also showed the same landing pattern

Table 3.7 Districtwise landings of Pelagic and Demersal Group of fishes

Districts	1984 Q1			1984 Q2			1984 Q3			1984 Q4		
	Pelagic	Demersal	Total	Pelagic	Demersal	Total	Pelagic	Demersal	Total	Pelagic	Demersal	Total
Trivandrum	4087	542	4629	5489	870	6359	9897	2765	12662	10671	2286	12957
Quilon	10922	4897	15819	9832	12679	22511	9543	20748	30291	8050	6343	14393
Alleppey	10961	612	11573	13242	4065	17307	25637	876	26513	18184	3065	21249
Ernakulam	15864	2214	18078	6950	4306	11256	15435	7826	23261	19758	2541	22299
Trichur	5193	164	5357	611	324	935	2290	346	2636	8933	645	9578
Malappuram	17602	2356	19958	1714	1017	2731	2526	1259	3785	10183	3459	13642
Kozhikode	16496	2419	18915	8922	631	9553	7207	1721	8928	10814	3300	14114
Cannanore	20386	9044	29430	3007	981	3988	2173	1683	3856	5386	769	6155
Total	101511	22248	123759	49767	24873	74640	74708	37224	111932	91979	22408	114387

Source: Department of Fisheries, Government of Kerala, Survey of Marine Fish Landings, Nos.I to VI, 1984-85.

maximum landing of pelagic species was from Alleppey (25,637 tonnes) out of 74,708 tonnes and the maximum landing of demersal species from Quilon 20,748 tonnes out of 37,324 tonnes and this is about 56 per cent of the total demersal fish landings of the state in that quarter. The last quarter of 1984 also showed somewhat similar landing pattern of these two species groups, i.e., the highest landing of 19,758 tonnes was from Ernakulam out of 91,979 tonnes. In the case of demersal species Quilon accounted 28 per cent of the total landings (6,343 tonnes) in that quarter.

3.3.4 The production by major species and district for 1984 is given in table 3.8. The maximum 23.84 per cent of oil-sardine was from Ernakulam, followed by Kozhikode (19.95%) and Alleppey (15.34%). In the case of anchoviella the maximum 66.03 per cent was from Alleppey alone. 37.57 per cent of the export species prawn was contributed by Quilon, followed by Ernakulam (20.02%) and Cannanore (16.93%). This is because of the fact that mechanised fishing in Kerala is concentrated only in these three areas. The highest landings of mackeral (43.61%) was from Ernakulam. The highest landing of mackeral and oil-sardine from Ernakulam showed the presence of purse-seining for catching these two pelagic fishes. Cat fish landing was 49.31 per cent for Quilon and 14.73 per cent for Cannanore. Cochin and Quilon produced the maximum quantity of scianeids

Table 3.8 Marine production by species and district (1984)

Species	Total Kerala	Trivan-drum	Quilon	Alleppey	Ernakulam	Trichur	Malappuram	Kozhikode	Cannanore
Sardine	173724	4093	13691	26645	41919	12084	18590	34657	22275
Anchoviella	46624	5075	2614	30786	1928	2985	865	1719	652
Prawn	31139	192	10453	5008	6234	330	1217	2433	4791
Mackeral	20894	2743	1666	951	9112	634	1528	2975	1285
Cat fish	13928	126	6868	1865	1089	143	1038	750	1999
Seiaenids	7126	1206	2082	472	2525	104	443	248	48
Elasmobranches	5036	44	1592	312	158	192	955	377	1406
Cephalapodes	4910	1810	3078	--	2	--	5	15	--
Tunnies	4715	3830	548	83	195	3	--	49	7
Seer fish	3988	1009	693	80	275	39	254	312	1276
Perches	2808	334	1101	1	45	58	1218	--	23
Others	107826	16145	38628	10439	11352	1934	16003	7075	9667
Total	424718	36607	83014	76642	74834	18506	42116	50610	43429
				IN PERCENTAGE					
Sardine	100	2.36	7.88	15.34	23.84	6.96	10.70	19.95	12.97
Anchoviella	100	10.84	5.61	66.03	4.14	6.42	1.86	3.69	1.41
Prawn	100	0.62	33.57	16.08	20.02	1.06	3.91	7.81	16.93
Mackeral	100	13.13	7.97	4.55	43.61	3.03	7.31	14.24	6.16
Cat fish	100	0.90	49.31	13.39	7.81	1.03	7.45	5.38	14.73
Seianeids	100	16.92	29.21	6.62	35.43	1.46	6.22	3.48	0.66
Elasmobranches	100	0.87	31.62	6.19	3.14	3.81	18.96	7.49	31.06
Cephalàpodes	100	36.85	62.68	--	0.04	--	0.10	0.31	--
Tunnies	100	81.23	11.62	1.76	4.14	0.06	--	1.04	0.15
Seer fish	100	25.30	17.37	2.00	6.89	0.98	6.37	7.82	33.27
Perches	100	11.89	39.21	0.03	1.60	2.06	43.38	--	1.65
Others	100	14.98	35.82	9.68	10.53	1.79	14.84	6.56	5.80
Total	100	8.62	19.55	18.04	17.62	4.36	9'12	11.92	10.77

Source: Department of Fisheries, Government of Kerala, Survey of Marine Fish Landings, Nos.I-VI (1984-85).

with 35.43 per cent and 20.31 per cent respectively. The production of elasmobranches concentrated mainly in two districts, viz., Quilon (31.62%) and Cannanore (31.06%).

3.3.5 The cephalapod production clearly shows a southward distribution as Quilon (62.68%) and Trivandrum (36.85%) produced almost the entire quantity. Tuna production also shows southward geographical distribution again with Trivandrum 81.23 per cent and Quilon 11.62 per cent. The maximum production of seer fish 33.27 per cent was from Calicut. Malappuram produced 43.38 per cent of perches followed by Quilon (39.21%). In the case of other species about 70 per cent of the production was from the southern coastal districts and only 30 per cent from the northern coastal districts. Among the maritime districts, 35.82 per cent of the other species was contributed by Quilon. In the case of total marine fish production, the highest 19.55 per cent was contributed by the Quilon district. The geographical basis of production of the major species is given in figure 3.1.

3.3.6 The monthwise landings of marine fish production is also important in analysing the various fishing seasons. The quantity and percentage monthwise landings of fish and other crustaceans for the year 1984 are given in appendix II. The maximum landing of sardine was recorded in January (18.92%) followed by 14.13 per cent in February, 12.43 per cent in

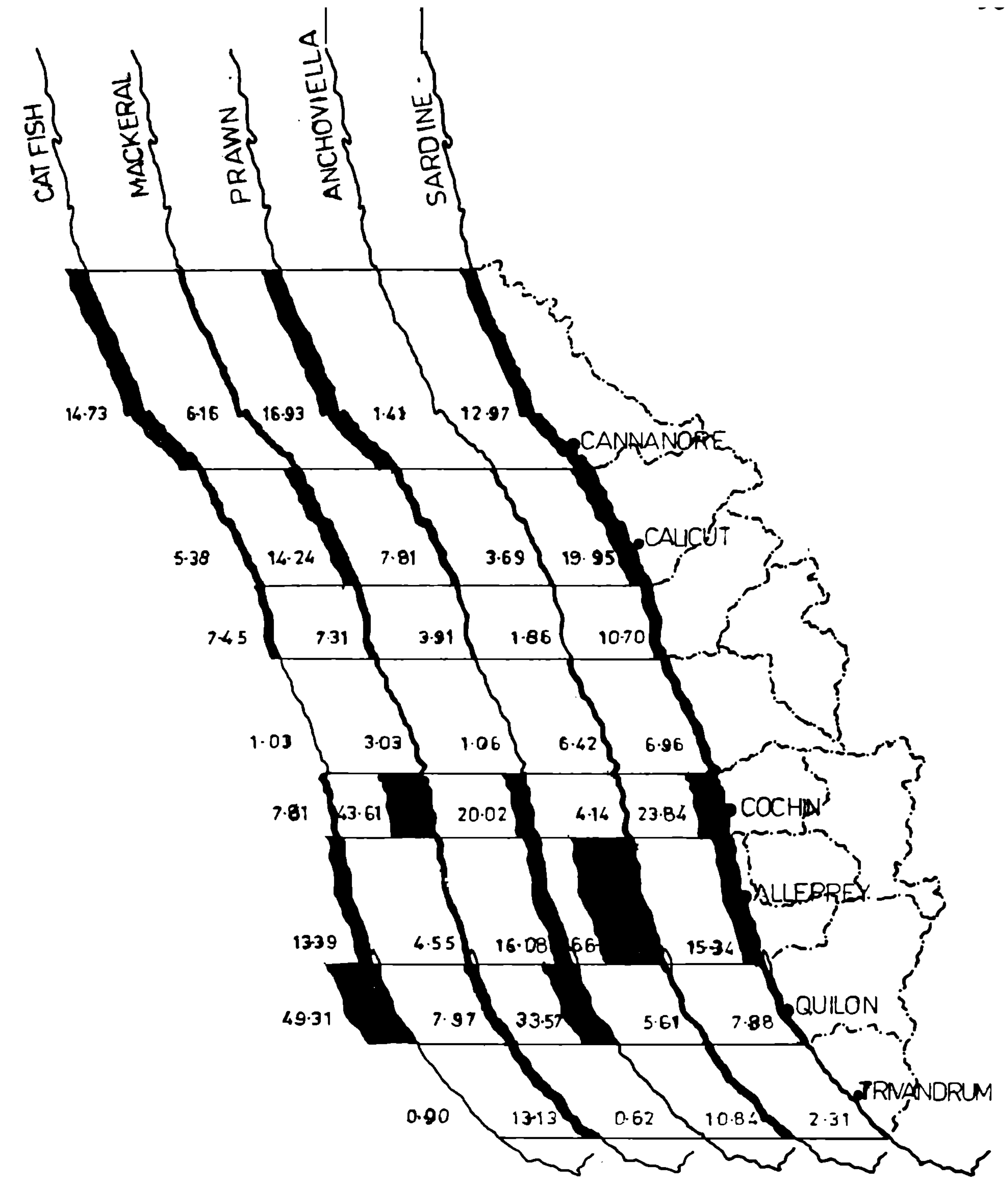


Fig.3.1(a) The geographical fish production of the major species (1984).

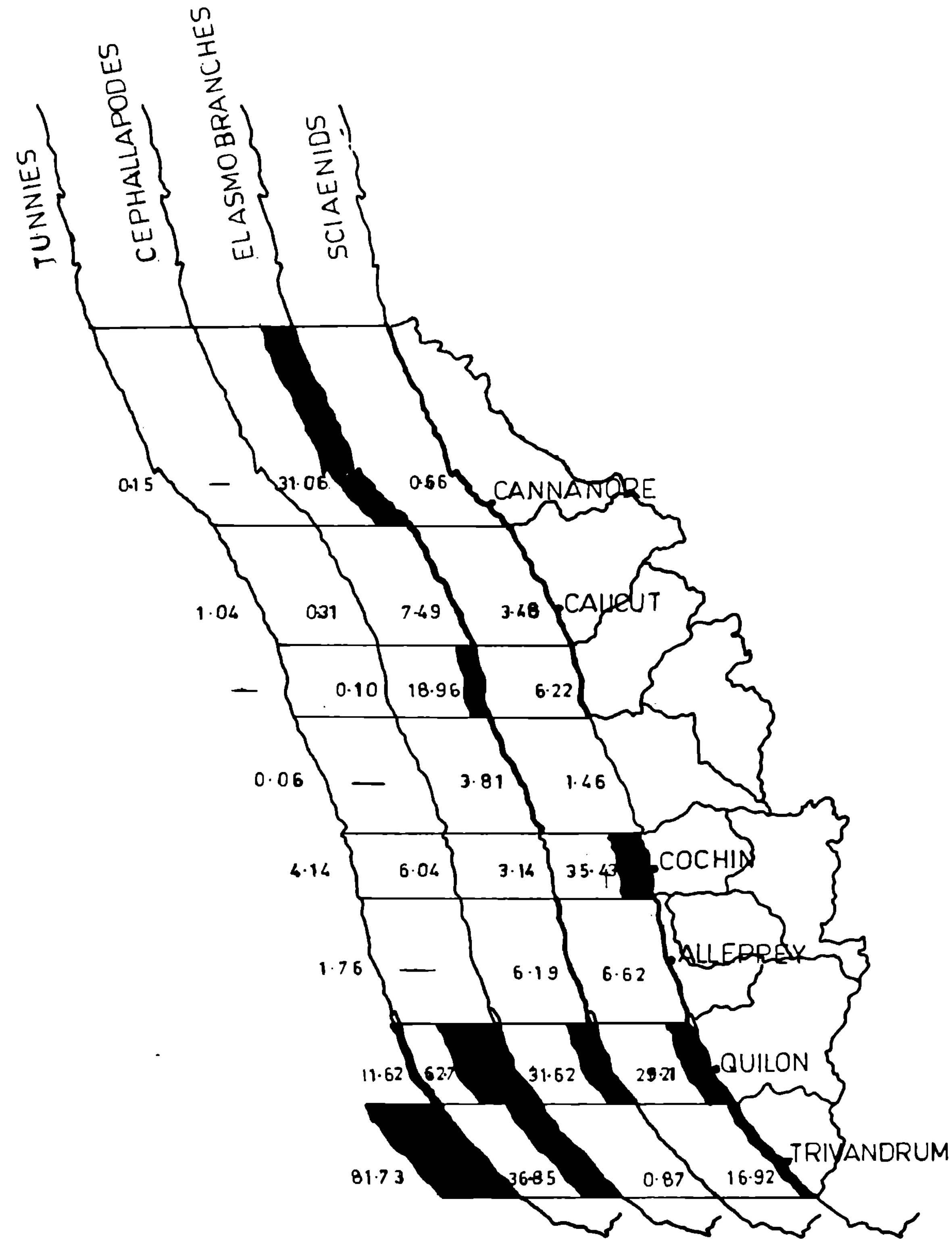


Fig.3.1(b) The geographical fish production of the major species (1984).

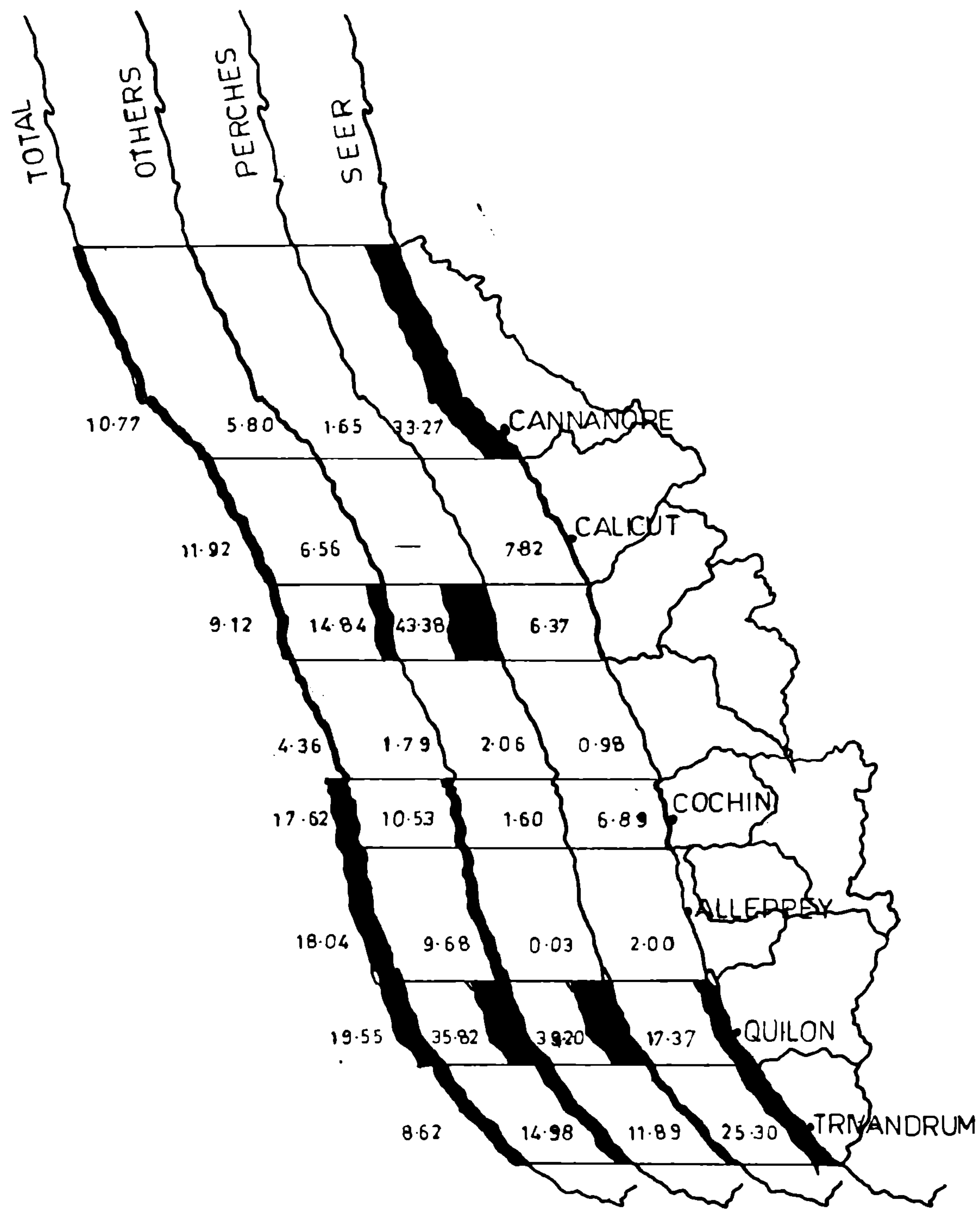


Fig.3.1(c) **The geographical fish production of the major species (1984).**

December and 12.03 per cent in November. The highest fishing month for anchoviella was recorded as July (43.11%). May to August was recorded as the major fishing season for prawn and the maximum landing of 16.13 per cent was recorded in June. The peak and lean landings for the principal fisheries of Kerala is given in table 3.9.

Table 3.9 Peak and lean landings of the principal species in Kerala for the year 1984

Species	Peak season	Lean season
Sardine	January, February November	August, July, May
Anchoviella	July, October	February, April
Prawn and other crustacean	June to August	March, April
Mackeral	September, October	February, January, December
Cat fish	June, September, August	July, December
Scianoids	October, August, September	December, June
Elasmobranches	January, February	June, August
Tunnies	November, October	January, February

Source: State Department of Fisheries, Government of Kerala, Survey of Marine Fish Landings, Nos.I to IV (1984-85).

3.4 Inland fish production

3.4.1 Kerala has approximately 10 per cent of the total riverine, and brackish waters of the country, exploitable for fishing. Besides this there is a large number of irrigation tanks. Kerala has the largest 'unmet' demand for fish for domestic consumption. So it is felt that Kerala's inland fisheries, if developed properly, can contribute about 3 lakh tonnes as against the present contribution of 27,000 tonnes. The production figures of 1984-85 show that Kerala's share of inland fish production was only 6.8 per cent of the national inland landings. Moreover, Kerala's fish production has been ranging from 23,000 tonnes to 28,000 tonnes for the last ten years.

3.4.2 Even though there are more than 20 species landed from inland resources, only six species are important both quantitywise and valuewise. They are prawn, etroplus, murrels, tilapia, cat fish and jewfish. The inland fish production for the years 1980-81 to 1984-85 is given in table 3.10. In all the five years prawn was the largest contributor of inland fish landings. It is ranging from 18 to 22 per cent of our total inland catch. In 1984-85 the share of prawn was 21.7 per cent. The next major contributor of inland landings was tilapia which is also ranging between 16 and 18 per cent. The production figure for 1984-85 was 17.3 per cent. Quantitywise, there was slight improvement in landings from year to year and in 1984-85 itself there was an increase of about 600 tonnes compared to the last year. When we compare our inland production figures with the national figures, our share is getting reduced from year to

Table 3.10 Species-wise composition of inland fish production in Kerala (1980-81 to 1984-85)

(in Tonnes)

Species	1980-81		1981-82		1982-83		1983-84		1984-85	
	Actual	Percent	Actual	Percent	Actual	Percent	Actual	Percent	Actual	Percent
Prawns	4724	18.51	5796	22.24	5850	22.17	5968	21.91	5992	21.70
Etroplus	2906	11.38	2915	11.19	2930	11.10	2971	10.91	2980	10.80
Murrels	2912	11.91	2899	11.12	2921	11.07	2962	10.87	2963	10.70
Tilapia	4172	16.34	4180	16.04	4255	16.13	4405	16.17	4784	17.30
Cat fish	2685	10.52	2691	10.33	2730	10.35	2827	10.38	2940	10.70
Jew fish	1520	5.95	1514	5.81	1533	5.81	1584	5.81	1672	6.10
Others	6607	25.89	6064	23.27	6166	23.37	6523	23.95	6286	22.70
Total	25525	100.00	26059	100.00	26385	100.00	27240	100.00	27617	100.00

Source: Government of Kerala, State Planning Board (SPB), Economic Review, 1982 to 1985.

year and the reduction is higher for the last two years. Our share of inland production in 1981-82 was 8.7 per cent and it reduced to 6.8 per cent in 1984-85.

3.4.3 A bad enough surprise when we compare our inland fish production of 27,000 tonnes with the neighbouring Tamil Nadu, the state which starves for water, which had a catch of 1.5 lakh tonnes from its inland fisheries. The large share of credit for Tamil Nadu's impressive catch, six times Kerala's, goes to the state's irrigation tanks (Kuruvilla, 1985).

3.4.4 Kerala has rich potential of fresh water fisheries, the main resources are provided by 44 rivers, whose total length is 3200 km. The potential provided is about 85,000 hectares. Leaving aside the deeper river mouth for the traditional catch and navigation, roughly 50,000 hectares can be had for cultural operations. Like most other regions in India, Kerala can have only 'warm water' fish culture facility.(Kuruvilla, 1985). So there is vast scope for the expansion of inland fisheries in Kerala.

3.5 Seasonal and temporal behaviour of marine fish landings in Kerala

3.5.1 In order to understand the seasonal pattern of marine fishes in Kerala, 22 species are presented after isolating from time series components. Based on the seasonality of the fish landings 18 fisheries have been divided into five broad patterns A, B, C, D and E. Eels, lizard fishes, carangids and silver bellies did not show significant seasonal patterns. Pattern A showed the highest landing in the fourth quarter (October to December), pattern B in the third quarter (July to September), pattern C in the second quarter (April to June), pattern D in the third quarter again and pattern E in the fourth quarter.

3.5.2 Like other natural resources, the availability of fishery resources are also not uniformly distributed throughout the year. Wide cyclical fluctuations are noticed for most of the marine fish landings. By considering the income and employment generating aspect of this sector, the study of cyclical and seasonal pattern is of immense importance to analyse the peak and lean landings of the various species under importance. Seasonality study of marine fish landings were noticed in India by many fishery scientists, and the most valuable among them was the study of seasonality conducted by Sudhindra et.al. for the Karnataka coast for the year 1985 (Sudhindra et.al., 1985). No such analysis has so far been done in Kerala to understand the seasonal patterns employing time series analysis in decomposing quarterly and monthly catch over the years. This study of the seasonal pattern is based on the above analysis for 28 quarters and the data is given in appendix III.

3.5.3 The multiplicative model (TCSI) is used to estimate for the estimation of Trend and Cyclical fluctuations (TC), the estimation of stabilised seasonal indices of the interactive procedure has been used. This is done to estimate (TC) components by weighted moving average method. These values are used to estimate seasonal indices and this cycle is repeated by re-estimating the TC values for seasonalising these data by dividing each observation by seasonal index.

3.5.4 Another method used in this analysis of seasonal pattern is the estimation of Friedman's two-way analysis of variance (Siegel, 1956). This is done by dividing the SI components by the corresponding TC estimate. For establishing seasonality and non-significant difference between years the year-by-quarter table of SI's is used. This suggests the use of arithmetic mean over years as an adequate measure of seasonality besides pointing to the persistance of a constant seasonal pattern from year to year.

3.5.5 To give a mathematical format to these indices and also to join them by a smooth curve, harmonic analysis of seasonal variation is carried out. For this, the seasonal indices of the species/groups were considered as the final figure with a functional relationship as,

$$f(t) = A_o + A \cos(t) + B \sin(t)$$

$$\text{for } A = \frac{2}{4} \sum_{i=1}^{4} \hat{f}(t_i) \cos(t_i)$$

$$B = \frac{2}{4} \sum_{i=1}^{4} \hat{f}(t_i) \sin(t_i)$$

It is not needed to work out the harmonic analysis beyond the $(\frac{r}{2})^{th}$ harmonic, 'r' being the number of intervals (Bajpai et.al., 1977). Here the analysis is considered only for the first harmonic and this is found to be a best fit for most of the cases.

3.5.6 The results show that there are demonstrable seasonal influences in all the species/groups. Table 3.11 gives the seasonal behaviour of fishes generated into five categories, depending upon the pattern of seasonal fluctuations in landings. This gives a comparison for the seasonal index between various seasonal patterns. This will also help to compare the seasonal 'effect' or 'influence' of the percentage fluctuation as a contribution of each quarter to the total amount, leaving the direction. Without any seasonal influence the base value considered is 100 for the seasonal factor in the multiplicative model of time series, Y = TCSI, and any deviation from seasonal index from 100 can be considered as a measure of effect.

3.5.7 Table 3.12 is obtained by ignoring the direction of such values as seasonal effect. Here only the magnitude and

Table 3.11 Seasonal indices averaged over the species/groups belonging to each pattern

Pattern	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
A	95	52	75	178	400
B	53	71	197	79	400
C	79	159	82	80	400
D	67	93	208	32	400
E	99	94	36	171	400

Table 3.12 Quarterwise seasonal influence under each seasonal pattern

Pattern		Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
A	Absolute	5	48	25	78	156
	Percentage	3	31	16	50	100
B	Absolute	47	29	97	21	194
	Percentage	24	15	50	11	100
C	Absolute	21	59	18	20	118
	Percentage	18	50	15	17	100
D	Absolute	33	7	108	68	216
	Percentage	15	3	50	32	100
E	Absolute	1	6	64	71	142
	Percentage	.5	4.5	45	50	100

the reduction to percentages are given. The maximum absolute seasonal influence is noticed in pattern D and the least in pattern E.

3.5.8 Tables 3.13 and 3.14 give the final iterative statistical seasonal indices. The 'seasonal influence' for 18 species/groups after grouping them into observed seasonal patterns of A, B, C, D and E is given in table 3.14. Four species did not show any significant seasonal patterns.

3.5.9 Table 3.15 gives the harmonic analysis worked out for the seasonal indices for each fishery and for the average indices under each pattern.

3.5.10 The result of table 3.15 are presented in figure 3.2 based on the mathematical form of f(t) of the seasonality nature in each case.

3.6. Pattern A

3.6.1 This pattern shows the highest landing in the fourth quarter (October to December) followed by the first, second, third quarters as given in table 3.13. The fourth quarter contributes as much as 50 per cent of the total seasonal fluctuations (table 3.12). The curve (fig.3.2) shows the curve fairly well to the seasonal indices, both in terms of direction and magnitude.

Table 3.13 Stabilised indices for 18 species/groups classified into five patterns

Pattern		Species group	Seasonal index Q1	Q2	Q3	Q4
A	i)	Seer fish	87.78	25.18	69.41	217.63
	ii)	Pomfret	82.78	42.15	75.18	199.89
	iii)	Oil-sardine	121.71	44.61	58.96	174.72
	iv)	Other sardines	80.07	65.38	97.65	157.00
	v)	Elasmobranches	103.10	80.96	76.40	139.54
B	i)	Ribbon fish	8.89	45.57	320.75	24.79
	ii)	Perches	34.49	22.57	316.78	26.15
	iii)	Lactarius	28.17	83.45	261.27	27.11
	iv)	Cephalapods	48.98	34.47	176.38	140.17
	v)	Anchovies	49.34	79.00	161.49	110.17
	vi)	Soles	72.03	78.53	159.26	90.18
	vii)	Siaenids	100.20	89.97	132.84	76.99
	viii)	Cat fishes	39.54	123.20	128.35	108.61
	ix)	Other clupeids	95.53	86.21	113.79	104.47
C	i)	Tunnies	51.18	208.20	71.69	68.93
	ii)	Mackeral	106.33	110.35	92.61	90.70
D	i)	Prawns	66.76	93.27	208.19	31.77
E	i)	Other crustaceans	99.06	94.05	36.04	170.94
		Total	70.89	78.18	142.06	108.78

Table 3.14 Percentage seasonal influence for 18 species/groups classified into five patterns

Pattern	Species group	Seasonal influence Q1	Q2	Q3	Q4
A	i) Seer fish	5	32	13	50
	ii) Pomfret	9	29	12	50
	iii) Oil-sardine	11	29	21	39
	iv) Other sardines	18	30	2	50
	v) Elasmobranches	4	22	28	46
B	i) Ribbon fish	21	12	50	17
	ii) Perches	15	18	50	17
	iii) Lactarius	22	5	50	23
	iv) Cephalapods	18	29	35	18
	v) Anchovies	35	15	43	7
	vi) Soles	24	18	50	8
	vii) Siaenids	--	15	50	35
	viii) Cat fishes	50	19	24	7
	ix) Other clupeids	12	38	38	12
C	i) Tunnies	23	50	13	14
	ii) Mackeral	19	31	22	28
D	i) Prawns	15	3	50	32
E	i) Other crustaceans	--	5	45	50
	Total	28	22	41	9

Table 3.15 Harmonic analysis for seasonal indices

Sl. No.	Pattern/Fishery	Functional form of f(t)*
	Pattern A	100 + 9.79 cos(t) - 33.05 sin(t)
i)	Seer fish	100 + 9.19 cos(t) - 96.23 sin(t)
ii)	Pomfret	100 + 3.80 cos(t) - 78.87 sin(t)
iii)	Oil-sardine	100 + 31.78 cos(t) - 65.06 sin(t)
iv)	Other sardines	100 - 8.79 cos(t) - 45.81 sin(t)
v)	Elasmobranches	100 + 13.35 cos(t) - 29.29 sin(t)
	Pattern B	100 - 71.88 cos(t) - 3.65 sin(t)
i)	Ribbon fish	100 - 155.93 cos(t) + 10.39 sin(t)
ii)	Perches	100 - 141.15 cos(t) - 1.79 sin(t)
iii)	Lactarius	100 - 116.55 cos(t) + 28.17 sin(t)
iv)	Cephalapods	100 - 63.70 cos(t) - 52.85 sin(t)
v)	Anchovies	100 - 56.08 cos(t) - 15.59 sin(t)
vi)	Soles	100 - 43.62 cos(t) - 5.83 sin(t)
vii)	Seiaenids	100 - 16.32 cos(t) + 6.49 sin(t)
viii)	Cat fishes	100 - 44.41 cos(t) + 7.30 sin(t)
ix)	Other clupeids	100 - 9.31 cos(t) - 9.13 sin(t)
	Pattern C	100 - 1.71 cos(t) + 39.73 sin(t)
i)	Tunnies	100 - 10.26 cos(t) + 39.73 sin(t)
ii)	Mackeral	100 + 6.86 cos(t) + 9.83 sin(t)
	Pattern D (Prawns)	100 - 70.72 cos(t) + 30.75 sin(t)
	Pattern E (Other Crustaceans)	100 + 31.51 cos(t) - 38.45 sin(t)
	Total	100 - 35.59 cos(t) - 15.30 sin(t)

*General functional form of f(t)

$$f(t) = A_o + A\cos(t) + B\sin(t)$$

t = angular transformation of time interval, i.e., $0 \leq t \leq 2\pi$ with an increase of 30° per interval since 12 (monthly) intervals have been considered while plotting.

A and B are parameters of the equation where

$$A = \tfrac{1}{2} \sum_{i=1}^{4} \hat{f}(t_i)\cos(t_i) \text{ and } B = \tfrac{1}{2} \sum_{i=1}^{4} \hat{f}(t_i)\sin(t_i)$$

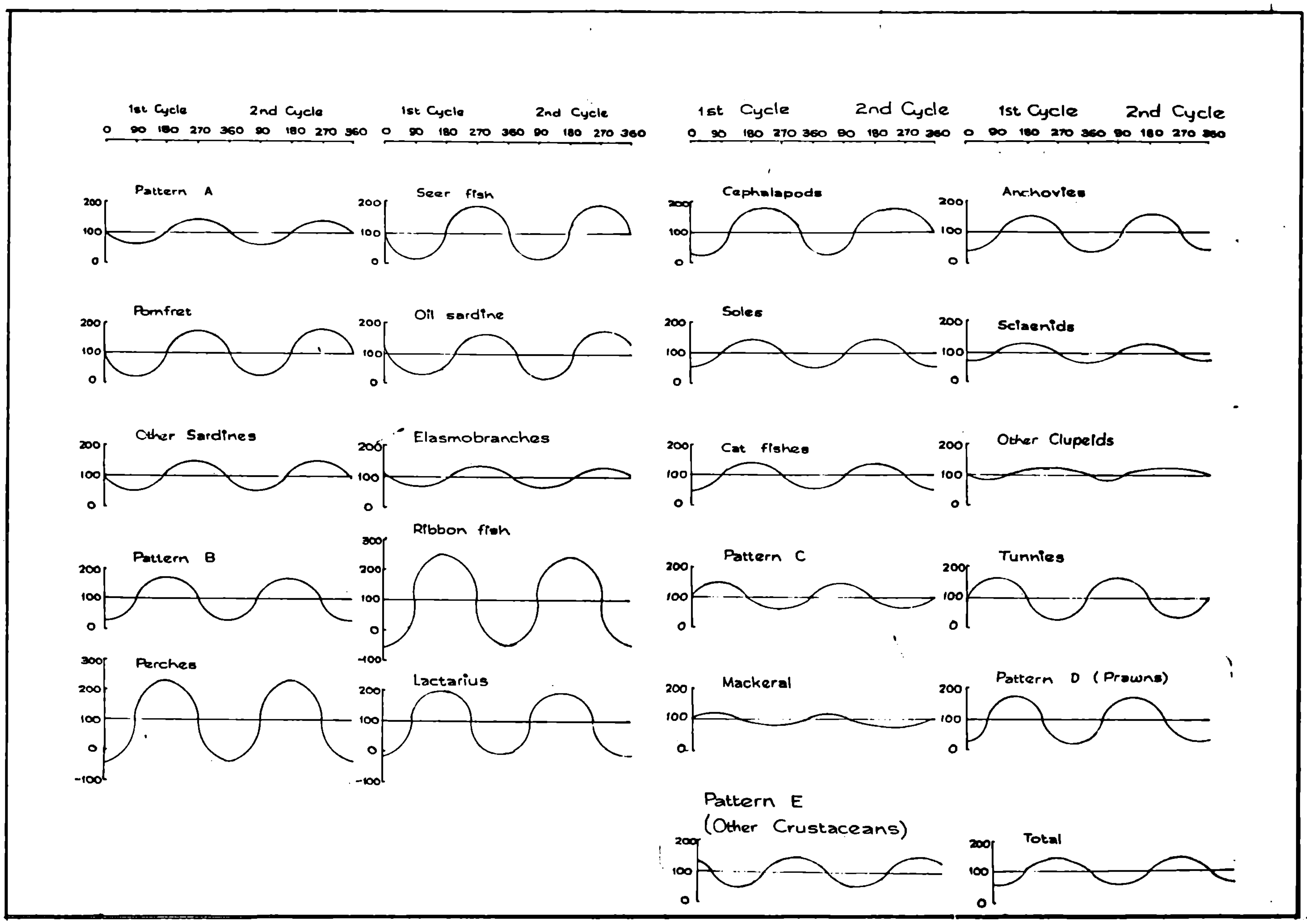


Fig.3.2 Harmonic analysis of seasonal periodicities for different species (2 cycles shown).

3.6.2 The fourth quarter is generally considered to be the best fishing season for demersal species like oil and other sardines. These species are mainly coming from the non-mechanised and motorised sectors and constitute about 40 per cent of the demersal fish landings of the state. A similar pattern of the landing of these species is also found in the neighbouring states of Kerala, especially in Tamil Nadu and Karnataka states (Sudhindra et.al., 1985). The second quarter (April to June) is considered to be the lowest landing season for these groups of fishes in Kerala. A study on the fisheries of the Cochin area also pointed out that species of this type and prawns appear in large quantities in the fishing seasons of September to October (Sankaranarayanan and Quasim, 1969). As per table 3.13 and fig.3.2 the fluctuation is most in the case of elasmobrances.

3.6.3 Oil-sardine (table 3.13 and fig.3.2) show that the landings of oil-sardine while confronting to pattern A differ from other species. The first quarter also experience very good landings. The high salinity of water in Kerala during this season resulted in very high catches of oil sardine (Rao et.al., 1973). The seer fish (table 3.13 and fig.3.2) shows that the fourth quarter contributes very highly to the annual catch and the first and the third quarters moderately and the second at a low rate.

3.7. Pattern B

3.7.1 This is the most common pattern with as many as nine species/groups as in table 3.13. This season (July to September) contributes maximum landings of fishes in Kerala followed by fourth, second, first quarters. The fourth quarter contributes to as much as 50 per cent of the total seasonal fluctuations (table 3.12). The curve (fig.3.2) shows the peak pattern for B sometime in the end of September.

The maximum fluctuation in the third quarter (table 3.13) and (fig.3.2) is noticed in the case of ribbon fish and lowest in the case of other clupieds. A wide variation in the landings of various species is noticed in this pattern B compared to that of pattern A. The landings of ribbon fish is overwhelming in the third quarter, moderate in the second and negligible in the first and fourth quarters. In the case of cat fishes a somewhat moderate landing is noticed in the second, third and fourth quarters with little higher in the third quarter. In this case the seasonal pattern of the Kerala coast is not much different from the north-east coast (Sudhindra et.al., 1985).

3.8 Pattern C

3.8.1 Even though pattern C consists of only two species of tunnies and mackeral, both are considered to be very importan in Kerala's fish landings and mackeral especially very important in the non-mechanised sector and this comes next to sardines in the landings of the demersal species. The larve and juveniles of mackeral are most frequently observed between 9° and 13°N around 30 mts depth zone. The fishery is sustained by immature fish, mostly 16 to 20 cm in size believed to be mostly 0-years class fish. A considerable portion of the stock, particularly the juveniles, migrates to inshore waters after the south-west monsoon, while much of the adults remain inshore (Rajiv, 1979). This explains to a great extent the wide annual fluctuations in the stock size.

3.8.2 The maximum landings of this pattern is from the second quarter (table 3.13) and (fig.3.2) followed by third, fourth, first in the case of tunnies and first, third, fourth in the case of mackeral. The fourth quarter contributes to as much as 50 per cent of the total seasonal fluctuations (table 3.12). The mackeral fishery depends on the inshore migration of the fishery from the north to south and high catch is noticed in Kerala during the first two quarters.

3.9 Pattern D

3.9.1 The pattern D is usually represented by the most important commercial fishery prawns. This specie is mostly contributed by the mechanised fishing sector and also during the months of July to September, quarter third (table 3.13), followed by second, first, fourth. This fishery also shows a 50 per cent (table 3.12) of the seasonal fluctuations registered in quarter third. Fig.3.2 shows that the peak landing is correctly noticed in the curve during the third quarter.

3.9.2 The prawn catch has generally been higher when cooler, denser waters prevail along the west coast. So the ideal conditions for the abundance of prawn is noticed along the continental shelf during the monsoon period of July to September (MFIS, 1979). After monsoon, once the upwelling of the sea ceases, the demersal fishes and crustaceans, which had a shoreward migration during upwelling, will disperse and disappear in offshore regions. The demersal species memipterus japnicus which is caught in large quantities during monsoon months from Sakthikulangara and which disappears in September in this area will be subsequently available only in deep waters (George, 1980a). A study of the marine prawn fishery of Kerala state shows that the catches are higher during the monsoon months of July to September, and this period itself contributes about 60 per cent of the total prawn catches (Bhaskaran Pillai, 1981). The predominant specie of monsoon prawn catches is P.Styliferia, and the landings in Neendakara during this season are of the size range of 51-120 mm because of the upwelling of the sea.

3.10 Pattern E

3.10.1 The other crustaceans include crabs, lobster, and stomatopods and this fishery follows the pattern E (table 3.13). This is an important fishery in Kerala because of its export value and is available in plenty in Kerala coast. About 50 per cent of the total seasonal fluctuations is accounted for the fourth quarter (table 3.12) like that of pattern A. Fig.3.2 shows that the peak for pattern E is towards the end of October.

3.11 Fish production forecast based on Seasonal Auto Regressive Moving Average (ARMA) models for 18 species (based on their seasonal landing patterns).

3.11.1 Here an attempt is made to forecast the seasonal quarterly fish production of different species using Auto Regressive Moving Average Model (ARMA). The data base for using this model is the quarterly fish production (see appendix III).

3.11.2 A model which is extremely useful in the representation of certain practically occurring series is the so called autoregressive model. The current value of the process is expressed as a finite, linear aggregate of previous values of the process and a random component - a_t. The model is of the form (Box and Jenkins, 1970)

$$Z_t = \phi_1\tilde{Z}_{t-1} + \phi_2\tilde{Z}_{t-2} + \cdots\cdots + \phi_p\tilde{Z}_{t-p} + a_t$$

where Z_t is the current value of the series

$\tilde{Z}_{t-1}, \tilde{Z}_{t-2}\ldots\tilde{Z}_{t-p}$ representing the past values of of the series and $\tilde{Z}_t = Z_t - \mu$, μ being the $E(Z_t)$.

$\phi_1, \phi_2\ldots\phi_p$ are the parameters of the auto-regressive model, AR(P) and

a_t is the random component.

3.11.3 Another kind of model of great practical importance of the representation of observed time series is the finite moving process, where the current value is linearly dependent on a finite number of a's (Box and Jenkins, 1970).

This is,

$$\tilde{Z}_t = a_t - \theta_1 a_{t-1} + \theta_2 a_{t-2} + \cdots + \theta_q a_{t-q}.$$

where a_t's are random components

$\theta_1, \theta_2\ldots\theta_q$ are parameters of the moving average model MA(q). Further $a_t, a_{t-1}, a_{t-2}\ldots$ are random components with $E(a_t) = 0$, $Var(a_t) = \sigma a^2$ and covar $(a_t)(a_{t+k}) = 0$ for $k \neq 0$.

3.11.4 To achieve greater flexibility in fitting of actual time series AR and MA terms are jointly used. This is given by,

$$\tilde{Z}_t = \phi_1 Z_{t-1} + \phi_2 Z_{t-2} + \ldots + \phi_p Z_{t-p} + a_t - \theta_1 a_{t-1} - \ldots - \theta_q a_{t-q}$$

That is

$$\phi(B)\, Z_t = \theta(B) a_t$$

where

$$\phi(B) = 1 - \phi_1 B - \ldots - \phi_p B^p$$

$$\theta(B) = 1 - \theta_1 B - \ldots - \theta_q B^q$$

and B is the backward shift operator defined by

$$B\, Z_t = Z_{t-1}$$

3.11.5 Since most of the marine species show high seasonal fluctuations seasonality models of the ARMA types are highly suitable for forecasting the future values. Based on the seasonality of fish landings 18 species are divided into five broad patterns of A, B, C, D and E. For this the seasonal fish production data of 18 species quarterwise is used.

3.11.6 The general multiplicative model representing a seasonal series is given by

$$\phi_p(B)\,\Phi(B^s)\,\nabla^d\,\nabla_s^D\,Z_t = \Theta_q(B)\,\Theta_Q(B^s)\,a_t$$

where

$\phi_p(B)$ is a polynomial in B of degree p,

$\Phi_P(B^S)$ is a polynomial in B^S of degree P,

$\nabla^d = (1-B)^d; \quad \nabla_s^D = (1-B^s)^D$

$\Theta_q(B)$ is a polynomial in B of degree q,

$\Theta_Q(B^S)$ is a polynomial in B^s of degree Q.

This multiplicative model is of order,

(p, d, q) X (P, D, Q)

3.11.7 Autocorrelation function is used as the major factor for identifying the model. The autocorrelation function of a series is defined as the correlation between the data points at k time lag difference (Johnston, 1963), i.e.,

$$\rho_k = \frac{\text{Covar}(Z_t \cdot Z_{t+k})}{\text{Var}(Z_t)}$$

Table 3.16 Estimated Autocorrelation Functions (ACF)

Species / Time lag	1	2	3	4	5	6	7	8	9	10	11	12
Series A												
A(i) Seer fish	0.3609	-0.6319	-0.8015	-0.4010	0.1206	-0.2163	-0.4095	0.3721	-0.4833	-0.3871	-0.3790	0.4557
A(ii) Pomfret	-0.5860	0.1509	0.1529	-0.8098	0.1772	-0.1228	-0.1370	0.0919	0.0380	-0.0814	0.0700	0.0824
A(iii) Oil-sardine	-0.0388	-0.6280	0.0828	0.7407	0.1292	-0.7096	-0.0941	0.5014	0.1782	-0.5989	-0.6489	-0.0663
A(iv) Other sardines	0.3200	0.3519	-0.7715	-0.8049	-0.1834	-0.1360	-0.3261	-0.1763	-0.0052	-0.0014	-0.0416	0.0999
A(v) Elasmobranches	0.1437	-0.2862	-0.0847	0.1838	-0.4328	-0.0699	-0.1664	0.1664	-0.0825	-0.2856	-0.1110	0.2250
A Total	0.1524	-0.6085	-0.3932	0.3343	-0.0980	-0.5111	-0.1021	0.4228	0.1341	-0.4463	-0.5152	0.0601
Series B												
B(i) Ribbon fish	-0.0411	0.6343	-0.7128	0.2250	0.5276	-0.3150	0.8695	-0.5543	-0.7313	0.9585	-0.9893	0.9049
B(ii) Perches	0.0728	0.5065	-0.6708	0.4588	-0.1651	0.1609	0.3658	-0.3421	0.0523	-0.1956	-0.2655	0.2438
B(iii) Lactarius	0.2365	-0.0573	-0.4814	0.4013	-0.4245	0.3484	0.1489	-0.1735	0.3618	0.0843	-0.5889	0.7514
B(iv) Cephalapods	0.8259	-0.0758	0.3742	-0.3898	-0.6652	-0.0296	0.8099	0.1838	-0.8681	-0.3838	0.4260	-0.2327
B(v) Anchovies	0.2043	-0.1095	-0.0943	-0.1059	-0.1480	-0.4276	0.0121	0.0267	0.2159	-0.0875	0.0127	-0.0129
B(vi) Soles	-0.3413	-0.4023	-0.2569	-0.7779	-0.7954	-0.6121	0.2011	0.6272	-0.7709	-0.1037	-0.4522	0.1014
B(vii) Siaenieds	-0.1320	-0.1831	-0.6293	-0.2969	-0.3677	0.3421	0.3143	-0.1864	0.0662	0.9070	0.3357	0.1824
B(viii) Cut fishes	-0.2593	-0.0698	-0.1837	-0.0812	0.2746	0.4042	-0.6289	-0.0458	-0.0525	0.8103	0.3245	0.1446
B(ix) Other clupeids	-0.1235	-0.4496	-0.0268	0.6159	-0.3681	0.2482	-0.1024	-0.2564	-0.1987	-0.4548	-0.3753	-0.1987
B Total	0.1884	0.0071	0.1898	0.2023	-0.0858	-0.2932	0.2750	0.8849	-0.0470	0.0509	0.1273	0.4200
Series C												
C(i) Tunnies	0.1027	0.8595	-0.0141	-0.7557	0.4378	0.4943	0.4721	-0.2550	0.6933	-0.5844	-0.4181	-0.6059
C(ii) Mackeral	0.1483	-0.3982	0.4729	0.3995	0.3939	-0.6086	-0.5228	-0.2737	0.5345	-0.0739	-0.3758	-0.0780
C Total	-0.1802	0.1264	0.8347	0.3491	-0.1240	-0.8936	-0.2683	0.7094	-0.3798	-0.2911	-0.9580	-0.5431
Series D Prawns	0.3068	-0.2505	0.7973	0.1511	0.6865	-0.2168	-0.1080	-0.1053	-0.0663	0.0868	0.1900	0.1135
Series E Other Crustaceans	0.5268	0.4831	-0.0650	-0.5434	-0.0816	-0.2235	-0.6522	0.4657	-0.2528	-0.5587	-0.0558	0.1487
GRAND TOTAL	0.4515	-0.2670	-0.7880	0.2402	-0.8450	-0.5090	0.5787	-0.0656	0.1091	-0.8198	-0.9294	-0.2762

3.11.8 For each series the autocorrelation function is estimated and given in each specie model (see table 3.16). Using these autocorrelation functions the parameters of the model representing each specie is estimated using the R-spec procedure. For details see Appendix IV.

3.11.9 Table 3.17 shows the identification of the models of 18 species and its totals. The seasonality period for all the species is four. In this case the t^{th} value depends on t-4 and t-8 quarters and the random component a_t. But in the model A(v) (Anchovies) depends on x_{t-1}, x_{t-4} and also x_{t-5} plus a random component. This is because of the presence of non-seasonal component. In B total also there is a slight difference whose x_t depends on x_{t-4}, x_{t-8}, a_t and a_{t-1}. This is due to the presence of an additional random component $a_t - 0.44\, a_{t-1}$.

3.11.10 The forecast value based on the models (see tables 3.18, 3.19 and 3.20) show a stationary nature in all the cases. Very few species show slight improvement in the landing pattern, e.g., seerfish, other sardines, lactarius, cephalapods, mackeral etc. Some of the species like prawn and perches, show a decreasing tendency in the landing pattern. But a noticeable factor from the various model fitted is that the fish landings for certain quarters show a decreasing trend, while an increasing trend in certain other quarters. Examples are oil-sardine,

Table 3.17 Estimated seasonal ARMA models for different species

	Species	Estimated Models	σ_a^2
A(i)	Seer fish	$x_t = 0.71x_{t-4} + 0.29x_{t-8} + a_t$	415.33
A(ii)	Pomfret	$x_t = 1.302x_{t-4} - 0.302x_{t-8} + a_t$	443.24
A(iii)	Oil-sardine	$x_t = 0.81x_{t-4} + 0.19x_{t-8} + a_t$	2758.56
A(iv)	Other sardines	$x_t = 0.62x_{t-4} + 0.38x_{t-8} + a_t$	2084.51
A(v)	Elasmobranches	$x_t = 1.15x_{t-4} - 0.15x_{t-8} + a_t$	396.07
	A total	$x_t = 0.65x_{t-4} + 0.35x_{t-8} + a_t$	16179.86
B(i)	Ribbon fish	$x_t = 0.97x_{t-4} + 0.03x_{t-8} + a_t$	2693.40
B(ii)	Perches	$x_t = 0.96x_{t-4} + 0.04x_{t-8} + a_t$	2883.22
B(iii)	Lactarius	$x_t = 0.58x_{t-4} + 0.42x_{t-8} + a_t$	258.19
B(iv)	Cephalapods	$x_t = 1.39x_{t-4} - 0.39x_{t-8} + a_t$	600.59
B(v)	Anchovies	$x_t = 0.22x_{t-1} + x_{t-4} - 0.22x_{t-5} + a_t$	27984.45
B(vi)	Soles	$x_t = 1.38x_{t-4} - 0.38x_{t-8} + a_t$	1103.86
B(vii)	Siaenieds	$x_t = 1.017x_{t-4} - 0.017x_{t-8} + a_t$	703.18
B(viii)	Cat fishes	$x_t = 0.72x_{t-4} + 0.28x_{t-8} + a_t$	877.89
B(ix)	Other clupeids	$x_t = 1.35x_{t-4} - 0.35x_{t-8} + a_t$	67.33
	B total	$x_t = 1.025x_{t-4} - 0.025x_{t-8} + a_t - 0.44a_{t-1}$	6016.22
C(i)	Tunnies	$x_t = 0.55x_{t-4} + 0.45x_{t-8} + a_t$	572.23
C(ii)	Mackeral	$x_t = 1.18x_{t-4} - 0.18x_{t-8} + a_t$	1008.93
	C total	$x_t = 0.80x_{t-4} + 0.20x_{t-8} + a_t$	2240.76
D	Prawns	$x_t = 1.22x_{t-4} - 0.22x_{t-8} + a_t$	3687.39
E	Other crusta-ceans	$x_t = x_{t-4} + a_t$	1012.45
Grand Total		$x_t = 1.33x_{t-4} - 0.33x_{t-8} + a_t$	11579.67

Table 3.19 Forecast value of species B based on the estimated models from first quarter of 1985 to fourth quarter of 1988.

Species / Time lag (quarters)	B(i) Ribbon fish	B(ii) Perches	B(iii) Lactarius	B(iv) Cephalupods	B(v) Anchovies	B(vi) Soles	B(vii) Siaenieds	B(viii) Cat fishes	B(ix) Other clupeids	B Total
1	20.15	173.44	188.84	245.65	4374.24	1399.14	1146.99	2042.20	821.30	8360.40
2	642.97	179.91	314.60	71.10	7387.92	243.74	613.89	4078.12	483.15	14563.97
3	1500.53	1867.52	818.14	2668.29	26246.64	832.56	2991.13	4444.52	614.20	45546.22
4	256.36	869.12	91.26	2649.19	11539.34	4819.82	2326.32	3708.12	252.70	23515.70
5	20.00	171.58	232.59	220.55	4379.69	1435.67	1146.56	2131.18	860.25	8359.83
6	642.97	178.35	335.77	39.02	7389.12	230.72	613.48	4318.88	518.55	14567.52
7	1501.11	1860.34	744.58	2852.48	26246.90	718.77	2990.64	4514.37	662.22	45634.72
8	257.01	868.51	99.53	2804.48	11539.39	5229.77	2326.80	3211.93	228.44	23521.42
9	20.01	171.65	214.22	210.74	4379.70	1449.55	1146.56	2106.26	873.98	8359.81
10	642.97	178.41	326.88	26.50	7389.05	225.77	613.47	4251.47	530.94	14567.61
11	1501.09	1860.63	775.47	2924.31	26246.88	675.53	2990.63	4494.81	679.03	45636.93
12	353.99	868.53	96.05	2865.04	11539.38	5385.88	2326.81	3350.80	219.95	23521.56
13	20.00	171.65	221.93	206.91	4379.69	1454.82	1140.55	2113.24	878.78	8359.81
14	642.97	178.48	330.61	21.62	7389.04	223.89	613.48	4270.34	535.27	14567.61
15	1501.09	1860.39	762.49	2952.39	26246.88	659.10	2990.63	4500.28	684.91	45636.98
16	351.08	868.53	97.51	2888.65	11539.38	5444.74	2326.80	3311.96	216.97	23521.56

Table 3.20 Forecast value of species C,D,E and grand total based on the estimated models from first quarter of 1985 to fourth quarter of 1988.

Species / Time lag (Quarters)	C(i) Tunnies	C(ii) Mackeral	C Total	D Prawns	E Other Crustaceans	Grand Total
1	729.80	8564.73	7273.00	8251.92	23.00	109814.28
2	1066.40	4567.58	5070.20	12193.4	23.00	57591.70
3	1421.15	8839.00	8238.40	6073.54	8.00	79434.33
4	1963.40	7248.92	8390.60	4925.28	9.00	87618.17
5	6556.09	8709.24	7486.20	8246.40	23.00	111743.55
6	1019.42	4616.70	5114.00	12450.89	23.00	58385.38
7	1168.63	8989.80	8368.54	577.38	8.00	79739.36
8	2127.02	7336.20	8530.68	5042.60	9.00	84813.89
9	689.25	8732.89	7443.56	8245.19	23.00	112380.21
10	1040.56	4618 46	5105.24	12507.54	23.00	58647.56
11	1282.26	9011.04	8342.51	5704.90	8.00	79840.02
12	2053.39	7351.91	8502.66	5068.41	9.00	83888.48
13	674.33	8737.50	7452.09	8244.92	23.00	112590.31
14	1031.05	4619.56	5106.99	12520.00	23.00	58734.01
15	1231.13	9015.76	8347.72	5690.36	8.00	79873.24
16	2086.53	7354.74	8508.26	5074.09	9.00	83583.10

elasmobranches, ribbon fish and prawn. This kind of variation occurs probably due to the erratic seasonal landing pattern of oil-sardine and ribbon fishes. But the upswing and downswing in the case of prawn landings are largely due to larger effort and high availability of the species during monsoon quarters (Bhaskaran Pillai, 1981).

3.11.11 From table 3.20, by taking the annual forecast values (adding four quarterly values), the annual forecast for 1985, 1986, 1987 and 1988 are 334458.48, 334682.18, 334756.27 and 334780.68. By comparing the annual fish catch for 18 species in 1984 (see appendix I) is 3,33,780.00 with the 1988 forecast value of 3,34,780.68, show only a marginal increase of 1000.68. Unless we take some drastic measures to increase the fish landings, the present stagnation in landing may destroy the healthy existence of the fishing industry. One alternative suggested for this is to introduce deep sea and distant water trawlers to exploit the off-shore fisheries as the near shore fisheries exhibit stagnation.

3.12. Trends in volume and value of output

3.12.1 The economic importance of the fishing industry lies in the fact that it is a generator of income to the fishermen and to the state. The income to the fishermen largely depends on the shore prices of fish. The spiralling prices of most of the species resulted in wider variation in the value of output both in the mechanised and in the non-mechanised sectors. This is more true in the case of the prices of the export species (prawn) and other value species like seerfish and pomfret. The price index of marine fish in Kerala increased from 100 in 1963 to 2553 in 1984 (see table 3.23). This price rise is more in the case of fish than many of the agricultural and allied products. In the early 1960s fish was considered as a cheap source of animal protein, but today fish is more expensive than milk and meat and other forms of animal protein (Nair, 1978).

3.12.2 The variation in production has wider influence for the variation in value. The period 1956 to 1984 shows three important stages in fisheries i.e., stages of growth, stagnation and decline. The quantity increases from 2,52,600 tonnes in 1965-58 to 3,34,600 tonnes in 1964-66, giving an annual increase of about 4 per cent per annum. In the stagnation phase, i.e., from 1964-66 to 1974-76 the fish production reached to 3,90,400 tonnes with a mere increase of about 1.67 per cent landings. After 1974-76 the fish production decreased at an average rate of about 3.4 per cent per annum. The 1980-81 landing of 2,76,800 tonnes was the lowest since 1963. But the increased landings of the oil-sardine and mackeral during 1982-84 resulted in an increased average growth rate of 3,78,400 tonnes and again this was because of the increased fish production of 4,24,718 tonnes in 1984. This is shown in table 3.21.

Table 3.21 Percentage distribution of volume and value between species (1956-1984)
Q = Quantity in '000 tonnes, V = Value in Rs.lakhs, NA = Not available

Years		Total	Oil-sardine	Prawns	Mackerals	Rest of the species
			(Percentages)			
1956-58	Q	252.6	45.6	6.5	12.0	35.9
	V	NA	NA	NA	NA	NA
1964-66	Q	334.6	61.0	7.8	3.8	27.4
	V	769.30	40.5	21.1	6.2	32.2
1974-76	Q	390.4	28.0	14.4	4.0	53.6
	V	6093.1	13.7	39.3	5.6	41.4
1980-81	Q	276.8	39.2	13.5	6.3	41.0
	V	8266.40	7.5	64.0	4.1	24.4
1982-84	Q	378.4	35.2	7.7	3.9	53.2
	V	12043.33	12.42	30.68	6.1	51.8

Source: 1. Kurien, J. (1984) Marine Fish Production: Past Trends and Perspectives for the Future (mimeo) Centre for Development Studies, Trivandrum.
2. Catch: Compiled from CMFRI Published Data; Prices: Government of Kerala, State Planning Board (SPB), Economic Review 1981-1984.

3.12.3 In comparison with the change in the volume of output the value of output showed only an increasing trend in all the periods. The value increased from Rs.769.3 lakhs in 1964-66 to Rs.6,093.1 lakhs in 1974-76, further increased to Rs.8,266.40 lakhs in 1980-81 and reached to Rs.12,043.33 lakhs in 1982-84. The value of output over the period 1964-66 to 1982-84 has therefore increased to 36-fold.

3.12.4 A disaggregated analysis of the value of the most important species is of immense importance to analyse the source of variation of volume and value. For this, we consider oil-sardine, mackeral and prawn as economic species and all others are lumped together as 'rest of the species' (see table 3.21). Among these four categories oil-sardine dominated the fishery in the earlier periods both for volume and value. But the increasing trend of the percentage of both volume and value continued only upto 1966. Thereafter quantity percentage decreased considerably.

3.12.5 In the case of prawn the percentage share of quantity increased from 7.8 in 1964-66 to 14.4 in 1974-76 and the percentage share of value increased from 21.1 to 39.3. Both the volume and value showed a two-fold rise. This is because of the increased mechanised trawling of prawn during the decade 1966 to 1975. 1980-81 fetched the highest percentage of value for prawn, i.e., 64 per cent and this is due to the increased unit value realisation from the prawn export. In the period 1982-84 the share of quantity and value of prawn decreased to 7.7 and 29.68. The reduced share of the prawn landings is the result of the over-exploitation of this species by the mechanised boats in the important prawn-landing centres. The relative share of both volume and value of mackeral were on the decline. A wide fluctuation is noticed in the case of the rest of the species for the whole period and in 1982-84 period the share of both volume and value were more than 50 per cent.

3.12.6 The above trend in the volume and value in the four species' composition and its impact are analysed in table 3.22. for the period 1964-66 to 1982-84. The shift in the composition of output in this period in favour of the relatively high valued species, especially prawns and to a lesser extent the 'rest of the species', have contributed some 2.6 per cent of the increase in the current value of marine fish production between 1964-66 and 1982-84. Comparing to the species-mix change with that of the volume change, the percentage increase is only 0.9 per cent of the current value during the above-mentioned period. The remaining 96.5 per cent of the increase in current value is due to the rise in unit prices of all the species of fish as given in table 3.22.

Table 3.22 Sources of growth of value of marine fish output in Kerala during (1964-66) to (1982-84)

(Rs.in lakhs)

Growth of value due to			
Volume changes	Species-mix changes	Price changes	Total increase
100.7	292.74	10880.59	11274.03
(0.9)	(2.6)	(96.5)	

Note: Figures in the parenthesis indicate percentage to total.

The total increase in values of output between the base period (1964-66) and the current period (1982-84)	$V^c - V^b$ = Rs.11,274.03 lakhs
Increase in value due to changes in species composition between the base period and current period	$V^{cb} - V^b$ = Rs.292.74 lakhs
Increase in value due to changes in total output between the base period and current period	$(Q^c - Q^b) uv^b$ = Rs.100.7 lakhs

Increase due to price changes alone:

$$= (V^c - V^b) - (V^{cb} - V^b) + (Q^c - Q^b).uv^b$$

$$= 10,880.59$$

where

V^c and V^b are values in the current and base period.

Q^c and Q^b are quantity in the base and current period.

uv^b is average unit value of quantity in the base period

V^{cb} is value of quantity of current period in the base period prices.

3.12.7 The trend in total output, prices and the value of output is given in table 3.23. The average share prices of fish increased from Rs.129 per tonne in 1960 to Rs.3,293 per tonne in 1984. The increase in the retail prices are much higher than this depending upon the size of fish and the location of the market. The index of price of fish has reached to 2553 in 1984 with base 1960 and this shows a 25-fold rise in the price index. Comparing to the production trend, the increase in value is much faster and this is because of the high unit value realisation. The very high rise in the average unit value is due to three factors (Kurien, 1978a):

i) a shift in the composition of fish catch in favour of the relatively high valued species;

ii) a significant shift in the relative prices of different species of fish; and

iii) increasing trend in general price levels.

3.12.8 The sectorwise analysis of output and value is very useful for the fishery planning and management of marine fisheries in Kerala. The total specie-wise quantity and value of output

Table 3.23 **Volume and value of marine fish production in Kerala (1960-84)**

(Quantity: '000 tonnes, value: Rs.million; Price: Rs. per tonne)

Year	Quantity	Index of quantity	Value	Price	Index of price
1960	344	100	44.3	129	100
1961	268	78	35.0	131	102
1962	192	56	28.9	151	117
1963	203	59	41.5	205	158
1964	318	92	67.6	213	165
1965	339	98	68.5	202	157
1966	347	101	94.7	273	211
1967	364	106	105.7	290	225
1968	345	100	100.8	292	226
1969	295	86	161.8	549	426
1970	393	111	252.1	642	498
1971	445	129	292.9	658	510
1972	295	86	224.8	762	590
1973	448	130	491.3	1097	850
1974	420	122	529.5	1260	977
1975	421	122	739.7	1757	1362
1976	330	96	560.2	1697	1315
1977	345	100	658.5	1908	1497
1978	373	108	783.1	2098	1626
1979	331	96	648.5	1962	1520
1980	279	81	831.1	2978	2309
1981	275	80	822.2	2990	2318
1982	325	95	1004.5	3091	2396
1983	385	112	1212.7	3150	2442
1984	424	123	1395.8	3293	2553

Source: 1. Catch: Compiled from Central Marine Fisheries Researcl Institute published catch data.

2. Prices:Government of Kerala, State Planning Board (SPl Economic Review , 1960-1985.

is given in table 3.24. Between 1977-79 and 1982-84 the mechanise sector's output rose by 153.30 per cent, while that of the non-mechanised sector declined to 12.76 per cent. The average share of output of oil-sardine in the mechanised sector for the period 1977-84 is 23.48 per cent, for mackeral 3.03 per cent, for prawn 22.51 per cent and for rest of the species 50.96 per cent. The corresponding share of value is 10.14 per cent for oil-sardine, 2.21 per cent for mackeral, 61.19 per cent for prawn and 26.46 per cent for the rest of the species. It is an important aspect that of the value of prawn in the mechanised sector, i.e., with 22.51 per cent share in quantity 61.19 per cent share in value is realised. The highest share percentage of the non-mechanised sector is that of oil-sardine 50.77, followed by rest of the species 39.93. Maximum share of value is also realised for these two species in the non-mechanised sector, i.e., 36.82 per cent and 36.53 per cent. The most important factor in the non-mechanised sector is the importance of oil-sardine both for volume and value. The mechanised sector with a small share of 36.83 per cent earned 54.46 per cent share of value of the fish harvesting area.

3.13. Sectorwise, gearwise total income trends

3.13.1 Since fishery data are not easily available it is difficult to estimate the income trends of different fishing gears. Whatever data available, were highly aggregated and also were subjected to many errors. One method to overcome

Table 3.24 Total and species-wise quantity and value of output in various sectors (1977-1984)
(Q - in tonnes; V - in Rs.million) m: mechanised; nm: non-mechanised.

Year		Oil-sardine		Mackeral		Prawns		Rest of the species		Total	
		Q	V	Q	V	Q	V	Q	V	Q	V
1977	m-sector	1016	0.92	246	0.46	34087	289.81	66129	74.64	101478	364.83
	nm-sector	137094	119.90	19722	31.95	6267	51.70	80506	90.58	243590	294.13
1978	m-sector	2022	1.84	363	0.61	41113	373.56	69505	86.88	113003	462.89
	nm-sector	133829	120.78	25554	43.19	4315	39.52	96638	116.96	260336	320.44
1979	m-sector	3469	4.12	457	0.81	26567	265.71	64283	77.28	94776	347.92
	nm-sector	129279	120.35	18128	30.15	3056	30.44	103270	119.70	253733	300.64
1980	m-sector	12042	11.19	5067	8.66	46170	404.01	72026	122.30	135305	546.15
	nm-sector	69642	64.76	14422	24.37	8223	62.74	52951	133.00	144238	248.87
1981	m-sector	35548	53.47	4052	10.69	16309	269.33	40412	116.19	96321	449.66
	nm-sector	119090	146.96	12148	24.46	6169	82.69	40667	118.43	178074	372.54
1982	m-sector	58907	95.41	3862	10.64	21826	217.66	63645	182.07	148240	505.78
	nm-sector	92162	190.66	6855	19.57	4946	92.91	73164	195.84	177127	498.98
1983	m-sector	57316	100.85	4153	9.34	23961	364.61	78146	191.51	163576	667.31
	nm-sector	97556	208.04	8522	20.02	5896	106.12	109725	211.29	221699	545.47
1984	m-sector	68023	136.63	12542	46.72	18462	255.44	73524	203.91	162551	642.70
	nm-sector	105701	259.51	8352	26.45	12770	204.56	135344	262.60	262167	753.12
Average 1977-84	m-sector	29793 (23.48)	50.55 (10.14)	3843 (3.03)	10.99 (2.21)	28562 (22.51)	305.02 (61.19)	65959 (50.96)	131.85 (26.46)	126906 (36.83)	498.41 (54.46)
	nm-sector	110544 (50.77)	153.87 (36.82)	14213 (6.53)	27.52 (6.54)	6455 (2.97)	83.83 (20.11)	86533 (39.73)	156.05 (36.53)	217620 (63.17)	416.77 (45.54)

Source: (1) Catch: Central Marine Fisheries Research Institute Published Data.
(2) Prices: Government of Kerala, State Planning Board (SPB), Economic Review, 1977 to 1985.

Note : Figures in parentheses are percentage of a specie in the respective sectors output (Volume/value).

this kind of errors is to estimate the income trends of an average fishing vessel. The fishing data are collected for 31 species and other subspecies, by the fishery assistants from all over the 222 fishing villages. But there is no published price data either shorewise or marketwise for most of the species. Because of this the total species are classified into 13 groups.

3.13.2 This kind of gearwise unpublished data are collected from the CMFRI statistical cell for the year 1984 and classified into 13 groups. One more attempt has been made to know the income trends of each of the fishing sectors (gearwise) which is given in table 3.25.

3.13.3 These sectors are classified according to the social, economic and technological importance with reference to the fish economy of Kerala, i.e., mechanised sector, inboard sector, outboard sector and non-mechanised sector. This sectorwise inter-comparison of the gearwise income trends is expected to help future fishery planning in the state.

3.13.4 From the derived fish catch figures, a matrix (W) of weights of fish landed for different types of fishes are derived using different fishing gears,

Table 3.25 Gearwise, sectorwise fish production for the year 1984

Name of fish	Mechanised				Inboard engine			Outboard engine						Non-mechanised						
	TN	PS	PSC	Total	DN/GN	HL	Total	BS	GN	DN	HL	Others	Total	BS	GN	DN	HL	SS	Others	Total
1) Elasmobranches	718	6	--	724	3499	11	3510	12	258	276	1744	1	2291	102	252	315	364	3	25	1061
2) Cat fishes	3641	318	--	3959	3529	7	3536	889	312	217	2654	23	4095	56	148	78	659	46	--	987
3) Sardine	214	14468	1724	16406	103	--	103	79975	4821	--	--	--	84802	55437	6950	17	1	460	32	62897
4) Perches	21567	1	--	21568	59	277	336	2472	1	16	214	36	2739	583	65	234	1051	176	30	2139
5) Pomfrets	103	89	--	192	786	--	786	81	112	222	--	5	420	101	36	44	4	18	1	204
6) Mackeral	21	2448	--	2469	734	--	734	676	1666	148	403	7	2900	1184	3687	3285	310	1643	1000	6609
7) Seer fish	6	1	--	7	3300	--	3300	56	268	1267	139	--	1730	2	520	481	119	11	5	1138
8) Tunnies	--	--	--	--	1953	5	1958	--	225	728	270	--	1223	3	332	1262	1455	239	--	3291
9) Soles	10446	--	2	10448	12	--	12	9	1	1	--	225	236	6385	346	3	--	39	276	7049
10) Prawns	24971	1	--	24972	--	--	--	8845	32	9	--	38	8924	1329	227	117	--	521	116	2310
11) Other crust-aceans	7185	--	4	7189	--	--	--	2	2	--	3	158	165	16	65	25	43	27	83	259
12) Cephalapods	3307	--	--	3307	20	--	20	--	--	--	23	9	32	312	133	--	1162	443	1	1051
13) Miscella-neous	22273	1520	5	23798	2009	--	2009	27851	2257	559	2653	345	33665	22290	14348	1731	4387	8842	376	51974
TOTAL	94451	18852	1735	115038	16004	300	16304	120868	9955	3443	8103	847	143216	87800	27109	7592	8013	12468	1945	144927
No.of operations	3229	6954	62		87658	1131		311763	105872	48627	86912	4655		335562	780245	240868	484040	106111	25731	

TN- Trawl net, PS- Purse-seine, PSC- Purse-seine Carrier, DN- Drift net, GN- Gill net, HL- Hook and line, BS- Boat seine.

Source: Compiled from Central Marine Fisheries Research Institute Unpublished Data (1984).

$$W = \begin{bmatrix} W_{11} & W_{12} & \cdots\cdots & W_{1n} \\ W_{21} & W_{22} & \cdots\cdots & W_{2n} \\ \cdot\cdot & \cdot\cdot & \cdots\cdots & \cdot\cdot \\ \cdot\cdot & \cdot\cdot & \cdots\cdots & \cdot\cdot \\ W_{m1} & W_{m2} & & W_{mn} \end{bmatrix}$$

where W_{ij} are the weights of the j^{th} fish caught for the i^{th} fishing gear.

3.13.5 To analyse the value of the fish caught, the appropriate prices for the various fishes are needed. Shore prices of most of the species are available from the Economic Review, Government of Kerala. Using this information and estimating the prices of two species (perches and other crustaceans) not provided by the Review), a vector of fish prices for the year 1984 (P) is constructed:

$$P = (P_1, P_2, \ldots, P_n)^1$$

where P_k is the price of the k^{th} type of fish.

3.13.6 The values of the fishes caught are then calculated by using the following formula:

$$V = WxP'$$

where V_k is the value of the fishes caught using the k^{th} gear

3.13.7 The gross value of the fish caught for the year 1984 is 13,958.77 lakh rupees. Out of this ₨.6,427.02 lakhs were contributed by the mechanised fishing sector, i.e., consisting of trawlnet, purse-seine and purse-seine carrier. The gear-wise contribution of value of this sector respectively are ₨.5,922.04 lakhs for the trawlnet, ₨.462.02 lakhs for the purse-seine and ₨.42.96 lakhs for the purse-seine carrier.

	TN	PS	PSC	
Mechanised sector =	5,92,204.21	46,202.15	4,295.83	= 6,42,7

3.13.8 The second major contributor of value in the fish economy is the recently originated outboard sector, i.e., ₨.3,888 lakhs. Of this, the boat seine contributed ₨.3,323.51 lakhs, gill nets ₨.224.23 lakhs, drift nets ₨.146.45 lakhs, hook and line ₨.163.87 lakhs and other gears ₨.30.91 lakhs. It is given in the form of a row vector of income trends.

	BS	GN	DN	HL	Others	
Out board =	332351.40	22422.53	14644.51	16387.46	3091.49	= 38889

3.13.9 The next maximum contribution of ₨.310.93 lakhs comes from the non-mechanised sector. The gearwise contribution of thi non-mechanised sector is shown as follows:

	BS	GN	DN	HL	SS	Other
Non-mechanised sector =	175348.02	56239.70	23761.01	25384.25	30202.44	6345.

3.13.10 The contribution of boat seine to this sector is Rs.1,753.48 lakhs, gill net Rs.562.39 lakhs, drift net Rs.237.61 lakhs, hook and line Rs.253.84 lakhs, shore seine Rs.302.02 lakhs and other types of gears Rs.63.45 lakhs.

3.13.11 The inboard engine is the lowest gearwise contributor of value. It contributed only Rs.533.19 lakhs. The inboard engine consists of two types of main gears, drift net/gill net and hook and lines. The contribution of drift net/gill net is Rs.520.79 and hook and line Rs.12.39 lakhs as given below:

$$\text{Inboard engines} = \begin{bmatrix} \text{DN/GN} & \text{HL} \\ 52{,}079.75 & 1{,}239.96 \end{bmatrix} = 53{,}319.71$$

3.13.12 We have seen that the total value of fish caught for the year 1984 for the various gear types are Rs.13,958.77 lakhs This gross value of fish caught are subjected to certain errors. First, when we formulated the matrix V and P, we have eliminated a few types of fishes as it is very difficult to find out the prices and quantity. Secondly, the published shore prices are available only for major species and others are lumped into a single category as miscellaneous item with a common price, but actually the prices are not the same. Thirdly, the prices are not uniform in all the 222 fishing villages. Fourthly, the data sources are not completely accurate as there are many left-out quantities owing to the unorganised nature of the sector and

Chapter IV

MECHANISATION--PROBLEMS AND PROSPECTS

4.1.1 Fishery development in Kerala in the last 30 years has resulted in lopsided growth, resource depletion and manifold problems to the fishing industry. In spite of the over-emphasis given for mechanised fishing, the main demersal specie of prawn showed a declining trend (SIFFS, 1984). This is attributed mainly because of the indiscriminate trawling operations of the mechanised boats. This precipitated many a problem in the artisanal fishing sector affecting not only its catch, but also its earnings. This also marked the beginning of spontaneous clashes between traditional fishermen and trawlers. The operation of the traditional cattamaran canoes became uneconomic and the massive economic pressures brought on the traditional fishermen made a desperate bid to remain competitive by fitting their crafts with outboard motors. This helped a lot in reaching the fishing ground earlier and in taking the catch immediately to the landing centre. As a result of the Governmental and other co-operative sectors' help to the poor artisanal fishermen, motorisation is taking place in the traditional sector at a greater tempo.

4.1.2 Another problem facing the fishing industry today is the stagnating production in the inshore fishing sector. Maximum sustainable yield in the inshore areas of the state has already reached the total allowable level. This points to the need for expanding the fishery effort to deeper areas beyond the 50 m depth. Introduction of deep sea vessels is a method suggested for tapping the resources in the deeper and distant areas (Dixitulu, 1985). But this is a highly capital-intensive venture with many social problems. For this, medium size vessels appear to be more feasible which would help to exploit the deep sea and offshore fisheries and also to offer employment to the traditional fishermen.

4.2. Mechanised fishing in Kerala

4.2.1 Mechanisation of small boats on a planned basis to foster fisheries sector was started by the Department of Fisheries with the help of the Indo-Norwegian Project in Neendakara in 1953. This was done on the basis of a tripartite agreement signed by the representatives of the United Nations, Norway and India in October 1952. Since 1953 the Norwegian Government has offered technical and economic assistance in the form of bilateral projects (Klausen, 1968).

4.2.2 The first proposal of mechanisation related motorisation of the traditional crafts. To find out the feasibility of this programme, a 'thanguvallam' and 'kochuvallam' were shipped to Norway towards the end of 1952 (Asari, 1981). Experimental fishing with outboard engines showed that these crafts were not suitable for motorisation. Consequently the State Department of Fisheries in collaboration with the Indo-Norwegian Project developed small mechanised boats called the 'Pablo' boat. The boat was designed by the FAO naval architects. The pablo boats were of two types: one 24' to 25' fitted with 7½ HP - 12½ HP and the other 30' to 32' fitted with 32 HP engines. In 1953 itself the Government of Kerala established a boat building yard at Sakthikulangara under the Indo-Norwegian scheme. Departmental boat-building yards were also started at Vizhinjam, Azhikode, Beypore and Cannanore. The Central Institute of Fisheries Technology, Cochin, provided a number of designs (suited to Kerala conditions) in these yards. These boats were of different sizes which ranged from 25' to 43½'.

4.2.3 In the initial period most of the mechanised boats were gillnetters, i.e., the majority of the 192 small mechanised boats given to the state sector under the Indo-Norwegian Project were gillnetters. These were based on the modern craft technology and indigenous gear. Thus, by and by, the fishermen of Kerala were lured to introduce the concept of modern fishing techniques which extended the casual drift net fishing into an all seasonal activity.

4.2.4 In 1955 with the help of three imported schooners from Norway ranging from 50' to 70' attempted exploratory trawling operations at Cochin. The schooners helped to survey the entire coast of Kerala from the seven mile limit to the edge of the continental shelf and this comes about a distance of approximately 380 km in length and to about 48 km out to sea (Asari, 1981). In 1957 the Indo-Norwegian Project started commercial type of trawlin operations with the help of 4 medium size trawlers of 35'--2 from Cochin and 2 from Quilon. These trawling operations brought outstanding results and created an unprecedented demand for trawling boats. The 'pablo' boats of 30-32' introduced by the Department of Fisheries also started experiment with trawl fishing.

4.2.5 An important factor which led to the phenomenal increase in the number of trawlers was the higher price and demand for prawns in the foreign markets. Consequently, most of the mechanised boats issued to fishermen and the mechanised boats introduced by the industrialists as well as the public were shrimp trawlers of the range of 30-32' sizes. This is because of the fact that most of the economic size of the shrimp trawlers were found to be 30-32' size.

4.2.6 In 1961 there were only 172 mechanised boats in the state. This increased to 3,019 in 1979-80. The number of mechanised boats in the state in various years are given in table 4.1.

4.2.7 From table 4.1 it can be seen that after 1980 there is a fall in the number of mechanised boats. This is probably due to stringent licensing policies of the State Government

Table 4.1 Number of mechanised boats in Kerala from 1961-1984

Year	No. of mechanised boats
1961	172
1963	206
1966	788
1969	1,505
1972	1,944
1975	2,105
1977	2,641
1979	3,000
1980	3,019
1982	2,961
1984	2,984

Source: (1) Government of Kerala, Kerala Fisheries: Facts and Figures , Directorate of Fisheries, Trivandrum, 1982.

(2) Department of Fisheries, Government of Kerala, Survey of Marine Fish Landings, Numbers I-VI-- 1984-85.

consequent on fall in profitability in investment in the mechanised sector. In 1984, out of 2,984 mechanised fishing vessels 2,500 were shrimp trawlers and the remaining gillnetters.

4.2.8 Variation in fish production from 1951-55 to 1979-84 are given in table 4.2.

Table 4.2 Variation in marine fish production since 1951-55

Species	Average annual fish catches ('000 tonnes)							Difference between 1951-55 and 1979-84 (actual)	Per-cent
	1951-55	1956-60	1961-65	1966-68	1969-73	1974-78	1979-84		
Oil-sardine	25	110	145	228	151	112	127	+102	+408
Mackeral	22	31	22	6	47	18	22	0	0
Prawns	6	15	24	27	45	51	33	+27	+450
Others	78	103	73	91	132	197	156	+78	+100
All species	131	259	264	252	375	378	337	+206	+157

Source: Compiled from Central Marine Fisheries Research Institute Published Data.

4.2.9 Table 4.2 shows that production of almost all species have grown up tremendously since 1951-55. This was due to the intensified fishing activities, especially in the mechanised sector. The production of prawn increased manyfold as a result of the small boat mechanisation programme. The average prawn production reached the peak during 1974-78 period (51,000 tonnes) In spite of this prawn production, the period after 1973 has been showing a declining trend. From about 86,000 tonnes in 1973, the production of marine prawns declined to 45,000 tonnes in 1978. It further slumped to 21,826 tonnes in 1982. Another factor noticed in the mechanised fishing sector in recent years is the reduction in catch per unit effort. This has led shrimp trawling almost uneconomic. Increased effort and high concentration of mechanised boats in certain areas also contributed to reduction in size of the prawns caught. As shrimp trawling is facing diminishing returns to scale the government should see that no more trawling boats are to be added to the existing size of the fleet. The estimate of total prawn in the inshore waters of 50 m depth range is only 80,000 tonnes and in the deep seas between 50-200 m depth range is 15,000 tonnes (George *et al.*, 1977).

4.2.10 Oil-sardine and mackeral are the two other species which showed wide fluctuations since 1951-55. These two species occur in abundance in the catches of traditional craft. So any downward trend in the catches of these two species will have adverse effects especially in the traditional sector from which the major segment of the poorest among the population derives its livelihood. Oil-sardine, the production of which reached an average of 2,28,000 tonnes during 1966-68, has declined heavily thereafter and reached the 1961-65 level. In spite of high level technical innovations in traditional as well as in mechanised fishing, the average mackeral production in 1979-84 is exactly the same as that of 1951-55. Out of the estimated 1,80,000 tonnes of oil sardine and 80,000 of mackeral in the south-west coast, the Kerala's share comes to 80 per cent of this resource potential (George, 1977).

4.3 Purse-seining

4.3.1 The heavy concentration of mechanised boats in certain regions and the consequent competition for space and product paved the way for uneconomic operations of trawling for prawns in Kerala. So fishery scientists opted diversified fishing for species other than prawn in the mechanised fishing vessels. First attempt in this direction was mid-water trawling followed by purse-seining. Owing to several reasons mid-water trawling did not gather momentum and consequently purse-seining became predominant. Even though purse-seining was practised by the 36' medium boats of the INP as early as 1955, it gained commercial importance only in 1977 with the introduction of purse-seining in Karnataka coast.

4.3.2 Mackeral and oil-sardine are the two principal species from the purse-seine catches. The incoming shoals are encircled by the purse-seine which resulted in preventing them from moving towards the shore. In purse-seine operation Karnataka forged ahead with 120 purse-seiners in 1977 and by the end of 1980 the number of purse-seiners increased to 325. The number of purse-seiners in Kerala during the period of 1977-80 was only 37 and at present it is about 53. The fall in catches of the south Kanara-based purse-seiners in recent years resulted in the migration of these purse-seiners to the shores of Cannanore and Cochin for fishing.

4.3.3 The advent of purse-seining for pelagic fishes gave an impetus to the production of oil-sardine and mackeral and also it emanated many problems to the traditional fishermen, as they get only few catches. The bulk landings of purse-seine fishes in the initial periods in Cochin resulted in low prices for oil-sardine and mackeral affecting the income of the poor fishermen who otherwise have only a hand-to-mouth existence. Further, the low catches in the traditional sector of the economy resulted in the regulation of purse-seining in Kerala waters with the Marine Fisheries Regulation Act of 1981. With this Act purse-seining is allowed only in Cochin and also beyond 16 km limit. Table 4.3 shows the quantity of fish caught in 1984 through purse-seining from the 53 purse-seiners from Kerala and from the other migrated purse-seiners.

Table 4.3 Monthwise production of purse-seiners in Kerala (1984)

(Quantity in tonnes)

Month	Quantity	Month	Quantity
January	4060	July	--
February	1104	August	--
March	296	September	5489
April	1786	October	1443
May	760	November	1530
June	--	December	2138

Source: (1) Government of Kerala, Kerala Fisheries: Facts and Figures , Directorate of Fisheries, Trivandrum, 1982.
(2) Department of Fisheries, Government of Kerala, Survey of Marine Fish Landings, Nos.I-VI, 1984-85.

The maximum landings from the purse-seiners of Cochin were obtained during September, i.e., 5,489 tonnes. During the major mechanised fishing season of June-July-August these purse-seiners used to go for shrimp trawling to Neendakara and other fishing areas.

4.3.4 The fish landings of the mechanised boats amounted to 28,117 tonnes in the year 1969 and this constituted 9.6 per cent of the total landings. But after 1969 there has been a gradual increase in the percentage landings of the mechanised sector with slight discrepancies in some years. In 1975 the mechanised fish landings reached a peak level of 1,80,111 tonnes with the share of 4.28 per cent of the marine fish landings in the state. In 1976 there was a large decline in the percentage landings of the mechanised sector. It declined from 42.8 per cent in 1975 to 17.7 in 1976. Quantitywise this was the greatest decline in the marine fish landings of the mechanised sector, i.e., from 1,80,111 in 1975 to 58,717 in 1976. The highest percentage landings of the mechanised boats came in the year 1980 with 1,35,305 tonnes (48.44%) of the total marine landings. The next year showed a fall in production to 96,321 tonnes (35.1%). But in 1982 the production increased to 1,48,240 tonnes (45.60%). In 1983 the marine fish landings of the mechanised sector also showed a decline. In 1984 the mechanised boats contributed 1,62,551 tonnes (38.3%) of the aggregate marine fish production. This is given in table 4.4.

4.3.5 Prawn is the most predominant specie in the catches of the mechanised boats. The contribution of prawn in this sector was 28% in 1979 and 30% in 1980. The next four years showed considerable decline in the percentage landings of prawn in the mechanised sector, e.g., it declined to 17% in 1981, 15% in 1982, 16% in 1983 and 17% in 1984. The next major specie was perches. Its share was 19% in 1979, 12% in 1980, 7% in 1981, 6% in 1982, 7% in 1983 and 11% in 1984. There was also considerable amount of bye-catches of soles, sianeids, other crustaceans etc. from the mechanised trawling boats. The

Table 4.4 Marine fish landings in Kerala by mechanised boats (1969-84)

(Quantity in tonnes)

Year	Total landings	Landings by mecha-nised boats	Percentage share of mechanised boats landings in the total landings
1969	294787	28117	9.6
1970	392880	52571	13.4
1971	445347	47291	10.6
1972	295618	38648	13.1
1973	448269	93659	20.6
1974	420287	101412	24.1
1975	420836	180111	42.8
1976	331047	58717	17.7
1977	345037	107424	31.1
1978	373339	117571	31.5
1979	330509	94779	28.7
1980	279543	135305	48.4
1981	274395	96321	35.1
1982	325367	148240	45.6
1983	385275	112885	29.3
1984	424718	162551	38.3

Source: (1) Central Marine Fisheries Research Institute, Mar.Fish.Infor.Serv, T&E Ser., No.52:1983.
(2) Department of Fisheries, Government of Kerala, Survey of Marine Fish Landings, Nos.I-VI, 1984-85.

mechanised boats' contribution of oil-sardine, lesser sardine and mackeral are obtained from the purse-seiners operating from Cochin. About 3,469 tonnes of sardine and 457 tonnes of mackeral were landed by the purse-seiners in 1979. The contribution of purse-seiners in 1980 accounted for 12,042 tonnes of sardine and 5,067 tonnes of mackeral. In 1982 the contribution of sardine increased to 58,907 tonnes and of mackeral reduced to 3,862 tonnes. In 1984 the landings of sardine and mackeral were reduced to a greater extent from purse-seiners, i.e., it amounted to only 15,352 tonnes of sardine and 3,254 tonnes of mackeral.

4.3.6 If we look into the speciewise landing of the mechanised sector and its importance in the point of view of total fish catches in the state, it becomes clear that mechanised boats contributed considerably to the total production of elasmobranches cat fishes, perches, pomfrets, soles, crustaceans and cephalapods. The composition of fish landing and their share in total landings of the mechanised fishing boats from 1979 to 1984 are given in table 4.5.

4.3.7 Data show that the small boat mechanisation programme had helped to increase fish production in the state during 1960s and 1970s. But in 1980s the policies formulated for rationalising the level of exploitation to increase maximum level of stock with a corresponding optimum level of exploitation has not been achieve

Table 4.5 Composition of fish landings by mechanised fishing boats and their share in total landings (1979-84)

Sl. No.	Species	Composition of fish landings (in tonnes)					Share of mechanised boats landings in total landings (%)				
		1979	1980	1981	1982	1984	1979	1980	1981	1982	1984
1.	Elasmobranches	3773	4543	2452	3851	1420	54.3	59.4	50.3	61.3	40.3
2.	Cat fish	4823	11362	5122	5172	3107	42.6	81.5	53.6	54.5	39.6
3.	Chirocentrus	25	74	136	207	3723	2.2	7.4	14.0	19.5	18.6
4.	Oil-sardine	3469	12042	35548	58907	68023	3.0	17.3	24.2	41.1	40.2
5.	Lesser sardine	10	266	393	183	22551	0.1	2.4	5.2	2.5	6.2
6.	Anchoviella	573	609	732	1760	29589	8.7	7.8	17.1	13.0	12.4
7.	Perches	18338	16364	6651	9396	2071	90.6	91.9	77.8	84.9	69.5
8.	Scianeids	3901	4991	2478	2359	2383	74.5	81.0	78.8	65.9	62.6
9.	Ribbon fish	919	279	121	321	697	3.6	2.2	1.7	2.9	2.6
10.	Caranx	500	659	129	797	1289	4.1	15.0	7.4	26.6	25.1
11.	Chorenemus	105	88	25	206	29	82.0	60.7	7.9	38.6	7.1
12.	Leiognathus	1013	1460	873	7007	1745	28.2	35.2	30.9	80.3	40.3
13.	Lactarius	26	140	185	234	582	10.3	16.3	21.0	14.5	16.6
14.	Pomfrets	533	496	405	1347	678	30.7	54.7	29.5	31.8	26.2
15.	Mackeral	457	5067	4052	3862	12542	2.5	27.4	25.0	36.1	40.3
16.	Seer fish	1528	1331	852	2648	1925	24.4	35.4	25.6	47.1	35.6
17.	Tunnies	2988	2376	1646	2532	3365	19.4	22.4	29.9	34.8	26.5
18.	Soles	3932	4121	4188	5554	3351	87.6	93.8	83.2	47.9	53.5
19.	Prawns	26567	46170	16309	21826	18462	89.8	84.9	72.7	81.5	74.3
20.	Other Crustaceans	7384	7252	2980	4162	45	96.6	99.5	99.4	93.2	96.5
21.	Cephalopods	1537	3018	932	1511	3450	51.6	71.1	79.2	42.9	59.2
22.	Other Species	12378	13097	10112	4301	28573	70.4	69.6	62.1	43.8	40.5
	Total	94776	135305	96321	148240	162551	28.5	48.4	35.1	45.6	38.3

Source: (1) Bureau of Economics and Statistics, Government of Kerala, Statistical Handbook, 1983.
(2) Department of Fisheries, Government of Kerala, Survey of Marine Fish Landings, Nos.I to VI, 1984-85.

in spite of the efforts made during the past many years to develop skill and to improve technology of the fisheries sector in the state (Choudhury, 1986). The resources of the deeper sea beyond 50 m depth zone, estimated to be about 5.7 lakh tonnes, is not yet exploited (Kalwar Commission Report, 1985). So more effort and attention is now to be concentrated on diversified fishing in the inshore and deep sea regions.

4.4. Impact of mechanisation

4.4.1 The marine fish production during the last three decades has shown considerable increase, the export figures having touched Rs.140 crores. This has been possible through the modernisation of the fishing crafts and methods and the consequent exploitation of new fishing grounds. Though mechanisation of fishing crafts has brought about beneficial change in the standard of living of the progressive fisherman, its development has been keeping a slow pace among the poor fishermen (Krishnakumar, 1981). The whole developmental apparatus in the state seems to have favoured the industrial sector of the fishery because of its creditworthiness and economic and political leverage (Choudhury, 1986a).

4.4.2 As in any other industry the production largely for export is not helpful for sustained growth as there are many factors which cannot be controlled by the producers in the state.

The backlash of unlimited mechanisation in Kerala has been the economic over-exploitation of the shrimp resources and the conflict between the mechanised and traditional sectors reflecting a struggle for existence (Babu Paul Commission Re- rt, 1982). The traditional fishermen are of the opinion that indiscriminate and over-excessive trawling of the mechanised boats operating in the coastal waters is one of the reasons for the drastic reduction over years in the fish caught by the traditional fishermen (Kurien, 1984a). The greatest hit to the traditional fishermen is the monsoon trawling of the mechanised boats during June-July-August when most of the commercially important species are said to spawn (Kalwar Commission Report, 1985).

4.4.3 During the last decade, there is an alarming declining or stagnating trend both in the artisanal and mechanised sector. The marine fish production during the period fluctuated between 2.74 and 4.48 lakh tonnes. The absolute catch and the catch per unit effort declined drastically during this period in spite of increased fishing effort in the mechanised sector. The prawn production, which is the mainstay of the mechanised sector, has declined from 51,714 tonnes in 1971-73 to 26,314 tonnes in 1981-8: in obsolute terms and from 32.2 kg to 5.6 kg of catch per unit effort (Choudhury, 1986a).

4.4.4 The impact study of mechanisation based on the distribution of output between workers and owners in different regions showed that the working fisherman had not reaped the full benefits of the increased output in the mechanised sector (Kurien and Mathew, 1982). The majority of the surp us was accrued by private traders. The distribution of income between different groups of workers worsened in the non-mechanised sector because of the growing proletarianisation.

4.4.5 The greatest impact on mechanisation is the impact on mechanisation and conflict (Kurien and Mathew, 1982). The first of this nature is the competition for space followed by competition for product. The competition for space results in huge amount of capital loss to the traditional fishermen because of the definite superiority of the fishing methods of the mechanised sector. Introduction of pelagic and mid-water trawling has led to a series of sea clashes and consequently delimitation of fishing zones, thereby prohibiting mechanised trawlers within 5 km belt off the coast. The introduction of purse-seiners resulted in creating more problems and further delimitation of fishing zones by prohibiting the operation of the purse-seiners within 16 km of the coast would be necessary.

4.4.6 A major problem facing the mechanised fishing industry in recent years is the diesel scarcity and the hike in the price of diesel (Gopalan, 1980). As a result of this, the mechanised fishing industry is in sick bed. In order to bring down the overall cost of boats complete exemption in excise duty and sales tax in diesel should be given to all the mechanised fishing vessels, irrespective of their size and kind of fishery.

4.4.7 Another problem of the mechanised fishing industry in Kerala is the inadequate infrastructural facilities in the important landing centres (Krishnakumar, 1981). Unplanned and haphazard growth in the number of mechanised boats poised serious problems of landing and berthing. This is especially true in highly concentrated mechanised areas like Sakthikulanga Neendakara belt and Cochin, where damages to hull in collision and delaying of the catch due to delayed landings etc. So ther is an urgent necessity to complete the proposed fishing harbour to strengthen and safeguard the industry and also to ensure increasing number of operation for boats.

4.5 Motorisation of traditional crafts

4.5.1 The marine fishing industry in Kerala, depends in spite of large scale mechanisation, largely on the indigenou fishing vessels which contributes more than 50 per cent of the total catch in the state. This trend of high dependence on the indigenous craft will continue to play an important role in the future also on account of their large number (estimated to be around 30,000). Several lakhs of people also depend on these crafts for their livelihood.

4.5.2 The motor of traditional fishing in Kerala has a long and varied history. As a part of the general process of mechanisation, indigenous crafts are being motorised with outboard and inboard engines in different maritime states including Kerala (Sathiadas, 1982). To improve fish production in the state it is necessary to improve the standard of living of the traditional fishermen. The introduction of petrol outboard motor transformed the artisanal sector by reducing the involvement of labour and also can go faster and in distant waters allowing fishermen to pursue large mobile schools of pelagic fish more easily. They can also indulge in more voyages and thereby increase the per capita income.

4.5.3 In 1984, out of the 61.7 per cent catch in the traditional sector, the share of the motorised sector was 26.9 per cent. The difference in the catches of the non-motorised and motorised sector is getting reduced year by year, because of the increased motorisation and increased percentage of catch in this sector. Moreover, the majority of the traditional craft pelagic species like oil-sardine and mackeral are landed by the motorised sector. The fish landings of different categories of crafts and their respective percentage of the four quarters of 1984 are given in table 4.6.

Table 4.6 Quarterwise fish landings and share of non-mechanised motorised and mechanised crafts during 1984

(Quantity in tonnes)

Type of craft	Landings during first quarter	Per-centage	Landings during second quarter	Per-centage	Landings during third quarter	Per-centage	Landings during fourth quarter	Per-centage	Total landings	Per-centage
I. Non-mechanised										
a) Cattamarans	3331	2.7	5295	7.1	10812	9.7	9328	8.1	28766	6.9
b) Dugout canoes	44659	36.1	13313	17.8	15630	14.0	26075	22.8	99677	22.78
c) Plank-built canoes	15355	12.4	4001	5.4	8184	7.3	15315	13.4	42855	9.6
Total	63345	51.2	22609	30.3	34626	31.0	50718	44.3	171298	39.2
II. Motorised										
a) Cattamarans	917	0.7	448	0.6	373	0.3	326	0.3	2064	0.5
b) Dugout canoes	4323	3.5	1227	1.6	2814	2.5	6884	6.0	15248	3.4
c) Plank-built canoes	14807	12.0	22803	30.6	27070	24.2	28877	25.2	93557	23.0
Total	20047	16.2	24478	32.8	30257	27.0	36087	31.5	110869	26.9
III. Mechanised										
a) Gillnetters	9324	7.5	1333	1.8	1570	1.4	2162	1.9	14389	3.1
b) Trawlers	25583	20.7	23673	31.7	39990	35.7	20309	17.8	109555	26.5
c) Purse-seiners	5460	4.4	2546	3.4	5489	4.9	5111	4.5	18606	4.3
Total	40367	32.6	27553	36.9	47049	42.0	27582	24.2	142550	33.9
Grand Total	123759	100.00	74640	100.00	111932	100.00	114387	100.00	424717	100.00

Source: Department of Fisheries, Government of Kerala, Survey of Marine Fish Landings, Nos.I-VI, 1984-85.

4.5.4 From table 4.6 it is clear that the highest percentage contribution of the landings of fish came from the second quarter of 1984 with 32.8 per cent and this was more than 2.5 per cent of the non-motorised sector and even 4.5 per cent less only to that of the mechanised sector. Quantitywise the highest landing was recorded in the fourth quarter with 36,087 tonnes and the lowest in the first quarter with 20,047 tonnes. Among the landings of the three motorised traditional crafts (cattamaran, dugout canoes, plank-built canoes), the plank-built canoes contributed more than 90 per cent of the total landings of the motorised sector.

4.5.5 Traditional craft motorisation has gained momentum only in Alleppey district and most of the state's motorised crafts are operating in that district itself. About 85 per cen of the total landings of this sector in 1984 came from Alleppey district itself. Districtwise, craftwise landings of the traditional sector for the year 1984 is given in table 4.7.

4.5.6 The highest landing of the motorised plank-built were from Alleppey (64,992 tonnes). This was followed by Ernakulam (13,162 tonnes). The maximum landings of the dugout canoe came from Cannanore (7,836 tonnes), which was followed by Kozhikode (5,313 tonnes). Quilon district came first in the contribution of motorised cattamaran (1,052 tonnes), followed by Ernakulam (599 tonnes) and Trivandrum (401 tonnes).

Table 4.7 Districtwise,craftwise fish landings of traditional sector in Kerala during the year 1984

(Quantity in tonnes)

Districts	Motorised plank built	Motorised dugout canoe	Motorised cattamaran	Total
Trivandrum	207	--	401	608
Quilon	10633	74	1052	11759
Alleppey	64992	491	--	65483
Ernakulam	13162	929	599	14690
Trichur	10	39	--	49
Malappuram	1942	566	--	2508
Kozhikode	2552	5313	12	7877
Cannanore	59	7836	--	7895
Total	93557	15248	2064	110869

Source: Department of Fisheries, Government of Kerala, Survey of Marine Fish Landings, Nos.I to VI, 1984-85.

4.5.7 The use of outboard also meant that the catch could be landed faster and in better conditions and boat could respond quickly to weather changes and head for safety of the shore when storms appeared. At the present rate of fishing, non-motorised crafts are becoming uneconomic due to the competition offered by the motorised ones. By and large, those who could afford the new technology increased their wealth and status in society; those who could not, became dependent crew. Village life adopted a new form of social stratification and landed greater quantities of better quality fish. But the factor which is likely to affect the economics of the motorised craft is the disproportionate increase in their number leading to overfishing.

4.5.8 Outboards were not good news. They increased capital cost of entering the fishing and used dependence on fuel, spares and trained mechanics. The present attraction of motorisation from its economic gain is that the increased cost of fishing operation, mainly on account of the cost of fuel, is largely passed on to consumers through increase in the market price of fish. This, however, seems to be only a temporary phenomenon. The price of fossil fuel is likely to go up in the coming years upsetting the economics of the motorised crafts. The cost escalation and every increase in consumer price will definitely increase the elasticity of demand with the result that the off-take in the market may go down necessitating an inevitable fall or stagnation in price which would further reduce the net earnings.

4.5.9 Reduced fuel consumption in the artisanal fishery can be achieved through research into the use of diesel engines, the increased use of sail and by adoption of more passive fishing methods. The ability of diesel engines to reduce fuel consumption upto 75 per cent is well proven in many countries. But attempts at large scale motorisation of canoes have been less than successful. The reason for this is not fully understood, but the changes of technology from petrol engines to diesel engines is certainly a much greater step than is often realised. Not only do new mechanical skills need to be learnt, spare parts supplies established and increased capital for investment found, but also the design and construction of traditional craft need to be reviewed to accommodate diesel engines and inboards need accurate engine installation and shaft alignment.

4.5.10 Emphasis has been placed on closely integrated developments in new propulsion system with traditional boat-building and fishing practices. The inboard and outboard diesel engines have thus been introduced to both the traditional and the strengthened modified versions of these crafts. Diesel outboards have the obvious advantage of representing an easy transition from the existing motors, but fishermen are not familiar with their long-term field performances.

4.5.11 The Central Institute of Fisheries Technology (CIFT) Cochin conducted many field studies for finding suitable type of indigenously available light weight diesel engines and developed an inboard outboard drive (CIFT Special Bulletin, 1979). As a result of this innovation some indigenous manufacturers developed the modified versions of the drive unit called the Z type drive. One of this drive units named stern drive model GT 408 is basically comprised of two level gear boxes (Ayyappan Pillai, 1982). Another outboard model introduced indigenously was outboard diesel drive 750D. In this case there is an advantage that no hole need be made on the body of the vessel as in the case of the Z type drive (Ayyappan Pillai, 1982). Alongwith these, imported Yamaha and Johnson outboard motor have also come to the field in the initial period of motorisation. Trial runs conducted in the fishing villages of Purakkad in Alleppey district and Chellanam in Cochin showed that all these inboard and outboard crafts were found successful.

4.5.12 In order to understand the economic efficiency of various types of outboard engines (indigenous as well as imported) and the non-mechanised traditional crafts in Kerala, data of a comparative study conducted on mechanised and non-mechanised traditional craft of Purakkad of Alleppey district in 1980 is given in table 4.8.

4.5.13 From table 4.8 it is clear that the total hours operated is more in the case of GT 4018 and 750D (81 and 90 hours respectively), but in E8BK it is only 58. Almost double fuel cost is incurred for E8BK operating in fewer hours. As the average operating cost is less in the cases of GT4018 and 750D engines the average net earnings are also higher, i.e., Rs.477.70 and Rs.404.63 compared to that of E8BK which is only Rs.263.35. Average net earning shows clearly that the mechanised traditional craft is more economical than the non-mechanised traditional craft. The high cost of petrol, together with fuel consumption rate of the outboard motor, makes it costlier compared to the indigenous diesel engine drive units which consume less fuel and that too cheaper fuel.

4.5.14 In spite of less cost in operation of the indigenous outboard, low initial cost and less weight for easy handling and manoeuvrability, the imported outboard appeared to be the ideal choice for the mechanisation of the traditional crafts in Kerala. Even though the overall cost of the diesel engine drive will be economical in the long run, their high initial cost, compared to the imported outboard motor, stands in the way of their acceptability.

Table 4.8 Comparative studies on mechanised and non-mechanised vessels

Period of operation	:	October 1980
Place of operation	:	Purakkad of Alleppey District
Type and size of boat	:	Thanguvallam of 10.37 m
Application	:	Fishing with Koruvala (single boat seine)
Type of fish	:	Sardine and Mackeral

	Mechanised			Non-mechanised		
	With GT 4018	With out-board diesel drive 750D	Yamaha OBM E8 BK			
Total days operated	15	15	14	11	11	11
Total hours operated	81	90.75	58	65.75	69.25	72
Total catch (kg)	4300	3680	2570	1210	1285	1385
Total price (Rs.)	7375	6290	4200	2100	2300	2485
Total fuel consumed	Diesel	Diesel	Petrol+ Kerosene			
	71.25	75	106	--	--	--
Total cost of fuel*	209.5	220.50	513.13	--	--	--
Average operating cost Rs/day	13.97	14.70	36.35	--	--	--
Average earning Rs/day	491.67	419.33	300.00	190.90	209.09	225.91
Average net earning Rs/day	477.70	404.63	263.35	190.90	209.09	225.91

* Diesel: Rs.2.94; Petrol Rs.5.75; Kerosene Rs.4.00 (as on 1982)

Source: Ayyappan Pillai, S. "Mechanisation of Traditional Fishing Vessels in the South West Coast of India", Symp.Harvest and Post Harvest Technology of Fish, CIFT, Cochin (1982).

4.6 Off-shore and deep-sea fishing

4.6.1 In spite of rapid increase in the motorisation of fishing crafts and their progressive mechanisation, the marine fish landing has been stagnant during the past decade. Increasing knowledge about the availability of unexploited and under-exploited fish resources in our continental shelf and an increasing demand for fish--both for export and for domestic consumption--appear to have contributed for stimulating the interest for deep-sea fishing. The introduction of deep sea vessels is a measure suggested for exploiting the resources in the deeper areas.

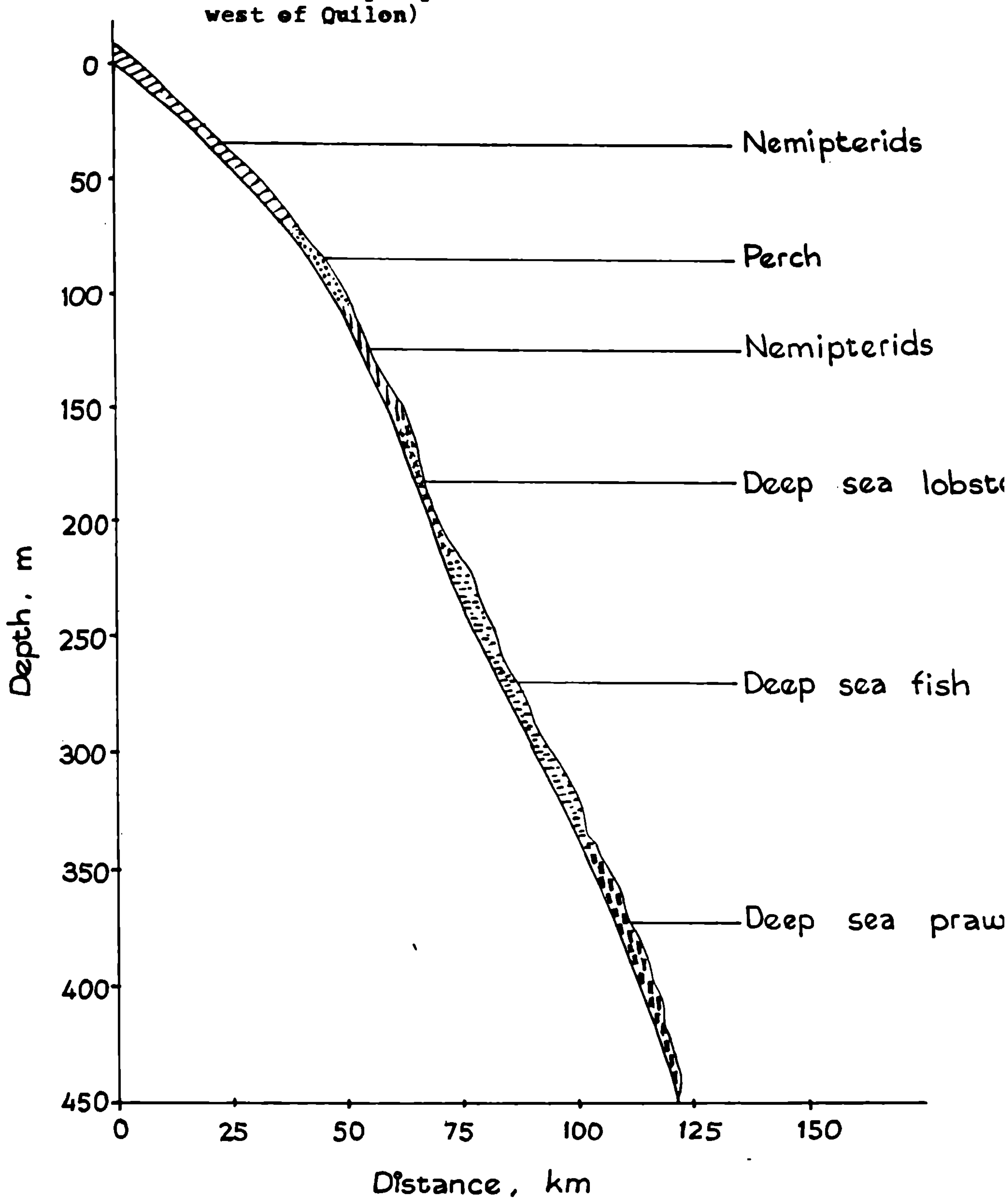
4.6.2 A large portion of the resources beyond the 50 m depth area have been remained unexploited due to lack of suitable mechanised fishing vessels. Under-exploited and unexploited stocks of fish are known to exist in the continental shelf (Anon, 1981). The present level of exploitation of the 50 m depth area is at the tune of 4.34 lakh tonnes and this is almost near to the allowable level in the inshore areas (Kalwar Commission Report, 1985).

4.6.3 The waters outside the 50 m depth contour lines and also within the continental shelf are called off-shore waters. This region falls in three depth zones, 75 to 100 metres, 101 to 180 metres and between 181 to 450 metres. This area is said to have rich resources such as prawns, lobsters, crabs, cat fishes, sea perches and rockcods like kalava, valameen etc.

4.6.4 The salient information available on our trawl fishery potential on the basis of exploratory and experimental fishing surveys conducted in recent years showed the clear location of fishing grounds (Joseph, 1982). The best trawling ground for the ground fish are found within 90 m depth along the west and east coast. The figure 4.1 shows the demersal fishery resources by depth and distance from shore (south-west of Quilon).

4.6.5 The need for expanding the fishing effort in deeper areas is not as simple as it is made out. There are, however, some major constraints for introducing trawler fishing in these areas. As is known, exploitation of the estimated quantity of available fisheries resources beyond the 50 m depth area can only be organised through the progressive introduction of different types of larger vessels for diversified fishing as determined, supported by information on fishing grounds, technology, trained manpower, finance and shore facilities to enable smooth operation of the vessels and infrastructural facilities, proper preservation and processing of the catches and marketing of the produce.

Fig.4.1 Distribution of major demersal fishery resources by depth and distance (south-west of Quilon)



Source: Joseph, K.M. (1982), 'Choice of Size and Type of Deep Se Fishing Trawlers for India', _Symp. Harvest and Post Harvest Technology of Fish_, CIFT, November 24, Cochin, p.4.

4.7 Knowledge of fisheries resources and fishing grounds

4.7.1 Fishery resources survey should be conducted extensively to understand the fishery resources in the deeper waters of the Exclusive Economic Zone. Similar studies like the Fishery Resources of the Indian Economic Zone must be conducted every year for understanding the available potential for exploitation of the larger vessels (George et.al., 1977). The exploratory survey, conducted by the fishery survey of India, prepared a chart on demersal fishery resources of the wadge bank, is a valuable record on fishery resources in the south of Cape Comorin (Indian Express, 1985). This area has a depth varying from 40 to 250 meters covering a total of 12,000 km and extending from 15 to 60 miles from the main land.

4.7.2. The Fishery Survey of India deployed its survey vessel Matsya Nireekshani at wadge bank from October, 1981 to May 1983. Seventeen cruises of an average duration of 20 days were carried out. The chart, released on 25th August 1985, was prepared on the basis of data collected during the cruises. The chart is useful for a commercial entrepreneur to locate the productive grounds and ideal season for fishing.

4.7.3 The Fishery Survey led to the discovery of new deep sea fishery resources along the continental shelf edge and slope. Besides these, potentially rich grounds for known resources were also located. The survey located potentially rich fishing grounds for pomfrets along the south-east coast with a maximum catch rate of 800 kg/hr during March 1984. Heavy concentration of carangids was located along the Kerala-Karnataka coast between the latitude 13°N. Along Kerala-Karnataka coast this variety was available upto 400 m depth with peak occurrence in 100-150 m depth belts. The availability of deep-sea prawns and lobsters in significant quantities along the Kerala coast was alone established by the survey.

4.7.4 Other potential resources recorded during the survey were cat fish, nemipterus etc. Along the south-west coast, the distribution of nemipterus was recorded upto 225 m depth. Cat fishes accounted for about 12 per cent of the catch of the Kerala-Karnataka coast. Squids and cuttle fishes were recorded all along Indian coasts in appreciable quantities. It constituted only 2% of the catch along Kerala-Karnataka coast.

4.8 Technology

4.8.1 As far as Kerala is concerned, the sophisticated and capital-intensive technologies relating to lateral trawling and stern trawling with single net will not offer any help to traditional fishermen whose ranks are eroding day by day. Empirical evidence from all over the country shows that the economic operation of the smaller crafts operated in the artisanal sector is far superior to bigger ones. So we have to introduce mechanised vessels of the intermediate size (15 m OAL). This appears to be more feasible proposition which would help to exploit the deep-sea resources and offer employment to artisanal fishermen (Choudhury, 1986a).

4.8.2 In order to exploit the deep-sea resources fully, there is an urgent need to understand the operational details of the ideal size of the craft required and the gears suited for different seasons and regions etc. The Seventh Plan Working Group on Fisheries has in their report made a recommendation for introducing about 500 such intermediate technology crafts during the Plan period all along the coast.

4.9 Trained manpower

4.9.1 A training programme for building up the skills of the traditional fishermen who can be progressively absorbed in the new area should, therefore, be planned for. The Central Institute of Nautical Engineering & Training, Cochin, is the only institute in India to train personnel for high sea fishing activities. The candidates trained at the institute and its units undergo vigorous sea training in the commercial as well as Governmental fishing vessels for a specific period. It is also necessary to introduce a crash programme for providing training to qualified skippers and second hands in long-lining, pole and line fishing, squid-jigging etc. These trained persons will be available for employment on the vessels for diversified fishing to be introduced.

4.10 Finance

4.10.1 Finance for the acquisition of deep-sea vessels come from Shipping Development Fund Committee (SDFC), which is a statutory organisation under the control of the Ministry of Shipping and Transport. For indigenously constructed vessels the Committee grants loans to the extent of 95 per cent of the cost and for imported vessels 90 per cent. Initially loans were sanctioned at the rate of 4½ per cent interest rate per year. But the interest rate has recently been increased to 6.75 per cent per year for loans for the acquisition of indigenously constructed vessels and 7.5 per cent on loans for imported vessels. In addition to SDFC, finances are also available from the National Bank for Agricultural and Rural Development (NABARD) for the acquisition of larger fishing vessels. The rate of interest to this loan comes to around 11 per cent. Very few commercial banks show interest in financing for the acquisition of larger fishing vessels.

4.10.2 The most important factor influencing the economic position of the fishing industry is the common property character of the fishing grounds. Another factor influencing the ability of the industry to attract investment finance is the dependence on nature which accounts for uncertainty and increase in the risk element. Investment by commercial firms willbbe attracted only by commercial viability of fishery development.

4.10.3 The main factors which influence capital investment in the fishing industry are:

(a) Security in degree of risk

(b) Rate of return on the investment

(c) Possibility of capital acceleration

(d) Continuity of investment

4.10.4 The possibility of total loss and the rapid rate of depreciation of the vessels make fishing a higher risk venture than most other forms of investment. The factors which affect the earnings of the fishing industry are:

(a) assessment of fishing stocks

(b) information on resources

(c) seasonal fluctuation in fish supply

(d) seasonal fisheries to keep earnings up and

(e) utilisation of less popular varieties of fish.

4.11. Infrastructural facilities

4.11.1 The establishment of fishing harbours for providing shore facilities and services in selected centres are essential pre-requisites for the development, organisation and expansion of the fishing industry. The delays for the completion of deep-sea fishing harbours caused certain concern in the industry which retarded investment in mechanised boats and trawlers of medium size. So the potential generated by these investment for increased production, exports and foreign exchange earnings are affected.

4.11.2 Cochin has been developed as a major fishing port. Facilities are also available for landing and berthing at Neendakara, Vizhinjam and Azhikode. Out of these major fishing centres the development of various shore facilities has taken place only at Cochin fishing port.

4.11.3 It is reported that unexploited conventional shrimp stocks do exist in deeper zones upto 55 m fathoms. The offshore waters all along the coast are not covered at all for shrimp fishing. With suitable market tie-ups these stocks can well be utilised. The obsession that shrimp is overfished in offshore waters, calling for discouragement of the introduction of more number of shrimp trawlers seems to have arisen from the mistaken notion that these vessels fish in coastal waters. The bounty in the farther water is much more attractive to the medium and big trawler operation than the coastal shrimp.

4.12. New strategy needed

4.12.1 Taking into consideration the general nature of the industry to prefer acquisition of vessels capable of catching shrimp, it is necessary to formulate a new and effective strategy aimed at attracting entrepreneurs to go in for the appropriate type of vessels. Interest in acquiring trawlers for shrimping arose from the profitable operation of trawlers at present engaged in catching shrimp. The ready market for shrimp is a contributory factor. A change in the policy followed during the Sixth Plan is required during the Seventh Plan for the betterment of the industry. As an alternative strategy to be considered for adoption during the Seventh Plan is combination of fishing, in the first instance, suitable for two types of fishing. Of these, one will be arrangements for shrimp trawling and the other is method of fishing such as long-liners, pole and line vessels, purse-seiners, squid-jigging etc. New methods of fishing introduced in this manner are bound to catch up in course of time, and demand for vessels exclusively meant for the new method of fishing will arise.

4.12.2 This approach will guide and lead to the industry into new methods of fishing. Once these are found to be lucrative, there will be no looking back. The strategy will also facilitate the assessment of commercial feasibility of diversified fishing effort and will also serve as a means to confirm the results of exploratory surveys. Building up of markets for new products will come out of necessity and the need for this will actually be felt when combination of vessels are introduced.

4.12.3 The choice of trawler type suited to a given fishery is more an economic and practical problem than the technical and theoretical problem. So utmost care should be taken to ensure that the trawler is not overcapitalised as the strategy is to get the most advanced boat. The economic viability of the trawler highly depends upon an integrated fisheries plan consisting of fishing harbours, fish handling, storage distribution and marketing facility, manpower maintenance etc.

4.13 Deep-sea fishing activities in the state co-operative sector

4.13.1 The Kerala Fisheries Corporation got four Mexican trawlers in 1982, operating off Visakhapatnam coast. Two of them were 72' length and two were of 76'. These trawlers were used only for shrimp trawling. It was found that total value of Rs.113.52 lakhs were obtained from the catches during the financial year 1982-83. The estimated value of catches during 1983-84 would be Rs.130 lakhs and Rs.140 lakhs for the year 1984-85. Most of the catches obtained were sold to local exporters. The target of catch and value for the Seventh Plan period has been set up as follows:

1985-86	165 tonnes	Valued at	Rs.155 lakhs
1986-87	170 ,,	,,	170 ,,
1987-88	175 ,,	,,	185 ,,
1988-89	180 ,,	,,	200 ,,
1989-90	180 ,,	,,	200 ,,

4.13.2 The Kerala Fisheries Corporation in 1982 also obtained four vessels from M/s.Tropitauna Pvt.Ltd., Singapore to charter for fishing. The catches and turnover estimated were as follows:

1983-84	6,000 tonnes	Valued at	Rs. 80 lakhs
1984-85	13,600 ,,	,,	680 ,,

During the Seventh Plan period the turnover estimated are as under:

1985-86	16,400 tonnes	Valued at	Rs. 850 lakhs
1986-87	20,800 ,,	,,	1,125 ,,
1987-88	25,900 ,,	,,	1,450 ,,
1988-89	27,700 ,,	,,	1,610 ,,

4.13.3 As the Kerala Fisheries Corporation was amalgamated to Matsyafed in 1985, the present deep-sea fishing activities have been undertaken by Matsyafed with four fishing vessels operating in Visakhapatnam. Four more trawlers are expected to obtain soon. With this, it is anticipated that deep-sea fishing can be increased and more benefits can be obtained from this sector. Matsyafed is also organising programmes to join with some foreign countries especially Japan and Singapore for joint ventures to capture tuna at a larger scale. This would help to reduce the exploitation and competition in the inshore waters.

Chapter V

ECONOMIC IMPORTANCE OF FISH PROCESSING INDUSTRY IN KERALA

5.1.1 It was in the early 1950s that the fish processing industry in the modern sense came into being in Kerala. The acceptance of the first consignment of less than half a tonne of frozen shrimps exported from Cochin to the United States of America (1953) by an enterprising entrepreneur from Neendakara, Quilon ushered the emergence of the fish processing industry. Cochin, because of its ideal setting, attracted a large number of entrepreneurs from different parts of the state. The concentration of the units in and around Cochin enabled the introduction of modern techniques of processing the highly perishable fish and other marine products.

5.1.2 The emergence and growth of the fish processing industry has enabled to

i) preserve fish from spoilage

ii) even out price fluctuations

iii) assure supply at all seasons

iv) provide diversity to products for meeting the changing needs, and

v) meet the needs of the export market

5.1.3 The utilisation pattern of Kerala's marine fish catch between 1974 and 1983 (table 5.1) indicates the need for further improvement in the processing industry. Owing to bad handling and crude processing methods, about 10 lakh tonnes of fish get spoiled annually (NATPAC, 1982). To minimise the waste, processing methods like fresh fish preservation by radiation with radioactive rays and low doses of gama irradiation may be introduced. So also the introduction of a 'cold chain' for ensuring equitable and smooth distribution of fresh fish to the internal consumers is an urgent need. Improvements in processing are required to generate better demand for those items which have less demand at present.

5.1.4 The advantages and disadvantages of various methods of processing are discussed below:

5.2 Smoking, drying and salting

5.2.1 Smoking, drying and salting were the oldest and the cheapest methods of preserving fish. These methods were practised widely for preserving fish prior to the introduction of modern methods of freezing and canning. These methods are usually adopted by the fishermen or their family close to the fish landing shore. Capital cost of these methods is very low and ideally suited to the highly disposed and small-scale nature of traditional fisheries. But the drastic decline in the import

Table 5.1 Utilisation pattern of marine fish (1974-83)

(Quantity in tonnes)

Year	Fresh fish consumption	Dry Edible	Dry fish meal	Export		Total landings
				Fresh	Dry	
1974	220543 (52.48)	113323 (26.97)	18409 (4.38)	67210 (15.99)	772 (0.18)	420257
1975	209435 (49.77)	104082 (24.73)	21866 (5.20)	85094 (20.22)	359 (0.09)	420836
1976	209138 (63.17)	62158 (18.78)	16933 (5.11)	42439 (12.83)	379 (0.11)	331047
1977	202086 (58.57)	72740 (21.08)	17892 (5.19)	51924 (15.05)	395 (.011)	345037
1978	208938 (55.96)	92472 (24.77)	13460 (3.61)	58210 (15.59)	259 (0.07)	373339
1979	176359 (53.36)	78297 (23.69)	18079 (5.47)	57575 (17.42)	199 (0.06)	330509
1980	157076 (56.19)	60185 (21.53)	10287 (3.68)	51324 (18.36)	335 (0.12)	279543
1981	157197 (57.20)	56750 (20.65)	12009 (4.37)	48616 (17.69)	247 (0.09)	274820
1982	179936 (55.23)	76920 (23.61)	17788 (5.46)	50433 (15.48)	359 (0.11)	325795
1983	210399 (54.61)	94084 (24.42)	20535 (5.33)	59717 (15.50)	539 (0.14)	385275
Average	193100 (55.38)	81101 (23.26)	16726 (4.85)	57254 (16.42)	384 (0.09)	348646

Source: Compiled from Central Marine Fisheries Research Institute Published Data.

Note : Figures in parentheses are percentages to total.

of the cured products by the far Eastern Countries has practic reduced the importance of these methods of preservation of fisl

5.2.2 Research work carried out in the state in recent years has evolved methods which can turn out high quality, ext hygienic cured fishery products which can satisfy the quality requirements of even the most developed countries. These methods of preservation entail treatment of the cured and drie products with low doses of gamma irradiation. This destroys spoilage micro-organisms that stick to the cured fish during various stages of processing. A recent development in this field is the accelerated freeze drying. This works well with lean fishes and shell fishes, especially in balanced condition. If we modernise our curing techniques on these lines, we can exploit advantageously many a foreign market for cured fishery products, besides catering to the needs of the interior markets Hence modernisation of fish curing industry is an urgent need for the proper utilisation of our potential marine fishery resources.

5.3 Utilisation by freezing

5.3.1 Freezing as a modern method of preservation of fish was introduced in the state only in the 1950s. This method is applied to preserve export commodities such as prawn, squid, cuttle fish and some other costly varieties of fishes. Exports of frozen fishery products have become the mainstay of the Kerala sea food industry. Out of the total 32,514 tonnes of sea food worth Rs.140.26 crores exported in the year 1983, 93 per cent by quantity and 96.5 per cent by value were constituted by the frozen products. About 26,583 tonnes of frozen shrimp valued at Rs.134.01 crores were exported from Kerala during the year 1984-85. This works out to 87.93 per cent by quantity and 96.42 per cent by value of the total sea food exports and shows the unique position that this single commodity occupies among our marine products. In recent years we are also exporting some quantities of frozen frog legs, frozen fish, frozen squid and cuttle fish etc.

5.3.2 Accelerated freeze drying is the most common form of fish processing in Kerala. This is an ideal method of drying fish by removing its water content reversibly. The latest technological development in the fish processing and preservation industry is the application of contact plate freezers using freon refrigerant and this has become the most popular method in Kerala. Strict quality instructions are imposed by the importing countries, alleging high bacterial loads, including some of the harmful type called 'salmonella' in some of the consignments imported by them from our state. This explains the need for the introduction of sophisticated type of technologies developed in advanced countries such as brine-spray freezing, fluidised bed freezing and cryogenic freezing in our fish processing field. But these are all costlier methods difficult to introduce at the present situation.

5.3.3 Freezing is efficient only when the capacity is kept fairly well. So the capacity is formed with the availability of raw materials. It may not be adequate to handle gluts, and it will be inefficient in scarcity conditions. The unplanned and mistaken calculations regarding the projected future use of these plants and their capacities resulted in gross excess capacity in many plants (Status Report, 1981). The growth and development of the freezing plants during the various years in Kerala is given in table 5.2.

5.3.4 It is clear from table 5.2 that after 1977 most of the freezing plants are not utilising the full capacity because of the non-availability of raw materials for freezing. As a result of this about 45 units are considered as sick units and not functioning properly in the state.

5.3.5 Freezing plants require many supporting plants producing ice and cold store. They are essential for improving the fish marketing system and also for catering to the need of

Table 5.2 Growth of freezing plants in Kerala (1965-81)

Year	No. of freezing plants	Capacity in tonnes/ day	Changes in Number	Changes in Capacity
1965	26	230.50	--	--
1967	33	256.50	7	+11.3
1969	52	437.35	19	+70.5
1971	59	558.35	7	+27.7
1973	70	604.35	11	+8.2
1975	85	661.85	15	+9.5
1977	87	676.85	2	+2.3
1981	122	563.15	35	-113.7

Source: Government of Kerala, Kerala Fisheries: Facts and Figures , Directorate of Fisheries, Trivandrum, 1982.

the export market (Srivastava and Dharma Reddy, 1983). The districtwise distribution of ice-plants, cold storage and their capacity are given in table 5.3.

5.3.6 Because of the high cost of freezing, it is economical to utilise freezing technology for high value species like shrimp, lobster etc. As a result of this the Kerala fish freezing industry is almost export-oriented and contributes only very little benefit to the fish eating people of the state. High cost of freezing process enables that frozen fish is an unsuitable product to distribute to small scattered inland retail outlets where demand is small and consumers are of low income.

5.4 Utilisation by canning

5.4.1 Canning industry was established in the early sixtie This reached its climax in the mid-seventies. The record export of 2,408 tonnes of canned shrimp worth Rs.3.75 crores occurred in 1973. Thereafter the export of canned shrimp suffered severe setback and reached low export level of 28 tonnes valued at Rs.20.58 lakhs in 1984-85. The districtwise distribution of canning plants in Kerala is given in table 5.4.

5.4.2 Canning is a capital-intensive operation and the economics of production requires careful analysis. The economic viability of canning industry depends on many factors (Lawson, 1

Table 5.3 Districtwise distribution of ice plants, production capacity, ice storage capacity, cold storage and cold storage capacity in Kerala (1981)

District	Ice Plants			Cold Storage	
	No.	Ice production capacity (tonnes)	Ice storage capacity (tonnes)	No.	Capacity (tonnes)
Ernakulam	87	396.75	354.75	70	7067
Alleppey	48	464.00	805.60	20	1099
Quilon	48	509.00	841.00	25	1940
Calicut	30	290.50	583.00	9	461
Cannanore	24	216.75	555.00	7	435
Trichur	23	146.00	341.50	4	106
Kottayam	13	3.25	3.25	2	1.35
Malappuram	21	188.75	290.00	1	25.00
Trivandrum	10	74.00	115.00	1	15.00
Total	304	2289.00	3889.10	139	11149.35

Source: Government of Kerala, Kerala Fisheries: Facts and Figures , Directorate of Fisheries, Trivandrum, 1982.

Table 5.4 Districtwise distribution of canning plants in Kerala

District	No. of units	Capacity in tonnes
Ernakulam	25	81.124
Alleppey	11	54.960
Quilon	1	1.500
Calicut	2	10.000
Trichur	1	5.000
Total	40	152.584

Source: Government of Kerala, Directorate of Fisheries, _Kerala Fisheries: Facts and Figures_, Trivandrum, 1982.

Important among them are:

1) Supply of raw materials at all time at reasonable prices;

2) Supply of cans at reasonable price; the high cost of imported cans frequently make fish canning uneconomic

3) Adequate labour skills and

4) A ready market.

5.4.3 The canning industry in Kerala is in doldrums due to causes like high cost of imported tin containers and filling materials like edible oil and increasing labour cost. The major problem is the dependency on one commodity, viz., prawn which is not available in adequate quantities. Because of the high cost of operation, canning is not frequently used for species with low income demand, e.g., oil-sardine, lactarius, eels etc. As a result of this about 35 out of the 40 plants became sick units.

5.4.4 Substitution of cheaper containers like aluminium cans, synthetic film pouches and cheaper filling medium like edible oil filling with brine, curry, suace etc. are to be introduced with the intention of reaching these products at the hands of the low income demand groups of the population (Status Report, 1981). Technological knowhow is available at present to can oil sardine in its own juice, brine, curry, tomato suace etc, mackeral in curry brine, tuna, seer, pomfret, lactarius, eels, crab meat, clam, mussel and oyster meat etc. This can ensure full utilisation and better exploitation of the potential marine fishes.

5.5 Fish meal production

5.5.1 Economic utilisation of the less popular varieties of marine fishes which are referred to as 'trash fishes' can go a long way in bringing better returns to the fishermen. Cheap miscellaneous fishes and offal from the fish processing industry can be converted into fish meal either by wet rendering (drying as such and pulverising) process. Fish meal is rich in protein and is used largely as an ingredient of prepared feeds for poultry and cattle feeds.

5.5.2 At present an average of about 4.8 per cent of our marine landings is used for reduction of fish meal. The species used largely are the shoaling pelagic fishes like oil-sardine and others caught in large quantities. Now Kerala has three fish meal plants with a capacity to process 62.5 tonnes of raw materials per day in three shifts. But these three fish meal plants are almost lying idle for several reasons. The non-availability of sardine and other cheap fishes at sufficient quantity and at workable rate are the major reasons for the malfunctioning of these plants. The economics of fish meal production depends on the following factors:

5.5.2.1 Cost of raw material: To make production viable the cost of fish at delivery must not exceed Rs.750 per tonne.

5.5.2.2 Transport cost: The distance of the plant from the landing point has impact on the transportation cost. So also is the distribution cost after converting into fish meal.

5.5.2.3 Animal feed-stuffs: The economics of fish meal production depends on the price of alternative components of animal feed-stuffs also, especially soyabean meal.

5.5.3 Fish meal production is predominantly a large scale operation, provided the resources are available in plenty and the catching is carried out by small-scale fishermen. The development of this industry will lead to export-led economic growth as fish meal has great export potential. The industry has also some favourable linkage effects in other industries, especially forward linkages into the manufacture of nets, jute, paper bags, fishing vessel and processing equipments (Clucas, 1981). This will help to generate income and employment in rural areas. The existence of cheap fish meal industry will also help to develop the poultry and cattle industry and thereb the nutritional level of the state.

5.6 Diversified products from marine fishes

5.6.1 Several of the less popular varieties of marine fishes which command poor demand from the fresh fish markets are yet to find better utilisation. The present use for fish meal is due to lack of suitable handling and processing methods to suit human consumer needs. Technology is now available for this by utilising them as raw materials for many diversified products.

Fish kheema

5.6.1.1 Fish kheema is prepared with the help of a fish bon separator. Meat picked from trash fishes is frozen in small blocks. The product called 'Kheema' finds good acceptability as a base for several products such as fish cutlets, edible fish flour and fish soup powder. If it is kept in proper frozen conditions the kheema was in edible condition upto 10 months to one year without any spoilage. The average protein content of such fish kheema is observed to be about 17 per cent.

Fish Protein Concentrate (FPC)

5.6.1.2 Edible fish protein concentrate is prepared as a colourless and odourless dry powder from picked meat after cooking and extraction with solvents to remove fatty and odouriferous compounds. The shelf life of fish protein concentrate in an air-tight packet of 400 ghague polythene bag was between six and eight months. FPC can be incorporated with meat flour to the extent of 10 per cent for preparing popular dishes like 'chapathi' and 'puri' and baked products like bread and biscuit, increasing their nutritive value without imparting any fishy odour or flavour to the products. A protein concentrate, fit for human consumption, and glucosemine, a pharmaceutical compound, also have been successfully isolated from the same material. FPC is also considered as a panacea for solving malnutrition.

Fish silage

5.6.1.3 Fish silage is produced from waste fish and fish offal to which some bacteria fermenting agent in the form of molasses is added. Fish silage has immense scope in small scale fisheries as it is too cheap to prepare. It is labour intensive. It neither requires high capital outlay nor regular supplies of fish. Its production can be organised if the quantity of raw material or its transport cost is uneconomic for fish meal production.

Other uses of fish

5.6.1.4 Other uses of fish include the manufacture of fish lever oils, fertilisers, leather and pharmaceutical products. The oil-sardines which are landed in huge amounts during certain seasons sometimes exceed the limits of utilisation by ordinary methods. They are then used for the extraction of oil. Several value added industrial products such as factice (artificial rubber), printing ink, lubricating oil, and insecticidal soaps have been developed out of the oil, besides the conventional use for fat liquoring in leather industry and application in wooden boats as a protective. Technical know-how has now been developed for extraction of rays from shark fins, which are actually used in the preparation of shark fin soup fetching better returns from foreign markets. Similarly, fish maws which are the air bladders found in some of our marine fishes used for the clarification of wine, beer etc. also have got export value in recent years.

5.7 Idle capacity utilisation

5.7.1 Though in the beginning the processing industry was centred around Cochin, the availability of export varieties of prawns in other parts of Kerala (especially in Quilon) resulted in the starting of more and more new plants. Today there are 122 fish processing (freezing plants) in the state engaged in freezing of prawns, lobster tails, frog legs, cuttle fish and squid for export with an annual installed capacity of about 1,50,789 tonnes based on 250 working days with three shifts. The flourishing trend set by the marine product export industry over the last two decades attracted many new entrepreneurs into this field of valuable foreign exchange earnings. With the increase in the number of fish processing plants, the total installed capacity has also increased considerably, but the quantity of raw materials (prawn and fish) required for processing had not increased to the installed capacity (Krishna Iyer et.al., 1982b). The seasonal nature of shrimp coupled with gradual depletion of resources in the sea has caused the present underutilisation of the existing capacity and many plants had gone as sick units as given in table 5.5.

5.7.2 To identify the causes for the idle capacity utilisation of the processing plants in Kerala the study conducted by Krishna Iyer et.al., 1982b for the years 1978 to 1981 is of much importance to suggest measures for reducing

Table 5.5 Details of registered processing units and the number of units not functioning/gone sick in Kerala

	No.of units registered	No.of units not functioning/ gone sick	No.of units now functioning
1. Canning plants	40	35	5
2. Freezing plants	122	45	77

Source: Status Paper on the Marine Products Processing Industry in Kerala, Marine Products Export Development Authority 1981, p.84.

the idle capacity in the fish processing industry. The idle capacity of each of the 15 per cent sampled plants was worked out by taking the difference between the installed capacity and the actual production during the year for one, two and three shifts and by taking 200 and 250 working days. By fixing the sampling error at 20 per cent on the total installed capacity 16 plants were sampled for the study. The percentage of idle capacity in Kerala (1978-81) is given in table 5.6.

5.7.3 The estimates show that there is a decreasing trend in the idle capacity over the four years. There is also a very high reduction in the idle capacity for the years 1978 and 1981

Table 5.6 Percentage idle capacity in Kerala (1978-81)

Shifts	Days / Years	200 Days				250 Days		
		1978	1979	1980	1981	1978	1979	1980	1981
One shift		38.8	35.1	22.4	18.4	50.9	48.0	37.9	34.7
Two shift		69.4	67.6	61.2	59.2	74.9	74.0.	69.0	67.4
Three shift		79.6	78.4	74.1	72.8	82.9	82.7	79.3	78.2

Source: Krishna Iyer et.al. (1982b), "Idle capacity utilisation in Kerala" Symp. Harvest and Post Harvest Technology of Fish, CIFT, Cochin.

for both 200 and 250 working days in an year for all the three shift cases. This was mainly due to freezing of large quantities of cuttle fish, squid, pomfrets, seer fish etc. by a few producers. In the three different shift cases, when the working days of the plants increased from 200 to 250 days, there is an increase in the percentage of idle capacity for all the years. There is also a positive relationship between the number of shifts and the idle capacity. As the number of shift increases, the idle capacity also increases. But when we compare the idle capacity figures, the Kerala state's figures are almost close to all India figures; because more than one-third of the total freezing and canning plants are located in Kerala.

5.7.4 The estimation of idle capacity of the different capacity groups--less than 5 tonnes, between 5 and 10 tonnes and greater than 10 tonnes--shows that idle capacity is less in the case of 5 to 10 tonnes capacity groups for 250 working days as shown in table 5.7.

5.7.5 The highest idle capacity is worked out for greater than 10 tonnes capacity groups for all the years. In the cases of units less than 5 tonnes and greater than 10 tonnes the idle capacity is reduced from 1978 to 1981 for the three different shift groups. But in the case of 5-10 tonnes groups the idle capacity is increased considerably from 1978 to 1981.

Table 5.7 Percentage idle capacity utilisation of different size plants in Kerala for 250 working days (1978-81)

Size / Shifts / Years	Below 5 tonnes			Between 5 and 10 tonnes			Greater than 10 tonnes		
	One shift	Two shift	Three shift	One shift	Two shift	Three shift	One shift	Two shift	Three shift
1978	50.9	74.1	81.8	9.5	54.7	69.8	80.4	43.5	--
1979	37.0	68.6	79.1	20.9	60.4	73.6	80.8	93.6	--
1980	35.0	66.5	77.7	35.9	68.0	78.7	45.9	82.0	--
1981	26.4	63.2	75.5	32.5	66.2	77.5	47.7	82.6	--

Source: Krishna Iyer et.al. (1982b), "Idle Capacity Utilisation in Kerala", Symp. "Harvest and Post Harvest Technology of Fish", CIFT, Cochin.

5.7.6 The major causes for the idle capacity of the fish processing plants in Kerala are:

1) Non-availability of raw materials
2) High cost of production
3) Frequent power failures/shortages
4) Labour troubles
5) Unsteady foreign markets
6) Competition for procuring the raw material
7) Lack of proper transport facilities
8) Investment in holding the material upto shipment, and
9) Delay in getting the purchase order.

5.7.7 The non-availability of raw materials (prawn) for processing was the major factor (85 per cent) responsible for the underutilisation of plants. Other factors were found to affect the industry during the peak seasons.

5.7.8 The only way to reduce idle capacity of fish processing plants in Kerala is to increase the supply of raw material (Krishna Iyer et.al., 1982b). But this is possible only if we increase the total fish production in the state. So steps have to be taken to deep-sea fishing and aquaculture facilities, as there is saturation in the near shore capture fisheries. Another way to solve this is to diversify the products with new processing techniques by developing cheapter and durable containers and packing materials for the export to compete successfully in the international market.

Chapter VI

FISH TRANSPORTATION AND MARKETING IN KERALA

6.1.1 Transportation is the movement of goods from one place to another. Goods must be produced and distributed before they can be consumed. The transportation of goods to the places where they are wanted and can be consumed creates value. Transportation enhances the ability of goods to satisfy demand by making goods available not only where they are needed but when they are needed. Any kind of transportation normally involves three mechanical elements, i) the vehicle, ii) motive power, and iii) the way. High speed transportation services are relatively more expensive, but the prices for emergency high speed transportation must be measured in terms of the loss which would be suffered if the goods were unavailable or spoiled.

6.1.2 Marine products which are highly perishable, require an efficient and faster transportation system. The highly perishable nature also demands the shortest possible distribution channel, with the minimum involvement of intermediaries, to reduce the delay associated with repeated channels of ownership. Furthermore, the species which are in demand at one place need not be in demand on another place. Therefore, quick and speedy methods of transportation to take the products from the place of production to the place of demand. The problem of fish handling/transportation can be analysed under three heads, viz., temperature control, rational handling within minimised time, and hygeinic and mechanical careful handling (Royrvik, 1982).

6.1.2.1 Temperature control is of decisive importance to maintain quality since fish is one of the most perishable produces.

6.1.2.2 It is important both with regard to economy and quality of products. So quality is mainly a function of time.

6.1.2.3 Hygeinic standard is important as bacterial growth enhances deterioration process in fish. Mechanical carefulness is also important because fish in unfrozen stage is very soft.

6.2 Methods of transportation

6.2.1 To avoid the spoilage of the highly perishable products quick and efficient facilities for transportation with good roads are very important. The fishermen in Kerala rarely resorted to any efficient method of transportation. They are contented either by taking the products to the local markets as headload or bycycles or disposing their fish catch to the intermediaries.

6.2.2 Headload is the usual type of transportation within a radius of 16 kms from the landing centre. This kind of vending is the traditional occupation of the fisherwomen community. The large number of women involved in fish vending displays a remarkable range of knowledge with regard to fish quality and weight, marketing techniques and price structures (Express Magazine, 1985). Once they have acquired the fish, the headload women sparkles sea sand on it with a view to retarding the decomposition process, and also to cover the fish with thick bark in order to protect it from direct sunlight.

6.2.3 Bicycle is the mode of transportation within a radius of 40 kms. They procure fish from the fishermen operating in their area and market them at different centres.

6.2.4 Bulk landing calls for schemes relating to bulk marketing, which, in turn, call for large scale truck transportation and icing facilities. Generally, while going for fish catch the fishermen are not habituated to carry ice due to various factors, such as ignorance, superstition and cost. To protect the commercially important species like prawn from spoilage and pilferation while transporting, some of the fishermen, especially in the mechanised vessels, use ice during fishing. The use of ice by fishermen according to district is given in table 6.1.

Table 6.1 Districtwise details of containers and quantity of ice used

District	No. of containers			Quantity of ice used (in tonnes)
	Bamboo basket	MPEDA box	Others	
Trivandrum	1262	--	9504	403.90
Quilon	3357	336	2718	8626.45
Alleppey	1213	103	1695	625.35
Ernakulam	3051	277	455	7865.00
Trichur	630	142	605	397.35
Malappuram	695	--	233	222.75
Calicut	1850	--	197	4330.19
Cannanore	316	--	1674	446.31
Total	12374	858	17081	22917.30

Source: Government of Kerala, Kerala Fisheries: Facts and Figures , Directorate of Fisheries, Trivandrum, 1983.

6.2.5 From table 6.1 it is clear that bamboo baskets are the most common form of containers used for transportation. But they were useful only for short distance transportation. With increased use of ice an extension of area covered by fish vendors became possible. A new type of container called the MPEDA box developed for transport of fish namely plywood boxes lined on all sides with expanded polythene enables the preservation of fish in ice for 72 hours. This type of boxes is mostly used for long distance truck transportation. The use of ice will help to preserve the fish fresh while transporting to distant places. According to table 6.1 the use of ice is maximum in Quilon (8,626.45 tonnes), Ernakulam (7,865 tonnes), Kozhikode (4,330.19 tonnes) and Alleppey (625 tonnes) followed in that order.

6.2.6 The main problem, which needs consideration in expanding the activity of marketing, would pertain to quick and efficient transport, involving short and long journeys, for carriage of large quantities of iced and frozen fish. The alternative models of delivery available today represent significant differences in the time taken, with cost varying in direct proportion to the delivery period as shown in figure 6.1.

6.2.7 As the delivery period lengthens, the cost of lost sales increases due both to the unwillingness of customers

Figure 6.1 Relation between freight cost and delivery time

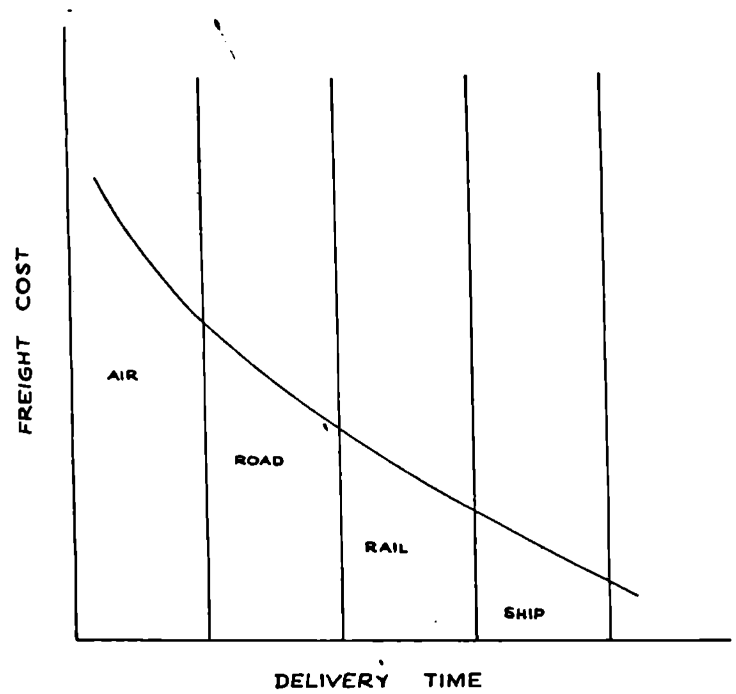
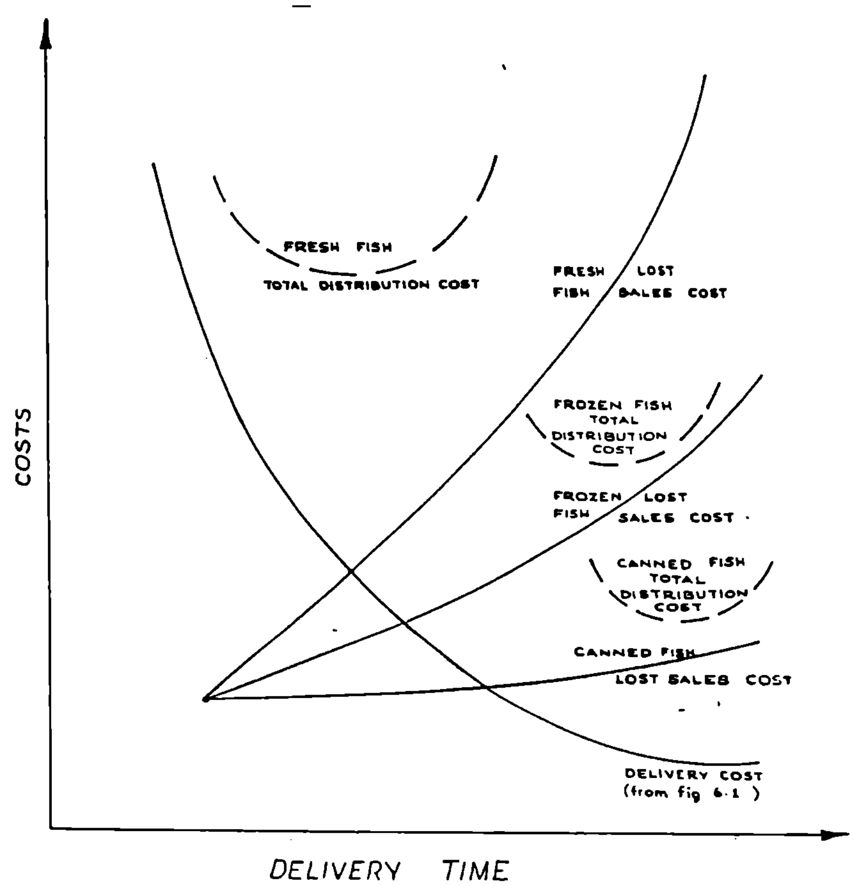


Figure 6.2 Relation between delivery time and cost for different types of fish



Source: Chaston, I (1983), <u>Marketing in Fisheries and Aqua-</u>

to accept delays and to the deterioration of product quality to a level unacceptable to the final consumer. The combined cost of delivery and lost sales can be used to evaluate the minimum total distribution cost and define the optimum delivery system as shown in figure 6.2.

6.2.8 The curves show that the three examples of product forms (fresh, frozen and canned) are major factors influencing the cost of the lost sales. Hence for the short life fresh product, the more rapid forms of road transport are the optimum method of transportation. The canned item has the longest product life and this permits the lower cost systems such as rail or water. However, in achieving efficiency in the transport of iced and frozen fish to be marketed as fresh fish there would be a need of an intermediate stage of introducing progressively well insulated road and rail vans.

6.2.9 Relationship between the distance transported and the use of ice and its spoilage is given in table 6.2.

6.2.10 During 1981-82 303,893.83 tonnes of fish were transported to a distance range of 1 to 500 kms. A maximum quantity of 52,940.55 tonnes was transported over a distance of 0-5 kms. According to table 6.2 about 31 per cent of the total raw material was distributed within 10 kms. The use of

Table 6.2 Distribution of quantity of fish, ice used, and spoilage according to distance transported

Distance km	Quantity of fish (tonnes)	Quantity of ice (tonnes)	Use of ice for a tonne of fish	Spoilage with the use of ice (tonnes)	Percentage spoilage
0-5	52940.55	21473.85	40.56	2796.71	5.28
6-10	43289.69	30693.57	70.90	1669.38	3.86
11-15	10281.30	5444.62	52.96	763.69	7.43
16-20	18088.55	8885.27	49.12	3093.07	17.10
21-25	10629.34	7894.48	74.27	229.12	0.02
26-30	11529.34	10428.92	89.96	324.69	2.80
31-35	20601.48	10838.39	52.61	2252.96	10.94
36-50	18604.70	12726.21	68.40	512.81	2.76
51-75	12095.16	10868.10	89.85	1221.94	10.10
76-100	15707.07	18065.28	115.01	553.68	3.53
101-150	43600.10	40195.29	92.19	2225.84	5.11
151-200	13060.78	13037.03	99.82	888.26	6.80
201-300	2105.24	2002.00	95.10	21.84	1.04
301-500	30207.42	27188.30	90.01	684.57	2.27
Above 500	6090.11	6500.00	106.73	59.49	0.98
Total	308893.83	226241.31	73.24	17298.05	5.60

Source: National Traffic Planning and Automation Centre, Study on Transportation of Marine Products in Kerala, Trivandrum, 1982, p.15.

ice for a tonne of fish was in the range of 0.41 tonnes to 1.07 tonnes for the various distance groups. For this distance group there is also a range of spoilage between 5.28 to 0.98 per cent. The maximum spoilage occurred in the distance range of 16-20 km with 17.10 per cent using 0.49 tonne of ice per tonne of fish transported. The lowest spoilage was noted in the distance range of 21-25 km with 0.02 per cent, using 0.74 tonne of ice per tonne of fish. But the percentage amount of spoilage was less in the case of long distant transported fish, i.e., only 0.98 per cent spoilage occurred for a distance of above 500 kms using 1.07 tonnes of ice per tonne of fish.

6.2.11 Table 6.3 gives an analysis of the transportation time and the quantity of fish transported together with the quantity of ice used and the amount of spoilage.

6.2.12 Table 6.3 shows a clear positive relationship between the use of ice and the transportation time. As transportation time increases, the quantity of ice used per tonne of fish also increases. The quantity of ice used per tonne of fish was least for the transportation time-range of 16-30 minutes, i.e., only 33 kg. The maximum use of ice per tonne of fish was for the time-range of 121-150 minutes. The percentage spoilage of fish was minimum for the time range 0-15 minute

Table 6.3 Distribution of quantity of fish, ice and spoilage as per transportation time

Transportation time (minutes)	Quantity of fish (tonnes)	Quantity of ice (tonnes)	Use of ice per tonne of fish	Spoilage with the use of ice (tonnes)	Percen' age spoila
0-15	5461.09	4386.94	77.77	98.83	1.75
16-30	62349.41	20392.80	32.71	4102.93	6.58
31-45	1073.48	1412.54	131.59	59.28	5.52
46-60	38765.44	29336.36	75.68	1744.80	4.50
61-90	31318.15	15624.56	49.89	2369.42	7.57
91-120	19771.16	14328.50	72.47	402.09	2.03
121-150	3125.10	3443.06	110.17	115.36	3.69
151-180	14031.20	11829.36	84.31	1683.99	12.00
181-240	22054.07	17892.70	81.13	2704.12	12.26
241-300	26069.04	22070.26	84.66	507.50	1.95
301-360	9309.99	9534.63	102.41	807.77	8.68
Above 360	75385.70	75989.60	100.80	2701.96	3.58
Total	308893.83	226241.31	73.24	17298.05	5.60

Source: National Traffic Planning and Automation Centre, Study on Transportation of Marine Products in Kerala , Trivandrun 1982, p.16.

Even though the time used was less for transportation, the quantity of ice used was 78 per tonne of fish. The relationship of less time and more use of ice resulted in the minimum spoilage of all the time range, i.e., only 1.75 per cent. The percentage spoilage was maximum (12.26 per cent) in the time-range of 181-240 minutes, using 0.81 tonne of ice per tonne of fish. If we compare spoilage with the use of ice and the transportation time, we find hardly any relationship between them. But all these depend upon the species of fish transported

6.3 Fish transportation from processing centre to ports of exports

6.3.1 The unbalanced locational distribution of the various facilities such as freezing capacity, cold storage capacity and fish meal making facility are responsible for the need of wide transportation system in the state.

6.3.2 Table 6.4 gives the processing and preservation facilities available in various districts.

6.3.3 The maximum facilities for freezing 68.67 percent i.e., making 33.21 per cent, cold storage 53.26 per cent and peeling 50.62 per cent are available in Ernakulam. Freezing facilities are not available in Malappuram, Trivandrum and Kottayam districts.

Table 6.4 Capacity availability of preservation and processing in different districts

District	Freezing	Ice-making	Cold storage	Canning	Peeling	Fish meal
Ernakulam	555.00	929.00	8805.00	80.82	130.21	--
Quilon	104.85	431.50	1850.00	1.50	93.00	--
Alleppey	69.25	437.75	1647.00	51.40	19.00	--
Calicut	39.00	291.00	396.00	13.00	15.00	0.50
Cannanore	34.00	283.75	1095.00	--	--	50.00
Malappuram	--	187.00	5.00	--	--	--
Trichur	6.00	174.50	48.50	5.00	--	12.00
Trivandrum	--	62.00	15.00	--	--	--
Kottayam	--	1.25	--	--	--	--
Total	808.10	2797.75	13861.50	151.72	257.21	62.50

Source: Government of Kerala, Kerala Fisheries: Facts and Figures , Directorate of Fisheries, Trivandrum, 1982.

6.3.4 All the processors in the state prefer to use road transportation even if the road transportation distance is very long. The quantity of products transported from the different origins to various destinations is given in table 6.5. Table 6.5 gives an idea that the fish harvested in one district is transported even to another district processing plants even though that district itself has many processing plants. Out of the state's total of 10,64,623 tonnes of fish received from various landing centres of Kerala to the various processing plants, a total quantity of 2,264.55 tonnes were reaching to the processing centres of Cochin from Sakthikulangara itself. Because of the high competition for products among the exporters the processing plants located in each district is not fully made use of the resources available in their close vicinity for processing. This has resulted in increasing transportation cost from the harvesting place to the processing place. The various processing units in the state received substantial amount of raw material for processing from the neighbouring states of Karnataka, Tamil Nadu etc. The maximum quantity (1,905.43 tonnes) of raw material is received by the processing plants of Cochin from the states of Karnataka and Kerala.

6.3.5 The processors in Kerala are, as a rule, in favour of road transportation for transporting products for processing and shipping. Almost all the processors and exporters own their own insulated road transport vehicles. They use this type of

Table 6.5 Quantity of raw materials transported from different origins and destinations

Origin	Destination					
	Quilon	Alleppey	Cochin	Calicut	Cannanore	Tot
(1)	(2)	(3)	(4)	(5)	(6)	(7)
KERALA						
Kollengode	3836	2463	9547	2679	--	185
Vizhinjam	7977	5124	19859	5572	--	385
Kovalam	10973	7047	27310	7661	--	529
Valiyathura	1049	673	2611	732	--	50
Shangumugham	1039	667	2586	725	--	50
Anjengo	7534	4838	18752	5260	--	363
Eravipuram	7186	--	--	--	--	71
Sakthikulangara	1236306	584283	2264549	635265	--	47204
Puthenthura	501210	248685	963847	270384	--	19841
Alappad	98778	54830	212508	59613	--	4257
Valiyazheekkal	10522	6759	26194	7347	--	508
Arattupuzha	40153	25785	99943	28035	--	1939
Thottapalli	3989	2562	9932	2786	--	192
Purakkad	10627	15484	26453	7419	--	599
Ambalapuzha	5904	7024	14696	4123	--	317
Neerkunnam	27549	21049	68990	19319	--	1369
Vadakkal	33544	21542	83491	23421	--	1619
Ottamassery	29495	22009	73414	20594	--	1455
Arthumkal	29141	18713	72533	20347	--	1407
Thoppumpady	215633	138477	963178	150558	--	14678
Saudi	138	89	345	97	--	6
Fort Cochin	4054	2603	37369	2830	--	468
Malipuram	38880	24968	96772	27147	--	1877
Pallippuram	2072	1331	10499	1447	--	153
Munambam	8939	5471	143007	6242	--	1639
Azhikode	407	261	1013	283	--	19
Koolimuttam	2682	1687	6540	1835	--	126
Peringanam	885	568	2202	619	--	42
Chappallipuram	6992	4490	17405	4882	--	337
Nattika	1409	905	3508	983	--	68
Ariyankadappuram	15059	9671	37482	10515	--	727
Naduvattom	673	433	1677	130694	--	1334
Vellayil	--	--	--	40122	20507	606
Puthiappu	6246	4011	15546	18251	--	440
Quilandy	--	--	--	5030	15988	210
Melady	17445	11203	43419	12854	--	849
Badagara	4102	2635	10211	5526	--	224
Kurichil	--	--	--	--	725	7
Thayyil	--	--	--	--	2620	26
Kavikadappuram	--	--	--	--	4544	45
Chithari	--	--	--	--	6536	65
Kottikulam	--	--	--	--	10134	101
Total	2392374	1258610	5387388	1541197	61054	106406
KARNATAKA						
Mangalore	--	--	1196015	171653	13541	13812
TAMIL NADU						
Cape Comarin	33512	113623	--	--	--	1471
Tuticorin	135001	106435	--	--	--	2414
Rameswaram	6796	123993	--	6179	--	1369
Mandapam	234352	--	117230	100332	--	4519
Ramanathapuram	87700	16874	93909	--	--	1984
Cuddalore	--	--	62802	89567	--	1523
Madras	146371	109306	535475	137057	--	9282
Total	633732	470231	809416	333135	--	22565
PONDICHERRY	--	--	15515	--	--	155
OTHERS	42713	--	83964	119826	--	2465
Grand Total						145403

transportation because of its safety and flexibility while transporting to long distances. The intermediaries, processors and exporters are using 544 vehicles with a carrying capacity of 3,735.4 tonnes for transporting the products to the processing centres or to the place of shipment as given in table 6.6.

6.3.6 Out of the total 544 transporting vehicles 305 are insulated vans. Besides this, some other forms of road transportation are also used. The processors and exporters are very much aware of the spoilage of the products while transportation. So they use mostly refrigerated and insulated vans.

6.3.7 Even though the National Highway and the railway line from Trivandrum to Kasargode close to the coastal area provides a sound transport infrastructure to the state, many of the traditional fish landing centres lack road network system to connect the main link. This has affected very much the speedy movement of the fish products which results in much spoilage and economic waste.

6.4 Spoilage and economic value

6.4.1 In Kerala the insufficient use of ice for preserving fish at different stages like catch, storage and transit resulted

Table 6.6 Districtwise distribution of vehicles for fish transportation

District	Auto van		Tempo		Open Trucks		Covered Trucks		Insulated Van		Refrigerated Van		Total	
	No.	Capa-city	No.	Capa-city	No.	Capa-city	No.	Capa-city	No.	Capa-city	No.	Capa-city	No.	Capa-city
Trivandrum	2	1.0	--	--	--	--	--	--	1	10	--	--	13	11
Quilon	9	4.5	7	13.50	8	80	3	22.4	41	328.5	2	20	70	468.9
Alleppey	7	3.5	6	11.00	13	128	3	21.5	31	251.3	--	--	60	415.3
Ernakulam	49	24.5	40	76.20	43	428	10	78.0	211	1790	--	--	353	2396.7
Trichur	--	--	--	--	2	20	--	--	--	--	--	--	2	20
Kottayam	--	--	1	2.0	--	--	--	--	1	8	--	--	2	10
Calicut	4	2.0	3	5.50	19	168	--	--	16	129.5	--	--	42	305
Cannanore	--	--	1	2.0	7	70	--	--	4	36.5	--	--	12	108.5
Malappuram	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total	71	35.50	58	110.2	92	894	16	121.9	305	2353.8	2	20	544	3735.4

Source: Government of Kerala, Kerala Fisheries: Facts and Figures, Directorate of Fisheries, Trivandrum, 1982.

in spoilage and waste. Lack of cold storage facilities and inadequate transportation system also contribute to spoilage and economic waste of the marine products. Creation of facilities for use of ice while fishing and the use of the right type of containers and transportation through refrigerated and insulated vans will help a long way in reducing the spoilage of the highly perishable marine products.

6.4.2 Table 6.7 shows the relationship between spoilage during fish catch and landing. Almost all the districts in Kerala take three to four hours to return the products to the shore after fishing. Maximum quantity of ice is used by the fishermen of Quilon (8,626.45 tonnes) out of the total ice use of 22,917.30 tonnes and the spoilage value of the exportable species was the highest in Quilon (Rs.1.22 crores) out of the total of Rs.4.42 crores for all the districts.

6.4.3 But the production of the exportable species was also the highest in Quilon (12,561.31 tonnes) in comparison with other districts. The state total is 44,957.24 tonnes. The total non-exportable varieties production was the highest in Trivandrum (65,421.83 tonnes), the state total being 2,89,711.64 tonnes. But the economic value of the spoilage of the non-exportable variety was only Rs.74.33 lakh rupees. The economic value of the spoilage of the non-exportable

Table 6.7 Districtwise distribution of spoilage between fish catch and fish landings in Kerala

District	Fish landings (in tonnes) Exportable	Fish landings (in tonnes) Non-exportable	Quantity of ice used during fishing operation (in tonnes)	Average time taken to return to the shore (in hours and minutes)	Spoilage (in tonnes) Exportable	Spoilage (in tonnes) Non-exportable	Economic value of spoilage Exportable (Rs.in lakhs)	Economic value of spoilage Non-exportable (Rs.in lakhs)
Trivandrum	1113.46	65421.83	403.90	3-0	22.91	2375.05	7.07	74.33
Quilon	12561.31	50004.30	8626.45	3-45	395.29	2175.31	122.06	68.08
Alleppey	3609.29	49368.56	625.35	4-0	71.72	3075.27	22.14	121.29
Ernakulam	10070.80	26449.34	7865.00	2-45	270.84	1300.28	83.63	40.69
Trichur	5835.02	24869.57	397.35	3-45	206.90	1390.07	63.89	43.50
Malappuram	3840.01	9306.21	222.75	4-15	156.07	489.11	48.19	15.30
Calicut	4338.35	31795.71	4330.19	4-30	143.97	1972.68	44.45	61.74
Cannanore	3589.00	32496.12	446.31	3-50	162.55	1758.48	50.19	55.04
Total	44957.24	289711.64	22917.30	3-43	1430.25	15336.25	441.62	479.97

Source: NATPAC, Study on Transportation of Marine Products in Kerala , Trivandrum, 1982, p.43.

variety was the highest in Alleppey (121.29 lakh rupees) the state total being 479.97 lakh rupees. All these point to the fact that an amount of Rs.9.22 crores is lost due to spoilage between fish catch and landing in the state.

6.4.4 Table 6.8 shows that the economic value of the spoilage during transit is much higher in the case of the non-exportable variety compared with that of the exportable variety For example the total economic value of the spoilage during transit in transporting 2,65,366.84 tonnes of non-exportable variety of an average distance of 66.78 km comes to Rs.7.98 crores. While the spoilage value of the exportable variety in transit for transporting 43,526.99 tonnes of fish to an average distance of 66.78 kms was only Rs.56.03 lakhs. The low economic spoilage of the exportable variety of fish during transit is owing to the use of advanced preservation and transportation techniques (the use of insulated and refrigerated vans).

6.5 Fish marketing

6.5.1 The fish landing sites constitute the primary stage of marketing of marine fish. The producers offer their marketable surplus for sale, not on the basis of weight, but on the basis of heaps, lots or baskets. There is a wide variation in the unit measure depending upon the catch from

Table 6.8 Districtwise distribution of spoilage during transit in Kerala

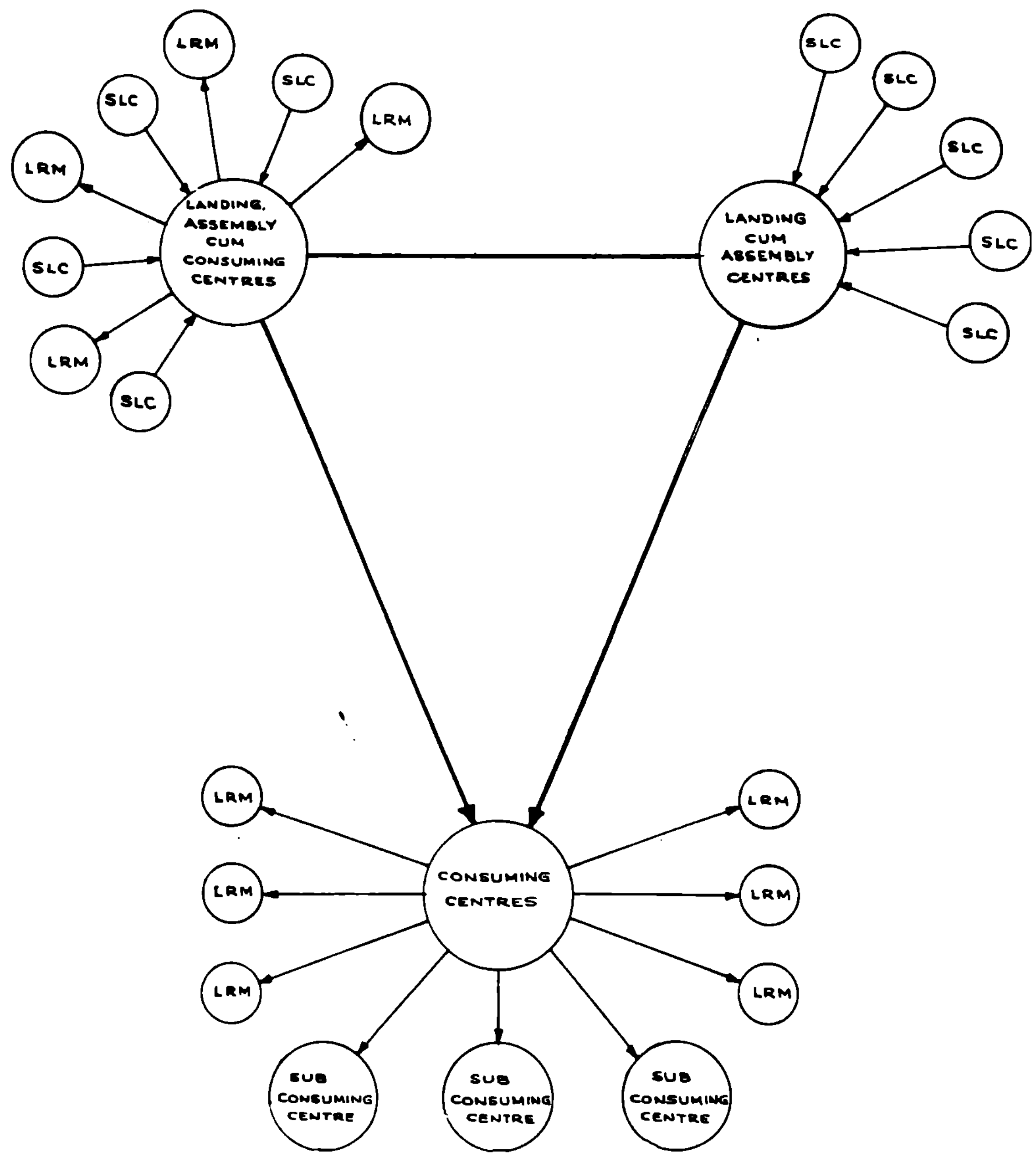
District	Quantity transported		Quantity of ice used (tonnes)		Average trip distance (in km)	Spoilage during transit (tonnes)		Economic value of spoilage (Rs.in lakhs)	
-	Exportable	Non-exportable	Exportable	Non-exportable		Exportable	Non-exportable	Exportable	Non-exportable
Trivandrum	1090.55	61526.59	1634.12	35317.82	27.36	4.46	3765.39	1.80	175.09
Quilon	12166.02	46250.61	18589.39	28052.02	50.57	33.67	1990.75	13.64	92.56
Alleppey	3537.57	44297.15	5437.34	24867.20	49.49	8.24	2851.20	3.33	132.58
Ernakulam	9799.96	23996.70	14662.44	16554.53	81.43	22.15	1564.95	8.97	72.77
Trichur	5628.12	22079.22	8308.91	10390.92	25.35	20.89	1107.82	8.46	51.51
Malappuram	3683.94	8556.28	5176.47	7189.57	180.71	24.75	1566.51	10.02	72.84
Calicut	4194.38	28794.59	6351.93	19464.00	147.75	11.33	2075.14	4.59	96.49
Cannanore	3426.45	29866.70	5219.84	19114.81	247.41	12.89	2237.91	5.22	104.06
Total	43526.99	265366.84	65290.44	160950.87	66.78	138.38	17159.67	56.03	797.70

Source: NATPAC, Study on Transportation of Marine Products in Kerala , Trivandrum, 1982, p.44.

locality to locality and even in the same locality. A broad picture of the flow of marine fish from different centres is given in figure 6.3.

6.5.2 The marketing of marine fish has important seasonal aspects in relation to production. There is much reduction in catch and market arrivals of fresh fish during lean seasons, especially during south-west monsoon. This is owing to reduced fishing effort. Table 6.9 gives the districtwise distribution of fish in peak and lean seasons.

6.5.3 Daily supplies of fresh fish to the retail markets show considerable fluctuations in line with the catches landed. During the days of plentiful catches the producers are generally at a disadvantage owing to low price and the retailers, who take larger quantities for marketing, are also at a disadvantage owing to undisposed and decomposed fish at the end of the marketing time. Data indicate that the production of non-exportable varieties was maximum in Trivandrum (i.e., 53,645.10 tonnes) in the peak season, the total being 2,40,301.23 tonnes for all the districts. For the lean season also Trivandrum tops with 11,776.73 tonnes for the non-exportable variety, the total being 49,410.41 tonnes for all the districts. But in the case of exportable species the maximum landing takes place in Quilon both for the peak and for the lean seasons.



SLC - Satellite Launching Centre
LRM - Local Retail Market

Fig.6.3 Marketing system (flow of marine fish).

Table 6.9 Districtwise distribution of fish landings according to peak and lean seasons

District	Quantity of fish catch (in tonnes)				Total
	Peak season		Lean season		
	Exportable	Non-exportable	Exportable	Non-exportable	
Trivandrum	703.91	53645.10	409.55	11776.73	66535.29
Quilon	9509.81	39878.49	3051.50	10125.81	62565.61
Alleppey	2692.43	43106.48	916.86	6262.08	52977.85
Ernakulam	9095.36	31161.79	975.44	5287.55	36520.14
Trichur	4791.48	20286.89	1043.54	4582.68	30704.59
Malappuram	3060.18	7640.53	779.83	1665.68	13146.22
Calicut	3304.34	26839.13	1034.01	4956.58	36134.06
Cannanore	2536.08	27742.82	1052.92	4753.30	36085.12
Total	35693.59	240301.23	9263.65	49410.41	334668.88

Source: NATPAC, Study on Transportation of Marine Products in Kerala', Trivandrum, 1982,p.8.

6.5.4 The marketing of quality fishes and other acceptable varieties does not pose any problem; so is the case with export varieties of fishes. But the trawl catches of the mechanised sector provide large quantities of lesser quality fishes which have no acceptability in the markets. Such varieties pose serious problems in marketing. Most of the traditional sector's catch constitutes species like oil-sardines and mackeral, which also lack acceptability in the local market. As a result of the greater production of ice and storage capacity the marketability of these species has increased considerably in distant markets.

6.5.5 For the disposal of the products to various markets the principle of concentration of fish landings is a viable approach. In order to get economic price for the produce it would be practicable to cover all the fish landings in one area or to a particular place. Most of the mechanised fishing districts in Kerala have the facility of this kind of landings with marketing sheds. But the traditional fishermen, who are operating non-mechanised boats, would not like to land their catches at the minor or major landing centres because of the competition in marketing their produce with that of the mechanised boats.

6.6 Market intermediaries

6.6.1 It is rare in today's society to have direct trade between producers and the final consumers. Typically they execute a transaction through one or more intermediaries. The bulk of the fish trade, however, involves intervention of some middlemen agency as most of the fishermen have neither adequate time to take care of marketing catch nor do they have the business acumen and knowledge of marketing condition. Traders, commission agents and middlemen are the important intermediate links between the fishermen and the domestic markets for providing necessary raw material.

6.6.2 A very common situation within the distribution channel is where the intermediaries are willing to handle products from a limited number of suppliers. A characteristic feature of the fish industry is the presence of large number of primary processors, and there is intense competition for entry into the available distribution channels. It is natural to expect that the larger the chain of intermediaries between the producers and consumers the higher will be the cost of the incidental components and proportionately less will be the share of producers in consumer price.

6.7 Types of intermediaries

6.7.1 Following are the types of intermediaries functioning in the marine fish marketing:

Auctioner

6.7.1.1 Most of the produce of the fishermen are disposed of through auction with the help of auctioners. Majority of the auctioners work on commission basis and commission is collected from the fishermen. Some auctioners are jetty owners who provide landing and berthing facilities to the mechanised boats. In such cases the auctioner's charge includes the jetty facility charges also. Auctioners are also a source of finance to the fishermen.

Commission agents

6.7.1.2 The main business of the commission agents is to collect fish from small and large landing centres on behalf of the wholesalers located at the large assembly centres or consuming centres. The role of commission agents play double role and receive commission both from the fishermen and from the wholesalers. They are also responsible for packing and forwarding the products to the consuming centres. In many locations these commission agents also assist the fishermen in procuring the facilities like ice, diesel, spare parts etc.

Wholesaler

6.7.1.3 The main role of the wholesaler is to pool fish together, produced at different centres. Their business is linked directly either with the commission agents or with the fishermen. Wholesaler also acts as a major source of finance to the fishermen. This would help the wholesalers for.ensuring adequate volume of business and resulted in 'bonding of boats' (Platteau, 1984).

Retailers

6.7.1.4 Retailers are considered to be ultimate link in the fishery trade channel. The procurement of the product by the retailers is either from the fisherman or from commission agents or from wholesalers. Family members of the fish producers also function as retailers. Retailers again perform the marketing process in different ways. They sometimes perform the marketing activity for a day or perform for several days with the help of cold storages.

6.7.1.5 There are 4,156 types of intermediaries functioning in the state. This is given in table 6.10.

Table 6.10 Districtwise distribution of different types of intermediaries

District	Purchase and sale	Commission agents	Employed by exporters/ processors	Total
Trivandrum	689	12	--	701
Quilon	741	61	7	809
Alleppey	501	42	4	547
Ernakulam	661	55	8	724
Trichur	402	14	--	416
Malappuram	185	13	--	198
Calicut	594	24	4	622
Cannanore	124	15	--	139

Out of the total of 4,156, 3,897 intermediaries are engaged in purchase and sale of fish as auctioners, wholesalers or retailers. There are 236 commission agents in the state engaged in various activities with a maximum of 61 in Quilon district. To collect the export varieties of fish to the processors, the processors have employed 23 persons as intermediaries and they are concentrated in Quilon, Alleppey, Ernakulam and Calicut.

6.7.1.6 Table 6.11 gives the distribution of intermediaries on the basis of the type of operation. Out of the total of 4,156 intermediaries functioning in the state 191 deal only in exportable variety.

6.7.1.7 According to table 6.11 the maximum intermediaries, i.e., 55 are in Quilon and this constitutes nearly 30 per cent. Ernakulam and Calicut districts followed in that order of the total intermediaries dealing with non-exportable variety, the maximum number of 650 is in Trivandrum district and the lowest in Cannanore (82). With regard to the intermediaries dealing in exportable and non-exportable varieties, the maximum number is in Quilon (185 out of 498).

6.8 Intermediaries and fish marketing linkages

6.8.1 There are two types of market interlinkages in the traditional fishing villages of Kerala. The interlinkage of

Table 6.11 Districtwise distribution of intermediaries according to type of operation

District	Dealing only in exportable variety	Dealing only non-exportable variety	Both	Total
Trivandrum	8	650	43	702
Quilon	55	589	165	809
Alleppey	16	484	47	547
Ernakulam	35	626	63	724
Trichur	13	368	35	416
Malappuram	16	133	49	198
Calicut	29	536	57	622
Cannanore	19	82	39	139
Total	191	3467	498	4156

Source: Government of Kerala, Kerala Fisheries: Facts and Figures , Directorate of Fisheries, Trivandrum, 1982.

credit and marketing relations on the other (Platteau, 1984). The first envisages the loans against the commitment of future labour, while the other for the commitment of future delivery of catch. So the middleman is free to exploit the fisherman at his will as he can fix the price for the fisherman's product as he wishes. This often helps the middleman to have monopsony power over the fishermen. It is alleged that under such a system the fisherman has no incentive to save and invest; for any return accruing from the investment will be appropriated by the middlemen (Kirby and Szezepanik, 1957).

6.8.2 The problem of too many intermediaries put the producers and consumers at a disadvantageous position. The present system of marketing shows that collusion is rampant throughout the system from the shore to the market (Platteau, 1981). The overriding concern of every middleman is the difference between the price paid and the price received from the buyer. If maximisation of price differential is the middleman's goal, collusion would be plausible. All middlemen will stand benefitted from the price fixing.

6.8.3 The middleman's total profit is a function, not only of the price differential or margin, but also of the volume of fish handled. The volume of fish handled, in turn, is a decreasing function of the price differential. This means that the supply of fish handled by a dealer can be increased by raising the price to the fisherman and/or lowering it to the final buyer. Hence the dealer faces a trade off, as it will pay the dealer to narrow or shade his margin if the resultant percentage increases in his volume or exceed the percentage decreases in margin. This can be mathematically illustrated as follows:

6.8.4 Let π be the middleman's total net profit. Then,

$$\pi = Q\left[P_2 - (P_1 + Hc)\right] \qquad (1)$$

where Q is the volume of fish handled, P_2 the price received by the fishermen, P_1 the price he pays for the fish and Hc the handling cost per unit of fish.

Re-expressing (1) gives

$$\pi = Q.Z \qquad (2)$$

where $Z \equiv P_2 - (P_1 + Hc)$ is net profit per unit.

6.8.5 If the middleman reduces his margin, either by raising P_1 or by lowering both, the volume of fish handled by middlemen will increase. These two changes will act as opposing forces upon his total profits. The effect upon profits can be analysed by considering the total differential with respect

$$d\pi = Z.dQ + Q.dZ \qquad (3)$$

Dividing by Q.Z we have,

$$\frac{d\pi}{\pi} = \frac{dQ}{QZ} + \frac{dZ}{QZ}$$

which states that the percentage change in profits will be equal to the sum of percentage change in the volume of fish handled plus the percentage change in net profit per unit. In this case $\frac{dZ}{ZQ} < 0$ and $\frac{dQ}{ZQ} > 0$. As a result of the increasing handling cost we allow Z to decline.

6.8.6 The effect of shading the net margin will raise profits, i.e., $d\pi > 0$, if the percentage fall in the net margin is less than the percentage rise in the quantity of fish handled; in other words ie, $\frac{dQ}{QZ} > \frac{dZ}{QZ}$.

The net margin per unit must always remain positiv
It should then be noted that the above rules cover this proble
because,

$$\underset{Z \to 0}{Lt} \quad \frac{dZ}{Z} = \infty$$

6.8.7 His supply of fish as buyer and the demand for fis
which he faces as a seller should both be highly price elastic

This indicates that a good chance of finding that the percentage decline in his margin will be less than the percentage increase in the volume of fish handled.

6.9 Use flow

6.9.1 During 1983 out of the total production of 3,85,280 M.T. of marine products 56.23% was sold as fresh fish and 23.52% was dry edible mostly in the domestic market. Only 16.31% was exported and the balance 3.94% was used for fish meal. Table 6.12 gives the total use flow of marine fish production for the year 1983.

Table 6.12 Use flow of marine fish in Kerala (1983)

Type	Quantity M.Tonnes	Percentage
Fresh	2,16,643	56.23
Dry edible	90,618	23.52
Fish meal	15,180	3.94
Exportable Dry + Frozen	62,839	16.31
Total	3,85,280	100.00

Source: Compiled from CMFRI published data (1984).

6.9.2 The use flow is more than 55 per cent in all the three major fish producing centres of Kerala. Table 6.13 gives

Table 6.13 Use flow of marine fish for three major landing centres (1983)

Centre	Use flow								Total
	Fresh		Dry edible		Fish meal		Exportable		
	Quantity	%	Quantity	%	Quantity	%	Quantity	%	
Cochin	22827	57.62	8050	20.31	1909	4.82	6833	17.25	39617
Quilon	46011	56.55	17501	21.51	3507	4.31	14344	17.63	81363
Cannanore	69105	55.52	3703	22.58	847	5.13	2750	16.77	16400
Total	77943	56.73	29254	21.29	6263	4.56	23927	17.42	137380

Source: Compiled from Central Marine Fisheries Research Institute, Published Data (1983).

6.10 Physical flow

6.10.1 The production centres themselves consume about 64.3% of the total fish production, i.e., 1,93,233 M.T. in 1983. The other consuming centres located within a distance of 200 kms from the coast consumed 35.70% (1,07,285 M.T.). The inter-state flows of fish were not very high. Only 11,350 M.T. of fresh fish landings moved from Kerala to the neighbouring states and this was only 2.95 per cent of the total landings. The direction of the inter-state inflows of the fresh fish is also important. Kerala received 9,210 M.T. of fresh fish from the neighbouring states and this was about 4.62 per cent of the total consumption of marine fish.

6.10.2 The important landing-cum-assembly centres which despatched out of the state were Cannanore (896 M.T.) and Ernakulam (765 M.T.). Trivandrum was the most important consuming centre which received fresh fish from other states (3,762 M.T.). Next in importance was Cannanore, which receive 1,350 M.T. fresh fish from Karnataka. In 1983 also maximum despatches were from Neendakara landing-cum-assembly centre (22,675 M.T.), followed by Ernakulam landing assembly-cum-consuming centres with 9,425 M.T.

6.11 Price spread

6.11.1 Price spread analysis helps to determine the into two types for analysing and estimating the price spread:

1) Local sale at production centres

2) Sale to consumer centres located away from production centres.

6.11.2 Local sale at the production centres

6.11.2.1 In this category of sale, the cost incurred is less as it does not need much storage and transportation. Another feature of this is that the number of intermediaries involved is also few. As a result of it fishermen are getting high return from the sale. Inferior varieties of fish are mostly consumed in the nearby markets or in the landing centres themselves. So they are free from the cost of packaging, icing, transporting and other trade margins. Therefore, only average and quality products move to consuming centres located away from the landing centres. Some of the fishermen are overcoming these problems of price-spread as they themselves do the business of retailing and vending. In these cases the fisherman's share in the consumer rupee is quite high.

6.11.2.2 The price-spread analysis for fresh fish marketing at landing centres and landing and assembly centres for two cities of Cochin and Trivandrum are given in table 6.14.

Table 6.14 Price-spread analysis of fresh fish marketing for Ernakulam and Trivandrum

Particulars	Ernakulam		Trivandrum	
	Value	Percent-age	Value	Percent-age
Consumer price	4430	100	2516	100
Retailer price	456	10.3	318	12.6
Retailers' cost	121	2.7	70	2.8
Wholesalers'/ commission agents' selling price	3853	87.0	2128	84.6
Commission agents'/ wholesalers' profits	241	5.4	141	6.0
Commission agents'/ wholesalers' cost	14	0.3	29	1.2
Fisherman's price	3598	81.2	1948	77.4

Source: Compiled from CMFRI published data.

The fisherman's price is higher in Ernakulam (81.2%) in comparison with that of Trivandrum (77.4%).

6.11.3 Sales to consuming centres away from landing centres

6.11.3.1 Various intermediaries like wholesalers at landing centres, commission agents at consuming centres and retailers at consuming centres are there before reaching the final products in the hands of the consumer. So the price-spread between these intermediaries are also very high and the fishermen will get only less price for their products. Another feature of the share of the fishermen in this category is that the consumer rupee share will be changing as per the change in the variety of the fish (Panikkar and Sathiadas, 1982). Fisherman's share is higher in high-priced value species than in low-priced trash fishes.

6.12 Fish marketing by co-operatives

6.12.1 The development of fishery co-operatives was encouraged in the beginning as a marketing intervention on the hypothesis that fishermen do not realise adequate value of their catch and that traders exploit fishermen. The share of co-operatives in the total fish market was very small. The alarming feature is that the share of fishery co-operatives in the area of marketing had been declining over the years in spite of larger allocation and efforts (Kurien, 1980). As a result, all co-operatives were liquidated by the state order in 1978-79 due to very poor performances.

6.12.2 The reasons for the growth and development of private fishery trade and the failure of the marketing co-operatives are the alround command of the private traders in the several needed functions such as

1) provision of working capital at easy terms,

2) provision of fishery requisites,

3) capacity to manage trade risks and

4) efficient organisation and quick decision.

6.12.3 This led to the development of a 'bonding' system in the marketing of fish products. This is the major reason for the ill-functioning of the fishery marketing co-operatives and moreover the fisherman's inability to repay the loans also resulted in ignoring the co-operative methods in marketing.

6.12.4 In order to develop adequate marketing infrastructure, attempts should be made to meet fisherman's working capital needs and market should be on commission basis. Another remarkable feature needed for the sound functioning of the fishery marketing co-operatives is the need of vertical integration of marketing at least upto the retail market.

6.12.5 The Matsyafed (the Federation for Fishery Co-operatives in Kerala) has launched a new policy for the sound and efficient marketing of the fishery products in the 222 fishing villages. The marketing strategy will place sales in the hands of village fishermen's societies. This will involve the provisions of infrastructure facilities such as auction halls, ice storage etc., to eliminate the fishermen's dependence on middlemen.

Chapter VII

CONSERVATION AND MANAGEMENT REGULATIONS OF FISHERY RESOURCES

7.1.1 The present situation in the fisheries sector in the State indicates:

1) diminishing stock

2) conflicting use of coastal areas

3) insufficient information on fishery resources

4) ecological damage due to indiscriminate trawling of the mechanised boats, and

5) destruction of the fish breeding beds owing to various pollutants.

7.1.2 The uncontrolled and reckless exploitation of the "free access" fishery resources stresses the need for the management and regulation of exploitation of fishery resources in the State. The quantum of resources amenable for exploitation, called the Maximum Sustainable Yield (MSY), seems to be almost fixed. The major task of management is to determine the effort needed to exploit the allowable level of resources, called the Total Allowable Catch (TAC) (Choudhury, 1986b).

7.2 Principles of Maximum Sustainable Yield and Optimum Trawling Effort

7.2.1 In Kerala, today, over eight lakh workers in artisanal fishing sector are facing a grave crisis. It spells increasing pauperisation and severe depletion of marine resources. The crisis emanated from the introduction of trawlers three decades ago. The traditional fishermen hold the view that indiscriminate trawling off the coast and the consequent destruction of the fish breeding structures are the twin causes of drastic reduction in the average catch size and the consequent lower earnings of the traditional fishermen. The greatest harm, they claim, is caused during the monsoon months of June-August when many of the commercially important species of Kerala are known to spawn.

7.2.2 Commercial fishery is characterized by three key economic and technological factors. These three factors are relevant to formulate an economic theory of fish production. Let us see the nature of these three factors:

i) Fishery resource, although conceivably exhaustible, is replenishable, i.e., it is subject to laws of natural growth which define an environmental biotechnical constraint on the activities of fishing industry.

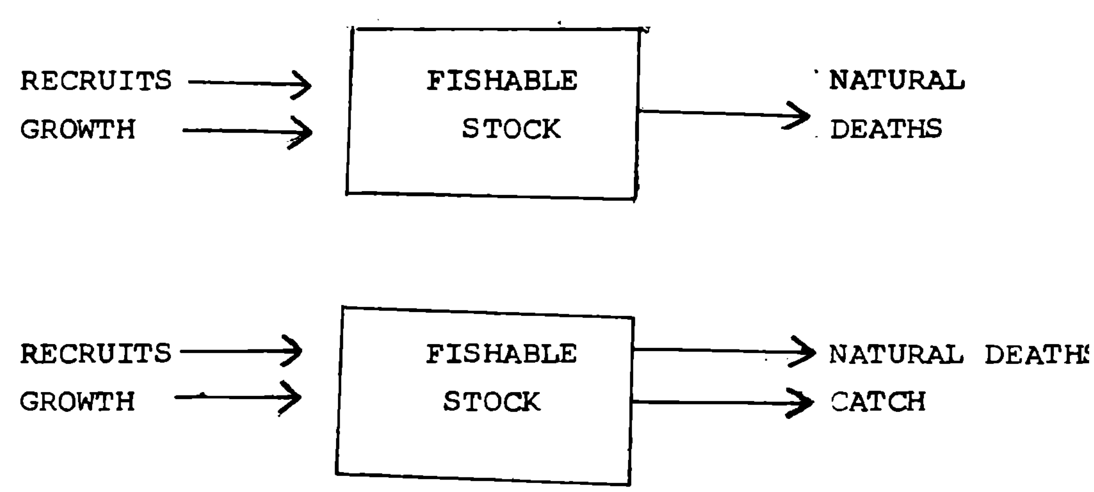
ii) The resource and the activity of production from in the population of fish mass depends upon the harvest rate relative to natural growth to the stock. If the harvest rate exceeds the growth rate, the stock declines and vice-versa.

iii) The recovery of harvesting process is subject to various external effects all of which represents external diseconomies to the firm: (a) Resource stock externalities result in the cost of a fishing vessel's catch decreases, as the population of fish decreases. (b) Mesh externalities result if the mesh size (or other kinds of gear selectivity variables) affects not only the private costs and revenues of the fisherman, but also the growth behaviour of the fish population. (c) Crowding externalities occur if the fish population is sufficiently concentrated to cause vessel congestion over the fishing grounds and, thus, increased vessel operating cost for any given catch. All these various types of externalities arise fundamentally because of the 'common property', unappropriated character of most fishery resources, especially ocean and large river fishery (Gordon, 1954).

7.2.3 When a population of fish has not been exposed to fishery it leads to the maximum size that the environment permits. Lack of food, suitable space, presence of predators, etc., often prevent the population from growing beyond the maximum. When, over the long run, gains to the population by recruitment and growth are balanced by losses due to natural mortality the population is said to be in equilibrium. There may be years of favourable environmental conditions when the population goes below the average level.

7.2.4 The controlled experiments have confirmed that each fish and shellfish stock can yield a certain catch without affecting its capacity to renew itself as given in figure 7.1.

Fig.7.1 An oversimplified model of stock of fish before and after fishing begins



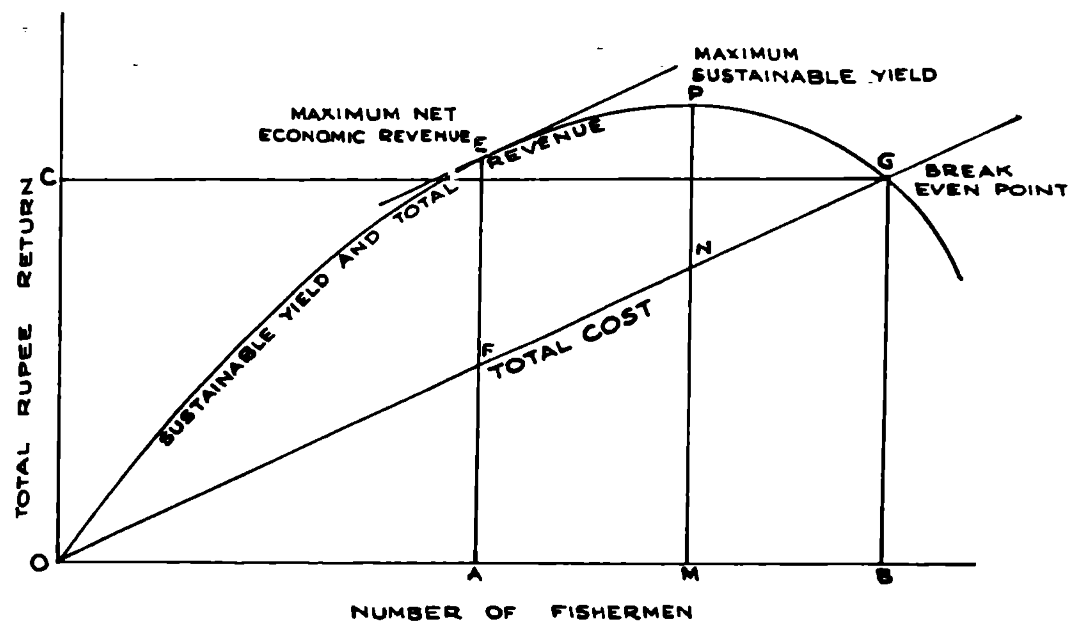
Before fishing begins the stock is in equilibrium with its environment (new births that reach fishable size), and their growth are balanced by natural deaths. These rates change from time to time as environmental factors change and are not always in balance. Thus the stock fluctuates from time to time, even in the absence of fishing, but, on an average, fluctuations occur at certain mean values. When fishing is added to natural mortality, on an average the stock is smaller. But this, in some extent is balanced by increase in survival of recruits, increased growth or by earlier maturity. All these rates may change, so that the stock returns to a new level of equilibrium, smaller on the average than the unfished stock, but still remaining in balance with its environment.

7.2.5 Fisheries typically progress from a relatively low level of effort, concentrated close to shore, and using sophisticated gear like gill nets, hook and lines to a much higher level of sophistication extending far from the home base with large equipments and advanced gear. The catch rises at first, with little notice of fluctuations in abundance, eventually reaches a fluctuating peak, then falls and suffers wide variation in catch as time goes on. Meanwhile, effort is increasing, with an increasing time lag as units of efforts become more complicated and costly, until at some stage there is far more effort than necessary to make the catch. In fact, effort usually continues to grow even after catch-per-unit-effort (CPUE) has already begun to decline. Competition grows and many vessels find that they can no longer compete successfully. This is especially true of the older, less efficient boats. The owners then must decide to turn to some other form of

7.2.6 Gordon (1954) was the first economist who introduced the concepts of costs clearly into focus as an important consideration in fishery management. The difference between the purely biological concept of the Maximum Sustainable Yield (MSY) and the Maximum Sustainable Economic Yield (MSEY) was that MSY only considered the fish stocks, whereas the real object of fishery management should be to provide the maximum benefit to man. The free entry, though it would maximise the biological yield if successful, involved fundamental economic waste. Only if costs could be brought to a minimum could the maximum rent be realized from a fishery as given in figure 7.2. Here the maximum net economic revenue is at the point where a tangent to the curve parallels to the total cost line. This is at a point to the left of the point of MSY.

7.2.7 When we analyse the fish production pattern in Kerala economy in the background of the above principles for the periods 1964 to 1984, we come across with two phases (Rajasenan, 1986b): (i) a period of growth, and also (ii) a period of stagnation. During the first phase, i.e., the period of growth 1964 to 1973, the average catch was about 3.59 lakh tonnes and the annual growth rate was 1.8 per cent. In the second phase, i.e., the period of stagnation 1974 to 1984, the average catch was 3.49 lakh tonnes with a declining growth rate of 1.4 per cent per annum.

Fig.7.2 The relation between number of fishermen and the total rupee return from a fishery



Source: Mc Hugh, J.L.(1984), Fishery Management: Lecture Notes on Coastal and Estuarine Studies, Springer Verlag, New York,p.173.

7.2.8 In Kerala Fisheries, the introduction of mechanised boats in 1960s and later periods were considered as a major breakthrough of the technological development. But data show that even during the development phase the contribution of the mechanised sector was only 21 per cent (93,600 tonnes) of the catch of the record year 1973. So during this phase itself the traditional fishermen, comprising of more than a lakh, contributed 79 per cent of the total fish production with one major technological breakthrough--the introduction of nylon nets in lieu of cotton nets. But in the second phase the major contribution to the production came from the mechanised sector with a share of 51 per cent (1.42 lakh tonnes). During this period the share of the traditional sector came down substantially as a result of the increased fortune of the mechanised sector. This has resulted in many conflicts between the traditional sector and the mechanised sector fishermen rather than developing a complementary relationship between the two.

7.2.9 When one examines the need for conservation of fishery resources three issues emerge: viz., (1) continuous decline in the total production, (2) size of the individual fish landed and, (3) decline in the catch per unit effort.

7.3 Decline in production

7.3.1 In Kerala prawns, oil-sardine and mackeral are the major species which have shown signs of decreasing trend in recent years. The maximum sustainable yield and level of exploitation of these species from 1970 - (1982-83) for the entire southwest coast is given in table 7.1.

7.3.2 The exploitation of prawn resources in the south-west coast exceeded the potential in 1973 and 1975. The landings of oil-sardine in 1970, 71, 82, 82 and 1982-83 exceeded the estimated sustainable yield. The production of mackeral exceeded the potential in 1970, 71 and 72. Since oil-sardine and mackeral are subject to wide fluctuations, one cannot definitely say that these species are subject to depletion. But in the case of prawns one can see an opposite relationship between catch and export. The export of prawns remain almost constant at about 6,000 tonnes. But the catch of prawn showed wide variations. So in a multispecies fishery it is difficult to make a correct prediction on the setting of the forces of depletion on a particular variety of fish.

7.4 Size of the individual fish landed

7.4.1 Another remarkable feature of the Kerala fishery is that of the decline in the size of the fish caught. This is most visible in the case of prawn. Well-informed trade sources point to a shift in the composition of export mix of penaeid prawns over time to the smaller varieties like 'karikkādi and 'poovālan' indicating that the catch pattern has also changed considerably.

Table 7.1 Sustainable yield and current exploitation of major species

(Quantity in tonnes)

Year	Species	Kerala	Karnataka	Goa	Total	Sustainable yield	Percentage of production to sustainable yield (column 6 to 7)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1970	Prawns	36954	7359	627	45120	80000	56
	Oil-sardine	191683	33834	1134	226651	180000	126
	Mackeral	54659	46337	14585	115581	80000	144
	Total	283296	87710	16346	387352	340000	144
1971	Prawns	32813	4420	279	37512	80000	47
	Oil-sardine	194977	11836	1994	208807	180000	116
	Mackeral	95164	64047	32258	191469	80000	239
	Total	322954	80303	34531	437788	340000	129
1972	Prawns	36577	80075	561	45213	80000	57
	Oil-sardine	104426	10610	3793	123829	180000	69
	Mackeral	34516	32449	19999	86764	80000	108
	Total	175519	55934	24353	255806	340000	75
1973	Prawns	85751	8236	785	94772	80000	118
	Oil-sardine	122783	15495	3426	141704	180000	79
	Mackeral	19780	35468	7616	62864	80000	79
	Total	228314	59199	11327	299340	340000	88

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1974	Prawns	60820	12696	1448	74973	80000	94
	Oil-sardine	102135	20784	2106	125025	180000	69
	Mackeral	10335	9696	7905	27936	80000	35
	Total	173299	43176	11459	227934	340000	67
1975	Prawns	77962	3074	1762	82798	80000	103
	Oil-sardine	97183	52701	7526	157410	180000	87
	Mackeral	14930	12469	6779	34178	80000	43
	Total	190075	68244	16067	274386	340000	81
1976	Prawns	34533	2594	4643	41770	80000	52
	Oil-sardine	123937	41451	1385	166773	180000	93
	Mackeral	19978	22455	6448	48881	80000	61
	Total	178448	66500	12476	257424	340000	76
1977	Prawns	40324	3335	1460	45119	80000	56
	Oil-sardine	117356	31145	807	149308	180000	83
	Mackeral	19968	26214	7661	53843	80000	67
	Total	177648	60694	9928	248270	340000	73
1978	Prawns	45428	8440	1673	55541	80000	69
	Oil-sardine	119937	46707	1398	168042	180000	93
	Mackeral	25917	50704	3371	79992	80000	100
	Total	191282	105851	6442	303575	340000	89

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1979	Prawns	29597	4660	1694	85851	80000	45
	Oil-sardine	116834	33080	3030	152944	180000	85
	Mackeral	18585	40084	4391	63060	80000	79
	Total	165016	77824	9015	251855	340000	74
1980	Prawns	54375	3226	1853	59484	80000	74
	Oil-sardine	69667	42727	2367	114761	180000	64
	Mackeral	18474	19634	2446	40554	80000	51
	Total	142516	65587	6666	214769	340000	63
1981	Prawns	22268	4122	2237	28617	80000	36
	Oil-sardine	146986	65614	7609	220209	180000	122
	Mackeral	16200	19766	3939	39905	80000	50
	Total	185454	89502	13785	288731	340000	85
1982	Prawns	26708	7698	3491	37897	80000	47
	Oil-sardine	143215	55126	5518	203859	180000	113
	Mackeral	10717	5511	2607	18835	80000	24
	Total	180640	68335	11616	260591	340000	77
1982-83	Prawns	32288	7732	5914	45934	80000	57
	Oil-sardine	159488	35501	5220	200209	180000	111
	Mackeral	9270	5304	66	14640	80000	18
	Total	201046	48537	11200	260783	340000	77

Source: Compiled from Central Marine Fisheries Research Institute Published Data.

7.5 Decline in catch per unit effort

7.5.1 Prawn is considered to be the backbone of Kerala's fishing industry. The Sakthikulangara-Neendakara belt itself accounts for the lions' share of the prawn catch in Kerala. The other major prawn-producing centres are Cochin and Calicut. In all these places about 80 to 85 per cent of the year's catch is made during the months of June-August (See table 7.3).

7.5.2 According to the fishery management norms the data indicate clear overfishing as the total catch of prawn in these three regions, as well as the catch per unit effort show declining trends. In the context of Kerala it is believed that there is only economic overfishing. But if proper measures are not taken on time this will perpetually lead to a biological overfishing crisis (Rajasenan, 1982).

7.5.3 A noticeable feature of the mechanised fishing in Sakthikulangara-Neendakara belt is the concentration of fishing in certain months. During the peak seasons of fishing, trawlers from neighbouring states also come and operate in these areas. The annual economic performance of all the vessels virtually depend upon the monsoon prawn catches. Thus the overall tendency was to operate these vessels on these peak months and keeping the vessel idle in the less productive seasons as indicated in table 7.2.

Table 7.2 Average number of mechanised trawlers operating per day according to months, during 1978-80 at Sakthikulangara, together with the local and outside units separately for 1980 and the monthwise catch for 1980

Month	Average number of trawlers per day					Total catch in tonnes during 1980	
	1978	1979	1980				
			Local	Outside	Total	Tonnes	Percent-age
January	850	160	205	--	205	654	0.77
February	333	205	218	--	218	699	0.83
March	318	190	320	147	467	2282	2.70
April	359	274	320	352	672	5804	6.86
May	942	669	320	633	953	7912	9.36
June	1003	287	320	432	662	3723	4.40
July	1578	932	320	900	1220	30025	35.51
August	1360	916	320	420	740	11521	13.63
September	963	725	320	808	1128	14687	17.37
October	371	437	320	129	449	3304	3.90
November	300	368	320	14	334	2637	3.12
December	288	228	285	--	285	1308	1.55
Mean (i.e., average No.of trawlers operating per day)	722	449	299	320	611	84556 (Total)	100.00

Source: Sathiadas, R. and Venkataraman, G."Impact of Mechanised Fishing on the Socio-economic Conditions of the Fishermen of Sakthikulangara-Neendakara, Kerala" Mar.Fish.Infor. Serv. T&E Ser., No.29: CMFRI, 1981.

7.5.4 The average number of boats operated daily during 1978-80 period came to 595 according to table 7.2. Neendakara Bay seems to be relatively quiet during the monsoon months of June to September, and at this time prawns are available in plenty. Hence a large number of boats migrate to this centre during this period and engage in trawling operations. This leads to depletion of resources. To avoid this certain regulatory measures are introduced to regulate the present system of unregulated exploitation of fishery resources by mechanised fishing boats.

7.6 Schaefer Model for fishery management regulation

7.6.1 Based on the time series data on prawn catch and effort of the three important mechanised fishing centres of Sakthikulangara-Neendakara, Cochin and Calicut, the impact of mechanised boat is analysed with the help of fishery management principles. To analyse this the Schaefer model is used (Schaefer, 1957). The model describes the linear relationship between effort and yield. The operation of fishery as an 'open-access' resources under free competition induces a level of fishing effort beyond the point of Economic Optimum Yield (EOY) and the tendency is for the point of Maximum Sustainable Yield (MSY) to be exceeded and the fish resources to be threatened by overfishing (Anderson, 1977). With this theoretical framework and based on the Schaefer model it is possible to examine the real situation of the prawn fishery of Kerala's important mechanised fishing centres, as prawn is the important commercial specie of this sector. The data of prawn catch and effort for the 15 years is given in table 7.3.

7.6.2 The model is worked out from the following three equations:

$$F = U_{max} - bf \qquad (1)$$

where

F = Fishing mortality (catch)

b = Slope for CPUE on effort

U_{max} = Maximum CPUE.

From this the MSY is estimated from equation (1),

$$MSY = \frac{U_{max}^{2}}{4b} \qquad (2)$$

Maximum Sustainable Yield (MSY) is the greatest yield that can be removed each year without imparting the capacity of the resource to renew itself. MSY has been used as a reference point for management purposes to describe the maximum potential productivity of the stock in terms of catch and is usually associated with exploitation rate (AMCRR, 1980). The effort

Table 7.3 **Observed annual values of prawn catch (Y), effort (f) and catch per unit effort (Y/f) for Sakthikulangara-Neendakara, Cochin and Calicut centres**

(Sakthikulangara-Neendakara : $Y/f = 48.38 - 0.0000212f$; Cochin: Y/f: $22.55 - 0.0000286f$; Calicut: Y/f: $13.95 - 0.0000346f$).

Year	Sakthikulangara-Neendakara			Cochin			Calicut		
	Effort in boat hours	Catch in tonnes	Catch/ hour in kg	Effort in boat hours	Catch in tonnes	Catch/ hour in kg	Effort in boat hours	Catch in tonnes	Catch/ hour in kg
1970	146185	1845	12.6	100000	2200	22.0	72000	1300	18.1
1971	276476	11004	39.8	632000	3850	6.1	92200	1050	11.5
1972	383227	11267	29.4	184000	2150	11.7	17600	200	11.4
1973	550370	45477	82.6	284000	6000	21.1	75200	625	8.3
1974	323719	27764	33.7	336000	3900	11.6	60000	420	7.0
1975	1331728	56750	42.6	334000	7200	20.9	74400	570	7.7
1976	536897	14993	27.9	280000	2800	16.0	83200	235	2.8
1977	1336732	24121	18.0	376000	5300	14.0	82400	340	4.1
1978	2413475	33143	13.7	536000	2160	4.0	52800	230	4.4
1979	723730	14582	20.0	356000	3350	9.4	68000	330	4.9
1980	4843440	36559	7.6	360000	3500	9.7	69600	380	5.5
1981	1088520	9633	8.8	346000	3277	9.4	62100	215	3.5
1982	1032421	9652	9.3	373000	4387	11.7	84300	596	7.0
1983	1013416	7807	7.7	423000	3967	9.3	86500	345	3.9
1984	1096400	10453	9.5	516000	6234	12.0	54600	243	4.4
Mean	1139782	21003	24.21	362400	4018	12.59	68993	472	6.96

Source: Compiled from Central Marine Fisheries Research Institute, Published Data.

required to generate the MSY is called f_{msy} and is calculated by

$$f_{msy} = \frac{U_{max}}{2b} \qquad (3)$$

The relation between fishing effort and catch per unit effort (CPUE) for the three places are given in figure 7.3.

7.6.3 As fishing effort increases, catch per unit effort becomes less. By finding the regression lines, maximum CPUE (U_{max}) can be estimated for the three centres as

Sakthikulangara-Neendakara	: $Y/f = 48.38 - 0.0000212f$
Cochin	: $Y/f = 22.55 - 0.0000286f$
Calicut	: $Y/f = 13.95 - 0.0000346f$

7.6.4 The highest Y-axis intercept value of 48.38 (U_{max}) for Sakthikulangara-Neendakara base shows the initial abundance of the annual stock per hour of trawling at the virgin biomass compared to that of 22.55 kg/hour of trawling for the Cochin centre and only 13.95 kg/hour of trawling at the Calicut centre. The estimated values of annual prawn catch (Y) and catch per unit effort (Y/f) for different levels of effort (f) for the three centres are given in table 7.4.

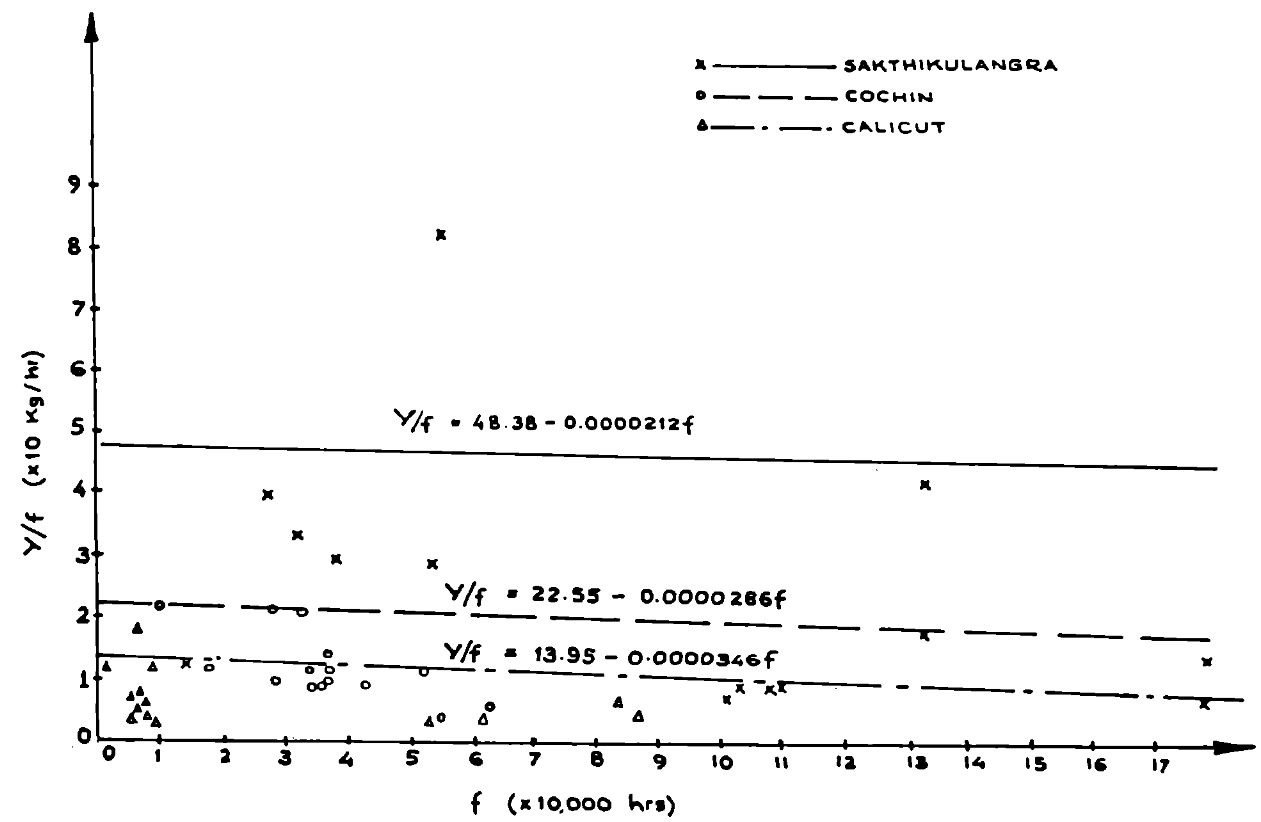


Fig.7.3 Relation between fishing effort and catch per unit effort.

Table 7.4 Estimated values of annual prawn catch (Y) and catch per unit effort (Y/f) for different levels of effort (f) for Sakthikulangara-Neendakara, Cochin and Calicut centres

(Sakthikulangara-Neendakara: Y/f: 48.38 - 0.0000212f, Cochin: Y/f: 22.55 - 0.0000286f, Calicut: Y/f: 13.95 - 0.0000346f)
(Y/f in kg and f in boat hours)

Sakthikulangara-Neendakara				Cochin				Calicut			
Annual effort in boat hours (10^4)	No.of boats per year i) 215 fishing days	Annual catch (tonnes)	Catch/hour (kgs)	Annual effort in boat hours (10^4)	No.of boats per year i) 215 fishing days	Annual catch (tonnes)	Catch/hour (kgs)	Annual effort in boat hours (10^4)	No.of boats per year i) 215 fishing days	Annual catch (tonnes)	Catch/hour (kgs)
25	145	10772.50	43.09	3	17	651.30	21.71	1.2	7	162.36	13.53
30	174	12609.00	42.03	6	34	1252.20	20.87	2.4	14	314.64	13.11
35	203	14339.50	40.97	9	51	1802.70	20.03	3.6	21	456.84	12.69
40	232	15964.00	39.91	12	68	2302.80	19.19	4.8	28	588.96	12.27
45	261	17482.50	38.85	15	85	2752.50	18.35	6.0	35	711.00	11.85
50	290	18895.00	37.74	18	102	3151.80	17.51	7.2	42	822.96	11.41
55	319	20201.50	36.73	21	119	3500.70	16.67	8.4	49	924.84	11.01
60	348	21402.00	35.67	24	136	3799.00	15.83	9.6	56	1016.64	10.59
65	377	22496.50	34.61	27	153	4047.30	14.99	10.8	63	1098.36	10.17
70	406	23485.00	33.55	30	170	4245.00	14.15	12.0	70	1170.00	9.75
75	435	24367.50	32.49	33	187	4392.30	13.31	13.2	77	1231.56	9.33
80	464	25144.00	31.43	36	204	4489.20	12.47	14.4	84	1283.04	8.91
85	493	25814.50	30.37	39	221	4551.30	11.67	16.6	91	1409.34	8.49
90	522	26379.00	29.31	42	238	4531.80	10.79	17.8	98	1436.46	8.07
95	551	26837.50	28.25	45	255	4477.50	9.95	19.0	105	1453.50	7.65
100	580	27190.00	27.19	48	272	4372.80	9.11	20.2	112	1460.46	7.23
105	609	27436.50	26.13	51	289	4217.70	8.27	21.4	119	1457.34	6.81
110	638	27577.00	25.07	54	306	4012.20	7.43	22.6	126	1444.14	6.39
115	667	27611.50	24.01	57	323	3756.30	6.59	23.8	133	1420.86	5.97
120	696	27540.00	22.95	60	340	2946.00	5.75	25.0	140	1387.50	5.55
125	725	27362.50	21.89	63	357	3093.30	4.91	26.2	147	1344.06	5.13
130	754	27079.00	20.83	66	374	2686.20	4.07	27.4	154	1290.54	4.71
135	783	26689.50	19.77	69	391	2228.70	3.23	28.6	161	1226.94	4.29
140	812	26194.00	18.71	72	408	1720.80	2.39	29.8	168	1153.26	3.87
145	841	25592.50	17.65	--	--	--	--	31.0	175	1069.50	3.45
150	870	24885.00	16.59	--	--	--	--	32.2	182	975.66	3.03
155	899	24071.50	15.53	--	--	--	--	33.4	189	871.74	2.61
160	928	23152.00	14.47	--	--	--	--	--	--	--	--

Table 7.5 Resource, MSY, f_{msy}, fishing effort and catch per unit effort for three important fishing areas

	U_{max}	Slope	MSY (kg)	f_{msy} (boat hours)	CPUE	No.of boats (215 days/ year)
Sakthikulangara-Neendakara	48.38	-0.0000212	27601702.0	1141037.7	24.19	663
Cochin	22.55	-0.0000286	4444951.7	394230.77	11.275	229
Calicut	13.95	-0.0000346	1406087.4	201589.59	6.98	117

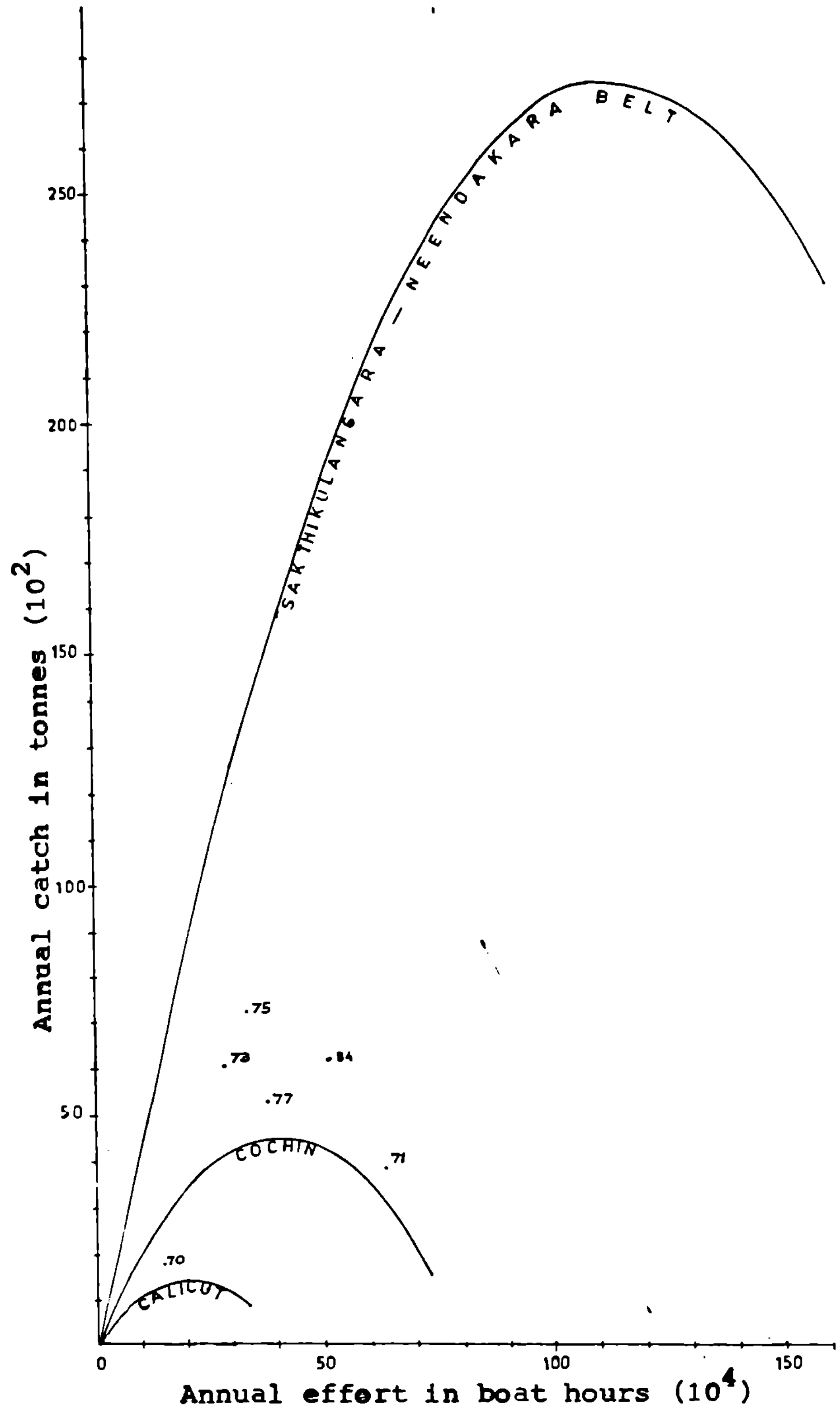


Fig.7.4 Comparisons of observed and estimated prawn yield curves for Sakthikulangara-Neendakara belt, Cochin and Calicut.

7.6.5 The U_{max}, annual MSY, f_{msy}, CPUE and the number of trawlers required for the three centres are given in table 7.5.

7.6.6 The MSY from the prawn stocks of Sakthikulangara-Neendakara base during the period 1970-84 is estimated to be 2,76,01,702 kilograms. For harvesting this amount of MSY, the annual effort (f_{msy}) required is 1,14,037.7 boat hours or 663 trawlers at the rate of 215 fishing days a year for 8 boat hours for a boat day. The distribution of annual yield and effort in the obsolute yield curve (figure 7.4) indicates overfishing. The average annual effort of 11,39,782 boat hours (662 trawlers at 215 fishing days a year) during 1970-84 was 99 per cent of f_{msy}. The average annual yield of 21,003 tonnes was only 76 per cent of the MSY. This shows that the effort has almost reached maximum possible level, but the yield has not reached at the MSY level (See figure 7.4).

7.6.7 The estimated value of MSY for prawn for the Cochin centre during the period 1970-84 is 44,44,951.7 kilograms. The level of f_{msy} for generating this MSY is 3,94,230.77 or 229 trawlers at the rate of 215 fishing days a year. The annual obsolute yield curve shows that overfishing happened in 1971, 1978, 1983 and 1984 (See figure 7.4).

7.6.8 A comparative analysis of the average annual effort of 3,62,400 boat hours (210 trawlers at 215 fishing days a year) during 1970-84 was 92 per cent of f_{msy}. The average annual yield of 4,018 tonnes was only 90.44 per cent of MSY. This shows that a small increase in the annual effort of about 8 per cent is possible to stabilise the yield at the MSY.

7.6.9 The MSY for the Calicut centre during 1970-84 is worked out as 14,06,087 kilograms. The corresponding calculated value of f_{msy} for generating this MSY is 2,01,589 or 117 trawlers at the rate of 215 fishing days a year. There is no indication of overfishing in this area as per the annual obsolute yield curve (see figure 7.4). In comparison with the annual average effort of 68,993 (40 trawlers at 215 fishing days a year) during 1970-84 was only 34 per cent of the f_{msy}. This shows that efforts should be increased at the earliest in order to stabilise the effort at the f_{msy}. The same is the result for the MSY and the annual average yield. The average yield of 472 tonnes is only 34 per cent of the MSY, also calls for the immediate increase in the effort to utilise the resources economically at this centre.

7.6.10 From the practical point of view, the resource estimate will become useful only when we are in a position to suggest the MSY of the important species in the different zones and based on this permissible fishing effort within the modern and traditional sectors as given in table 7.6.

Table 7.6 Area in km^2 from 0-20 m and 20-50 m distribution of TAC (in tonnes) for the coastal districts of Kerala

District	Area (km^2) in			Distribution of MSY in tonnes (Equation $Y = 4.6065X^{-0.6056}$)		
	0-20 m (only for the traditional sector)	20-50 m (tra net units)	Ratio of area in 0-20 m to area in 20-50 m	TAC in tonnes between the areas: Total (0-50m)	0-20 m (only for traditional sector)	20-50 m
Quilon	348.6	729.6	1:2.09	40411	13078	27333
Alleppey	742.4	1446.4	1:1.95	3781	1282	2499
Ernakulam	614.4	1523.2	1:2.48	2485	714	1771
Trichur	460.8	1356.8	1:2.94	1944	493	1451
Malappuram	512.0	1152.0	1:2.25	2347	722	1625
Calicut	716.8	1958.4	1:2.78	2140	574	1566
Cannanore & Kasargode	924.16	2406.4	1:2.60	3236	899	2337
Trivandrum	153.6	947.2	1:1.17			
Total	4472.76	11520.0	1:2.57			

Source: Kalwar, A.G. et.al., Report of the Expert Committee on Marine Fisheries in Kerala, Government of Kerala, C/o Central Institute of Fisheries Education, Bombay, 1985, p.91.

The MSY or the Total Allowable Catch (TAC) of 56,344 tonnes of prawns for all Kerala for the traditional fishermen in the 0-20 m (0-10f) grounds and the trawlers in the 20-50 m (10-25f) for each of the coastal districts is given in table 7.6. The 50 m depth limit fixed here is based on the condition that the small trawlers cannot operate beyond this area. The allocation of TAC in proportion to the area between 0-20 m depth zones are based on the assumption that uniform distribution of prawns from the coast is found to a depth of 50 m.

7.6.11 Out of the total MSY of prawns (56,344) in Kerala 71.72 per cent (40,411 tonnes) is from the Quilon district itself, showing the importance of the concentration of mechanised vessels in Sakthikulangara-Neendakara belt. From the total catch of the 0-20 m depth zone of the traditional sector (17,762 tonnes), 73.62 per cent (13,078 tonnes) is obtained from Quilon district itself. The same is the case with the 20-50 m depth zone of the tramel net units with 70.84 per cent (27,333 tonnes) in Quilon. When we compare this MSY of 40,111 with the total fishable area in kilometres Quilon is having only the lowest.

7.6.12 The Kalwar Committee (1985) estimated the MSY and the maximum effort (f_{msy}) required within the inshore areas of Kerala. The Committee found that the MSY of the state's inshore waters (50 m) contained about 4,39,203 tonnes consisting of 3,19,317 tonnes of pelagic and 1,19,886 tonnes of demersal stocks. Based on this the committee prescribed the maximum numbers of crafts needed to the state.

7.6.13 Kerala has over 3,000 mechanised boats; but if we analyse the Total Allowable Catch (TAC) the resulting Maximum Sustainable Yield (MSY) and the f_{msy} show that we need only 1658 boats. Due to the absence of any licensing and annual registration procedures the increase in the fleet has been largely anarchic since the resource base is common property. As long as a condition of free and open access is maintained, and as long as the demand for the product increases, a fishery will inevitably attract excessive units of capital and labour and will eventually become waste. This regime allows 'getting away what you can before your neighbour does' will lead to what is sometimes called the tragedy of the commons (Bell, 1978). In table 7.7 the resource availability base, the MSY principle and the Maximum Total Allowable Catch (MTAC) are worked out for various coastal districts together with the optimum number of vessels for the 20-50 m grounds. For the future it is important that all further construction and licensing of boats be regulated to keep the fleet strength to an optimum level.

Table 7.7 The total allowable catch (TAC) and the optimum number of trawlers in respect of the 0-50 m grounds area

District	TAC in tonnes	Optimum number of trawlers	
		(0-20 m)	(20-50 m)
Quilon	27,333	191	400
Alleppey	2,499	134	262
Ernakulam	1,771	69	171
Trichur	1,451	32	93
Malappuram	1,625	18	40
Calicut	1,566	8	21
Cannanore and Kasargode	2,337	61	158
Total	38,582	513	1,145

Source: Kalwar, A.G.et.al., Report of the Expert Committee on Marine Fisheries in Kerala, Government of Kerala, C/o Central Institute of Fisheries Education, Bombay, 1985, p.95.

7.6.14 It is true that the regulation of fleet strength will result in reduction of employment opportunities for the boat workers. But one must realise the fact that unplanned increase in the boat workers as a result of growing mechanisation has led to increasing pauperisation of the traditional sector. So regulation of the number of boats will have only short run problems, and it is expected that such a measure will start showing favourable effect to both the mechanised and traditional sector in two ways--first in the traditional sector, the reduction of mechanised vessels will help to get more catches and also the present motorisation of small vessels in the traditional sector in search of employment, the second effect is in the mechanised sector itself, i.e., the catch of the vessel allowed to operate will increase and this will definitely increase the income of the workers since they are working on a share-of-proceeds basis (Rajasenan, 1986b).

7.6.15 Once the policy makers decide to restrict the number of trawlers, the problem of rehabilitation of the excess trawlers will come up. As it is estimated that only 1,658 mechanised trawlers are considered to be the optimum, more than, 862 of the existing trawlers become excess. The question then is whether they can be used economically in the near future. The answer is positive. There is ample scope for expanding and explorating different types of fishery which we have not been exploited so far. These include the engagement of fishing in white bait fishery, hook and line fishery for some species, dory fishing, squid jigging, longlining, drift gill netting etc. It is estimated that more than 120 trawlers can be profitably employed in whitebait fishery in areas beyond 20 m line in day time pair trawling since whitebaits aggregate into compact schools in the sea bottom during day time. This would call for information on school location, school intensity and seasonal changes gathered from various sources. So there is need for undertaking UNDP-PFP type of survey (1972-75) every year for the benefit of the industry.

7.6.16 There is good potential for hook and line fishery for rock cods, perches and red snappers in the Kalava grounds all over Kerala in 72 to 114 m depths, especially of the Quilon and Trivandrum districts. So more than 180 vessels can be deployed for this purpose with maximum allocation to Quilon and Trivandrum districts. More than 60 boats can also be used in the dory fishing for towing non-mechanised canoes (3 to 5 canoes per boat) to the Kalava grounds of 72 to 113 m depths. About 100 vessels could be used for squid jigging. So the fishermen are to be trained in this new area of fishing. About 200 vessels may also be deployed for longlining for sharks in the 100-200 m depths. And the remaining vessels should be used for fishing the larger pelagic fishes like tuna, seerfishes and also for drift gill netting for waters beyond 50 m depth for larger seerfishes and tunas.

7.6.17 , A major problem facing administrators is how to effectively control effort in the heavily fished areas, while at the same time not preventing gains in economic efficiency or preventing development of new fisheries? Any fishery is likely to experience periods of high profitability, particularly in its early phase of development, and attract much more investment in vessels, gear etc., than is required in the longer term. Once stocks are fully exploited, competition amongst fishermen increases as they try to maintain their share of a static or diminishing resource, i.e., spend longer on grounds, use larger and more efficient engines, etc. It seems inescapable that fisheries require some form of regulation in order that the fishing industry shall remain viable and capable of generating capital employed in the long run. The most essential regulatory measure required in our fishery is a reduction in effort. Management and regulation of this nature is both economically and socially necessary and inevitable.

7.7 Legal measures

7.7.1 The entry of mechanised sector into fishing developed a conflict of interests with the traditional fishermen. The feeling of the traditional fishermen that they are squeezed out of existence in an unfair competition led to agitations, clashes and popular protests. In these circumstances, there arose an urgent need to evolve and enforce realistic legal measures, particularly to the near shore waters.

7.7.2 In 1976 the Government of India appointed the Majundar Committee to examine the question of demarcating separate areas for different types of fishing vessels and crafts. Prior to this Committee's submitting its report the Union Government directed the states to legislate setting apart waters upto five kilometres from the shore for the exclusive use of the traditional crafts. Accordingly the Kerala Marine Fishing Regulation Act 1980 came into existence with effect from November 29, 1980.

7.7.3 The Act empowered the Kerala Government, among other things, to regulate, restrict or prohibit (a) fishing in any area by any class of vessels, (b) the number of vessels that may be used for fishing in any area, (c) the catch of any species of fish for any particular period and, (d) the use of any fishing gear in any area.

7.7.4 This power can be exercised (i) to protect the interests of different sections of persons engaged in fishing, particularly the traditional fishermen, (ii) to conserve fish and regulate fishing on a scientific basis, and (iii) to maintain law and order in the sea.

7.7.5 The State Government issued in November and December 1980 a series of notifications under this Act. The notifications provided that:

1) Non-mechanised traditional fishing craft should be allowed to operate exclusively upto a distance of 10 km from

the shore where no other type of vessels should be allowed to fish.

2) Mechanised fishing boat should operate beyond a distance of 10 km from the coast.

3) Bigger mechanised fishing vessels OAL 20 m and above should operate beyond a distance of 23 km from the coast, i.e., beyond the outer limit of the territorial sea.

7.7.6 One of the objectives of delimitation was to safeguard and protect the traditional fishermen who constitute more than a lakh, operating with sail boats and beach seines in the coastal waters close to the shore. The present pathetic condition of the traditional fishermen who operate traditional crafts demand protection from encroachment by mechanised vessels and deep-sea trawlers by regulating mechanised fishing in terms of fishing areas.

7.7.7 But the sad part of the action initiated by the government is that, it is difficult to enforce any regulation in the sea as it is difficult to demarcate the fishing area. Its overall impact on the society is a matter of anxious considerations for those who are concerned about the future (Vincent, 1978). So once the need for enforcement of regulation is established, and the different interest groups made to realise that the need for compliance with regulation is bound to find acceptance by the fishermen over a period of time as in the case of some foreign countries who have introduced some kind of regulations.

7.8 Closed seasons and areas

7.8.1 Most fishermen in the traditional sector of Kerala feel that there is depletion of fishery resources. The operation of trawling boats during the months of June-August when most of the fishes are reported to breed, cause extensive damages to eggs and juveniles. One of the important regulatory measures widely accepted for fishery management is prohibition of fishing at certain times or in certain places. Seasonal closure is more viable in the peak spawning period of prawns. In the earlier periods the season for prawns extended throughout the year, but now as a result of overfishing many varieties of prawn are not available, and also the majority of the species are confined to few months and that too long in Neendakara area. The 'karikkadi chemmeen', the mainstay of the mechanised fishing sector in Neendakara during June-August seasons, dwindled in quantities. This 'karikkadi chemmeen', if allowed to grow, will attain a size of 110 mm and has a life-span of two years. So a closed season is not going to result in loss of fishery. In fact it will be more productive at a later stage because the size of prawns will be larger.

7.8.2 The fishing seasons in Kerala extend broadly from July to May in most districts. In the case of mechanised boats, year-round operations are reported from Neendakara and Cochin. In the northern districts of Kerala, trawling commences from October/November and ends by April/May. The peak seasons for some of the species are reported to be as shown below:

Species	Peak-seasons
White bait	October - November
Oil-sardine	October - November
Mackeral	November - January
Karikkadi	June - August
Poovalan	June - September
Naran	June - August

7.8.3 The breeding season for most of the fish varieties is understood to have been during the months of June-August. The considered opinion is that breeding takes place in 15 to 25 fathom depth range. The breeding seasons of different species of fish as reported by fishermen are given below:

Species	Months
Prawn (Naran and Poovalan)	June - August
Karikkadi	September/March-April
Oil-sardine	June - August
Mackeral	June - August

7.8.4 During the monsoon and the months immediately following, there is a movement of fish from the offshore to the inshore and coastal waters. The water pollution caused by the factory effluents discharged into the rivers and backwaters results in a tendency for fish to move away into outer waters. This creates the scarcity of fishery resources in the inshore waters causing very low catches in the traditional sector. But a wonderful phenomenon is that small fishes do not migrate to deeper waters. The breeding grounds of oil-sardine and mackeral are reported to be outside the coastal belt of 10-12 fathom depth range (Noble, 1974). Even though there are no sharply defined spawning areas, larve and juveniles of mackeral are frequently found in areas between 9° and 13° N with bottom depths of around 30 m. Bulk of sardine biomass is reported in areas between 10° and 13°N.

7.8.5 As an important regulatory measure, a seasonal restriction of this nature will help very much to recover our depleted demersal fishes. This will help to bring back the prawn fishing industry from the ill effects of trawling. This measure has to be directly enforced by closing the ports and vigilant watch at sea. The declining trend in fishing and the regulation including prohibiting certain destructive gears in certain seasons is not a new thing in Kerala inviting certain minority interests to raise in arms against it. If 'mathichala vala' and 'mathikkolli vala' were destructive gears in Kerala during 1943, trawling and purse-seiners were found to be destructive methods of fishing after 1976. So it has to be restricted (Kurien, 1984a).

7.8.6 But this may have some opposite effects. Any ban on the trawling operations along the coast of Kerala during the months of June-August will cause economic hardships to mechanised boat owners, processors and exporters and large number of labourers working on the boats, processing establishments and allied activities. It is estimated that about 6,000 fishermen and 20,000 other workers get employment during the south-west monsoon period in Sakthikulangara-Neendakara area on account of trawling during June-August. A ban on trawling operations during these months (which happens to be the most productive months) at Sakthikulangara-Neendakara (which happens to be the main prawn producing centre) would mean not only loss of employment for thousands of workers, but disaster to the entire mechanised trawling activity which has contributed substantially to the modernisation of the fishing industry in Kerala and economic well-being of the fishermen (Gopalan, 1980). It would considerably reduce the share of the country's foreign exchange earnings earned through the export of marine products.

7.9 Mesh regulation

7.9.1 An alternative to banning trawling operations during the said period is the regulation of the mesh size of the cod-ends of the trawl used. This will ensure a standing stock of fish which will reproduce themselves to maintain the flow of catch, ceteris paribus. An increase in mesh size will initially reduce the catch but will ultimately raise it by increasing the stock.

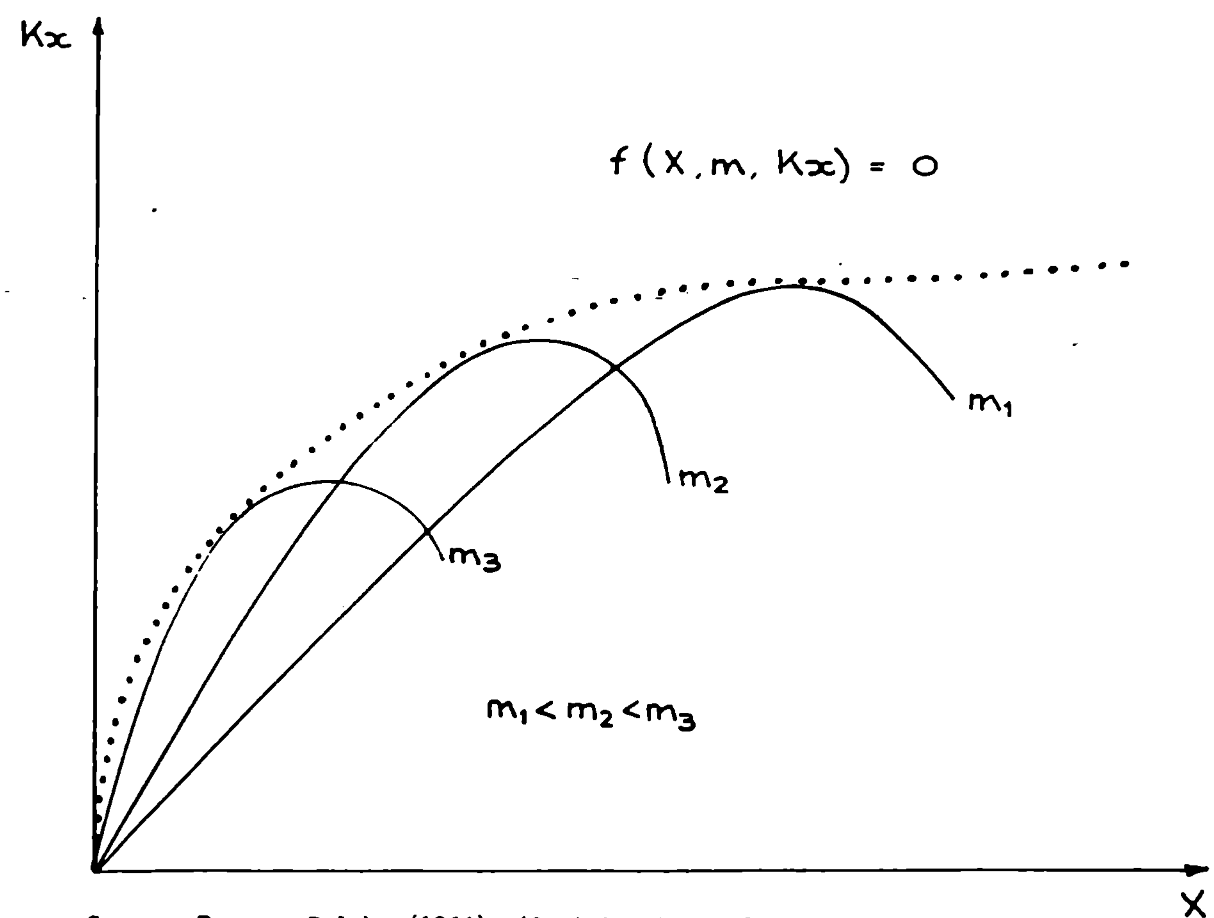
7.9.2 When the population is exploited by employing a mesh size m so that harvesting will be confined to those members whose size is m, a natural generalisation of the growth hypothesis is

$$X = f(x, m, kx) \qquad (1)$$

This equation assumes that f(x, m, kx) as a function of X for any given m and kx. Where k represents identical fishing vessels or firms, each producing at a catch rate x pounds per unit time. Total harvest rate is then kx which will provide an illustrative mapping of the recruitment function as given in figure 7.5.

7.9.3 It is assumed that $f_3 < 0$, i.e., any increase in harvest will lower net recruitment and also an interaction is assumed between the harvest and the productivity of the stock.

Fig.7.5 Relation between catch and recruitment



Source: Turvey, Ralph, (1964), 'Optimisation and sub-optimisation in fishery regulation', *American Economic Review*, LIV, No.2, Part I (March), p.68.

If there is no interaction, then $\dot{X} = f(x, m) - kx$; i.e., an additional tonne of catch reduces instantaneous growth by a tonne. If we let $\hat{\pi}$ be the minimum rate of profit required to hold a vessel in the industry, then total cost per unit of time is assumed to be given by $C = \emptyset(x, X, m, k) + \hat{\pi}$ for an individual fisherman and fishing vessel. Here m enters only as a private cost factor in $\emptyset$. As an externality it enters indirectly via equation (1). Finally an increase in the size of the industry, with x, X and m fixed, will increase each vessel's operating cost due to crowding. Where population size is very large relative to the industry, resource stock externalities are likely to be negligible. Hence we assume that

$$\frac{\partial c}{\partial x} \equiv C_1 > 0, \quad \frac{\partial c}{\partial X} \equiv C_2 \leq 0, \quad \frac{\partial c}{\partial m} \equiv C_3 > 0, \quad \frac{\partial c}{\partial k} \equiv C_4 \geqslant 0$$

Ceteris paribus industry revenue R(kx, m) is assumed to depend upon both the harvest kx and the mesh size m used by all k vessels in the industry. The profit of the industrial fishermen can be written as

$$\pi = P(m)x - C(x, X, m, k)$$

where $P(m) = \left[R(kx,m)\right]/kx$. Thus for given m, the individual fisherman perceives a fixed price $P(m) = \left[R\ (kx, m)\right]/(kx)$ at which he will sell unlimited quantities of fish x, giving him a revenue P(m)x. His profit maximising decision rules are therefore,

$$P(m) \quad \frac{R(kx,\ m)}{kx} \quad = \quad C_1(x,\ X,\ m,\ k) \qquad (2)$$

$$P'(m) \quad R_2\ \frac{(kx,\ m)}{k} \quad \leqslant C_3(x,\ X,\ m,\ k) \text{ if } \quad m = \underline{m} \qquad (3)$$

Condition (2) requires the perceived price to equal marginal catch cost, and (3) requires the marginal revenue from varying the composition of catch (mesh) to equal its marginal cost. If, in the latter case, marginal cost exceeds marginal revenue at the maximum, then $m = \underline{m}$, that is we make mesh as small as possible.

7.9.4 A necessary but insufficient condition for maximisation is that mesh size be such as to maximise catch (x) for the actual level of fishing effort (kx). In terms of figure 7.5 this means that the fishery must be 'on' the dotted envelope curve, known as the 'eumetric yield curve'. It is a property of this curve that, unlike the individual yield curves for a given mesh size, it is asymptotic to the horizontal, thus rising throughout its length.

7.9.5 If we analyse the trawl catches of Kerala fisheries we can see that trawl catch comprises of juveniles of prawn and other demersal fishes. This advocates for the regulation of mesh sizes. In respect of prawn, the main destruction is on juveniles which are caught in the trawl nets and stake nets. A stipulation that cod ends of trawl and stake nets should not have mesh size smaller than 35 mm, is to be enforced to conserve the juveniles. But when we consider the prawn resources of Neendakara, especially of P.Styliferia (Karikkādi) and M.Dobsoni (Poovalan), some are of opinion that if the mesh size is fixed at 35 mm, we are going to lose a good quantity of these resources.

7.9.6 Mechanised boat owners expressed that 35 mm to be too large to catch commercial shrimps effectively. The basic problem in shrimp size selectivity by gear is one of determining the optimum size of the shrimp by taking into consideration (i) the existing ban on export of shrimps of counts exceeding 500 per kg, (2) the optimum size of exploitation, (3) the length of recruitment into the marine stock from the backwaters and estuaries, (4) the size of the first maturity. Once we decide on the optimal length of the first capture (LC) to satisfy any or four criteria mentioned above, the coded mesh (m) necessary to realise this, is estimated from the relation,

$$m = \frac{LC}{k}$$

where k is the selection factor determined from the length frequency data for different mesh sizes. A study (Appukuttan *et.al.*, 1965) conducted for the observed length of first capture (LC) in mm and selection factor k = 2.0050 is given in table 7.8

7.9.7 The coded mesh size required to realise these values are 36.25 mm, 32.25 mm and 34.00 mm respectively. So the legal minimum of 35 mm is a reasonable one for all commercially important species.

7.10 Environmental problems

7.10.1 A great variety of pollutants are produced by man and many of them reach the aquatic environment either directly or indirectly. The magnitude of pollution depends partly on the density of population and partly on the level of industrialisation. Increasing industrialisation, urbanisation and exploitation of natural resources resulted not only in increasing deterioration of environmental quantity and depletion of exploitable resources, but also in human health hazards through consumption of contaminated food (FAO, 1971).

7.10.2 Different pollutants have different effects on living aquatic organisms and on fisheries. Some stimulate the growth of plants and could have beneficial effects if properly controlled; some are toxic and can kill aquatic organisms or make them unfit for human consumption and others

Table 7.8 Observed length at first capture (LC) in mm and selection factor mean (K) for covered coded method and trouser coded method

Mesh size (mm)	Mean values					
	P.Styliferia		M.Dobsoni		M.Affinis	
	LC	K	LC	K	LC	K
26.99	--	--	50.50	2.0927	--	--
33.69	52.00	1.5435	58.00	1.7216	--	--
39.69	87.25	2.1983	87.75	2.2109	--	--
44.45	93.33	2.0998	100.43	2.2595	84.00	1.8898
49.21	--	--	--	--	104.50	2.1236
52.38	--	--	--	--	113.50	1.9760
		1.9472		2.0712		1.9965
	Mean K for the 3 species = 2.0050					

Source: Appukuttan et.al., "On the Selection Action of the Coded Meshes of a Shrimp Trawl", Fishery Technology, 2(2), 220-248 (1965).

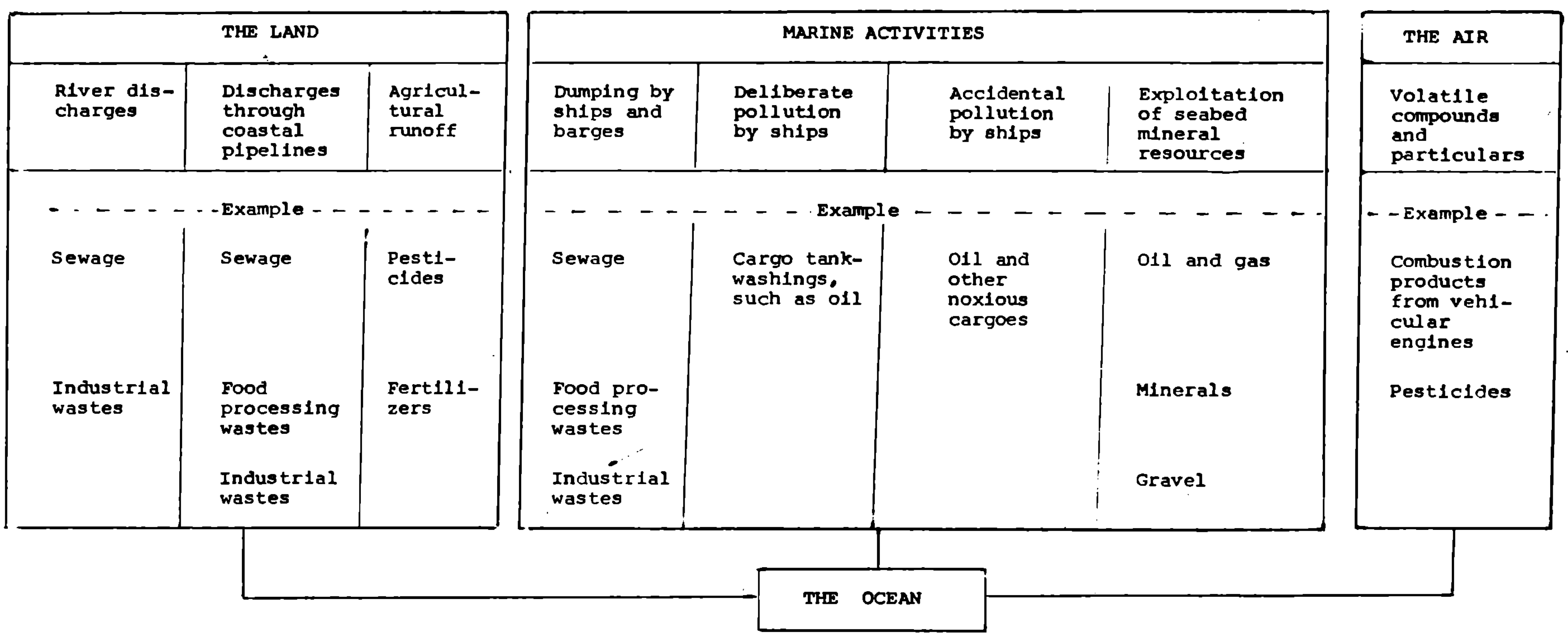
have little or no effect on the aquatic ecosystems. For the persistent pollutants the ocean is the ultimate sink in which they accumulate in the water, in organisms or in bottom sediments. These pollutants reach the sea by a variety of transport mechanisms as given in figure 7.6.

7.10.3 The effect of pollution in the harvestable fish resources of Kerala from the sea, rivers and backwaters are largely due to industrial effluents, domestic sewage, pesticides and also land reclamation. The nature of pollution of the different aquatic ecosystems are discussed below in some detail.

i) Rivers

7.10.3.1 About 175 large and medium scale industries discharge various effluents into the rivers in Kerala. Out of the 8,000 small scale industrial units about 2,000 are contributing to river pollution. A recent study shows that about 6.5 lakh m^3 of trade effluents are being dumped into rivers and tidal waters everyday. The waste from the chemicals contribute about 45 per cent chemical pollutants, 45 per cent from industries with organic pollutants and the rest is contributed by the waste from the engineering and other industries. The quantity of effluents and the mode of disposal discharged from major industries are presented in table 7.9.

Figure 7.6 The Origins of Marine Pollution



Source: "Pollution--An International Problem for Fisheries", FAO Fisheries Series, No.4, FAO, 1971, p.8.

Table 7.9 Quantity of effluents and mode of disposal from major industries in Kerala

Type/Name of industries	Waste water disposal (litres/day)	Mode of disposal
I. Non-ferrous metallurgical industries		
i) Indian Aluminium Co., Alwaye	13,700,000	into Periyar river
II. Ore processing industries		
i) Cominco Binani Zinc Ltd., Binanipuram	23,150,000	into Periyar river
ii) Indian Rare Earths Ltd., Chavara	2,299,000	into Ashtamudi Lake
iii) Indian Rare Earths Ltd., Udyogamandal	4,586,400	into Periyar river
III. Petroleum industries		
i) Cochin Refineries Ltd., Ambalamugal	8,250,000	into Chitrapuzha river
IV. Chemical industries		
i) Titanium Products Ltd., Trivandrum	1,000,000	into Arabian Sea
ii) T.K.Chemicals, Trivandrum	77,000	Land disposal
iii) Travancore Electro-Chemicals Ltd., Chingavanam, Kottayam	40,000	into Mulakanchira canal leading to Vembanad Lake
iv) Premier Tyres Ltd., Kalamassery	600,000	Land disposal

Type/Name of industries	Waste water disposal (litres/day	Mode of disposal
v) Travancore Cochin Chemicals Ltd., Udyogamandal	10,200,000	into Periyar river
vi) Hindustan Insecticides Ltd., Udyogamandal	325,000	into Periyar river
vii) Periyar Chemicals Ltd., Binanipuram	120,000	into Periyar river
viii) Appolo Tyres Ltd., Chalakudy	1,138,000	into irrigation canal and land disposal
ix) Gwalior Rayons, Mavoor	51,110,000	into Chaliyar river
V. Textile industries		
i) Madura Coats Ltd., Koratti, Trichur	2,500,000	into Chalakudy river
ii) Sitaram Textiles Ltd., Trichur	720,000	into Karimpuzha Thodu
iii) Travancore Rayons Ltd., Perumbavoor	73,000,000	into Periyar river
VI. Paper industries		
i) Punalur Paper Mills, Punalur, Quilon	8,900,000	into Kallada river
ii) Hindustan Paper Corporation Ltd.,Velloor	33,000,000	into Muvattupuzha river

Type/Name of industries	Waste water disposal (litres/day)	Mode of disposal
VII. Fertilizer industries		
i) Fertilizers And Chemicals Travancore Ltd., Udyogamandal	61,000,000	into Periyar river
ii) -do- Cochin Division, Phase-I	12,000,000	into Chitrapuzha river
iii) -do- Cochin Division, Phase-II	40,800,000	into Chitrapuzha river
VIII. Processing of animal or vegitable products,industries		
i) Lekshmi Starch, Kundara	1,150,000	into Ashtamudi Lake
ii) Padinjarekkara Agencies, Kottayam	92,000	Land disposal
iii) Travancore Sugars and Chemicals Ltd.	45,815,000	into Pampa river
iv) Tata Oil Mills Co.Ltd., Ernakulam	12,700,000	into Vembanad Lake
v) Milk Project, Edappally, Ernakulam	90,000	into Pathadipalam Canal
vi) Kerala Chemicals & Proteins Ltd., Koratti	2,400,000	into Chalakudy river
vii) Tapioca Products, Chalakudy	320,000	into Chalakudy river
viii) Western India Plywood Ltd., Balipattom, Cannanore	50,000	into Valapattanam river
ix) Vanchinadu Leathers, Kuttippuram	120,000	into Bharathapuzha river

Source: Kalwar, A.G.et.al., Report of the Expert Committee on Marine Fisheries in Kerala, Government of Kerala, C/o Central Institute of Fisheries Education, Bombay, 1985, pp.340-342.

7.10.3.2 The chemical industries are responsible for the pollution of the river Periyar. This river is subjected to the maximum quantity of effluents as 25 per cent of the chemical industrial units are concentrated in and around the banks of this river. The lower reach of the river Periyar below the Udyogamandal is heavily polluted. The discharge of waters containing mercury from the major chlor-alkali industry, viz., Travancore Cochin Chemicals, the likely presence of radioactive materials from the discharges of Indian Rare Earths Ltd. and the DDT and other insecticides from the Hindustan Insecticides Ltd., combined with polluting chemicals from the industries make the pollution problem in these rivers serious. River Pampa receives waste discharges from Travancore Sugars and stretches of river Kallada are heavily polluted due to discharges from the Punalur Paper Mills.

7.10.3.3 In addition to pollutants fish mortality is also caused by environmental and climatic patterns such as severe drought conditions, late commencement of monsoon etc. A recent study on acidity and fish mortality in the Vembanad Lake (wellknown for its fishery resource as well as for its role as a nursery ground for the commercially important crustacean fishery) to determine the caustive factor and to record the recovery of the situation due to pH variation and acidity (Pillai *et.al.*, 1983). The annual discharge of about 11,106 M m^3 of the four major river systems (Meenachil, Manimala, Pamba and Achancoil) enter into the Vembanad Lake through Thanneermukkam barrage. The ecology of the area with respect to ability to sustain life, both on land and in water, is conditioned by salinity, which, in turn, is controlled by the combination of flood waters and sea water entering into the lake. The reason for the persisting low pH could be that the river water input into the lake after several spells of monsoon showers has not been sufficient to flush the acids produced in the water.

ii) Backwaters

7.10.3.4 Extensive infenstation of Kerala backwaters by the water hyacinth locally known as 'African payal' (*Salvine molesta*) has reduced the biological productivity potential. Decaying water hyacinth contributes extensively to the biological pollution of Cochin backwaters. The presence of pathogenic bacteria like *Escherine coli* and *Salmonella falcalis* in the Kerala backwaters warrants thorough bacteriological quality control of the marine products marketed. Another source of backwater pollution is the faecal pollution. In Cochin itself about one million households have latrine openings directly into the backwaters while the remaining four million households have latrine openings into septic tanks (Unnithan et.al., 1974). Another reason for the deterioration in water quality in the Kerala backwaters is the retting of coconut husk (Remani et.al., 1981). All these led to high level environmental degradation in the Cochin backwaters, and this resulted in the presence of four species which remained hardest in 1983-84 in comparison with the presence of 22 species that flourished here during 1963-67.

iii) Marine

7.10.3.5 Everyday the Travancore Titanium Plant, Trivandrum discharges about 4,000 m^3 of effluents characterised by high temperature (at discharge point) 45 to 50°C sulphuric acid content of 3 per cent and ferrous sulphate content of 10-40 g/litre. Almost the same amount of effluent is discharged into the Arabian Sea by the Chavara Titanium Plant, Quilon. This kind of aesthetic degradation of nearshore region can be considerably reduced by controlling the source of pollution.

iv) Reclamation

7.10.3.6 Intensive land use pattern as a result of population pressures affected in widespread land reclamation along the Kerala estuaries and backwaters. A recent estimate of land reclamation in Kerala shows that reclamation of land in Kerala is over 1,20,700 hectares (Madhupratap et.al., 1979). Reclamation is done by constructing bunds and dewatering from low-lying lands along the waterways. Increasing land reclamation drastically changes the sediment transport pattern and gives rise to siltration and erosion, and adversely affect the nursery grounds of prawns in the backwaters and estuaries. Another feature of the land reclamation in the backwaters is that it affects the circulation of water and transport of young prawn especially in the traditional 'pokkali' fisheries (Rajasenan, 1985).

v) Beach erosion

7.10.3.7 During monsoon seasons about 25 per cent of Kerala's 590 km coastline is subjected to varying degrees of erosion. But this type of sea erosion is severe in various parts of the state especially between the shorelines of Trivandrum, Alleppey, many kilometers north and south of Cochin, the shoreline between Calicut and Cannanore and in the coastal areas of Mavassery, Thottappally and Purakad. The shore erosion has very high impact on the traditional shore landing facilities especially during monsoon on the fishermen community as they have very much reduction in landing.

vi) Aquaculture and water pollution

7.10.3.8 The relation between aquaculture and pollution is of the water affects very much to animals living in a water body. The animals are sensitive to the physical and chemical changes to which many of them have a low tolerance range. The tolerance of the animals also varies with their stage of development. Thus a very young animal may be more sensitive to pollutant than an adult. Fishes living in a culture system are subjected to changes in water to a greater extent than those in the natural surroundings as they cannot select the environment in which they live (Ramachandran Nair, 1981).

Chapter VIII

KERALA'S SEAFOOD EXPORT

8.1.1 The seafood industry of Kerala is one of the major export-oriented industries. The main objective in developing fishery based on species for export is to earn foreign exchange. The increased export earnings from marine products is mainly due to the mechanisation and modernisation of fishing methods, particularly shrimp trawling. The seafood export sector has two distinct phases. The oldest of them is the sector engaged in dried seafoods. Until about 1954, the entire seafood export of the state comprised only of dried marine products. With the adoption of new processing techniques like the freezing and canning there has been a drastic change in the composition of seafood exports. In 1984-85 freezed and canned products constituted about 90 per cent of the total quantity exported and 95 per cent of the total value earned through seafood export. The industry earns for the state valuable foreign exchange worth more than Rs.140 crores annually, and this is about 20 per cent of the total export earnings of the state at an average for the last three years.

8.1.2 For the sound flow of seafood trade the following factors are considered important:

i) Diversification of export production and export market

ii) A regular flow of market information

iii) Development of suitable packaging for the preservation and consumer attraction

iv) Quality control measures specially suitable to the foreign markets.

8.1.3 As many as 35 items figured in the export of marine products in the last 25 years. Of them ten accounted for the bulk of our exports, but the growth of seafood export largely depends upon the availability of a single item, namely shrimp. Shrimp alone accounted for 84.85 per cent in terms of quantity and 90.71 per cent in terms of value during the year 1984-85.

8.2 Export trend

8.2.1 Till the close of 1960 Kerala's marine products exports were largely confined to items like dried fish, dried prawns, dried shark fins and dried fish. However, after 1961 the position has changed. From now on the exports of dried marine products started witnessing a downward trend, frozen and canned items made their appearance and they began to make steady progress. Especially after 1966, the export of canned and frozen products have showed a significant rise. The devaluation of the Indian currency in that year helped in getting high unit value realisation for the fishery products (Rao, 1983).

Another remarkable feature of this period was the opening up of markets in many of the developed countries. As a result, Kerala's foreign trade in processed seafood has made rapid strides. The progress during the last 15 years is shown in table 8.1.

8.2.2 A total quantity of 30,577 tonnes of processed seafood was exported in 1984, netting a foreign exchange earning of Rs.140.41 crores in comparison with Rs.27.52 crores in value in 1970. Though the growth in the quantity has not been substantial, valuewise this is the highest recorded during the entire history of Kerala's seafood export industry. This is because of the increased unit value realisation of more than 40 per cent achieved for the exported commodity in 1984 (45.92/kg) compared to that of 1981 (32.58/kg).

8.2.3 If we compare the marine products exports of Kerala with that of India from 1965 to 1984 we can see that Kerala's share of export items of quantity had been showing a declining trend. In 1965, out of a total of 15,453 tonnes of marine products exports, Kerala alone contributed 9,930 tonnes, i.e., 64.3 per cent. This tendency of high export rate was maintained upto 1973 with a higher percentage in 1969, i.e., 74.4 per cent. But after 1979 Kerala's quantity share has been declining and it ranged between 34 and 40 per cent only. This is given in table 8.2.

Table 8.1 Annual growth rate of seafood exports

Year	Quantity (tonnes)	Value (Rs.in crores)	Annual growth rate Quantity	Annual growth rate Value	Average unit value realisation
1970	24077	27.52	+5.6	-0.6	11.43
1971	21569	30.16	-10.4	+9.6	13.98
1972	25519	42.27	+18.3	+40.2	16.56
1973	30826	54.08	+20.8	+27.9	17.54
1974	24529	43.36	-20.4	-19.8	17.68
1975	32478	60.30	+32.4	+39.1	18.57
1976	31155	87.95	-4.1	+45.9	28.23
1977	27802	74.68	-10.8	-15.1	26.86
1978	31855	85.02	+14.6	+13.8	26.69
1979	31988	109.87	+0.4	+29.2	34.35
1980	28472	88.46	-11.0	-19.5	31.07
1981	32260	124.45	+13.3	+40.7	32.58
1982	33215	138.46	+3.0	+11.3	41.69
1983	32555	140.28	-2.0	+1.3	43.09
1984	30577	140.41	-6.1	+1.1	45.92

Source: The Marine Products Export Development Authority, Statistic of Marine Products Exports , Cochin, 1981-1985.

Table 8.2 Quantitywise share of Kerala's marine products export

Year	Kerala			India	Kerala's share
	Cochin	Calicut	Total		
1965	9930	--	9930	15453	64.3
1966	11595	--	11595	19153	60.5
1967	14784	3	14787	21764	67.9
1968	16876	42	16918	24810	68.2
1969	22695	61	22756	30584	74.4
1970	23987	89	24076	37175	64.8
1971	21542	27	21569	34032	63.4
1972	25466	53	25519	38271	66.7
1973	30782	44	30826	48785	63.2
1974	24214	315	24529	46629	52.6
1975	32331	147	32478	53412	60.8
1976	31024	131	31155	62151	50.1
1977	27757	45	27802	64964	42.8
1978	31652	203	31855	77946	40.9
1979	31633	355	31988	92184	34.7
1980	28136	336	28472	74542	38.2
1981	31901	359	32260	75375	42.8
1982	32946	309	33215	75136	42.9
1983	32514	41	32555	86169	37.8
1984	30385	192	30577	89912	34.0

Source: The MPEDA, <u>Statistics of Marine Products Exports</u>, Cochin, 1981-1985.

8.2.4 Of the two ports through which we export our marine products, Cochin port constitutes the lions' share of Kerala's seafood export. The other port viz., Calicut accrues only a minor share. For example, out of an export of 30,577 tonnes in 1984 from the state, the share of Calicut port was only 192 tonnes. This shows that more than 99 per cent of the export shipped only from the Cochin port. The itemwise share of Kerala's export (quantitywise) is given in Appendix V.

8.2.5 A comparative analysis of the value earnings of Kerala's marine products export for the last two decades with that of all India figures, also shows that the value of exports from Kerala has declined over the years. The data are presented in table 8.3.

8.2.6 In 1965 the total earnings of the Indian seafood export amounted to Rs.6.92 crores. Of this, Kerala's share was Rs.5.83 crores, i.e., 84.3 per cent. Afterwards Kerala's share was getting reduced, and in 1984 the state's share came to as low as 36.4 per cent. In absolute terms, out of India's earning of Rs.385.50 crores Kerala's share was Rs.140.41 crores only. Out of the export earnings of the state's two ports, Cochin port contributed about 99 per cent of the Kerala's share. The value-wise and itemwise share of Kerala's export are given in Appendix VI.

Table 8.3 Valuewise share of Kerala's marine products export

Year	Kerala			India	Kerala's share
	Cochin	Calicut	Total		
1965	58338	--	58338	69237	84.3
1966	114657	--	114657	135246	84.8
1967	168498	4	168502	199785	84.6
1968	181362	61	181423	220846	82.1
1969	277060	166	277126	340731	81.3
1970	275100	110	275210	355359	77.4
1971	301565	33	301598	391725	77.0
1972	422628	64	422692	581317	72.7
1973	504746	43	504839	795763	63.4
1974	433045	560	433605	763127	56.8
1975	602688	275	602963	1049063	57.5
1976	979175	309	979484	1798620	54.5
1977	746632	122	746754	1797374	41.5
1978	848982	1203	850185	2121574	40.1
1979	1096887	1816	1098703	2620292	41.9
1980	883122	1450	884572	2188756	40.4
1981	1242952	1544	1244496	2867128	43.4
1982	1383385	1216	1384601	3422429	40.5
1983	1402609	185	1402804	3623231	38.7
1984	1402456	1641	1404097	3854983	36.4

Source: MPEDA, Statistics of Marine Products Exports , Cochin, 1981-1985.

8.2.7 Marine products occupy a dominant position as the main foreign exchange earner in the agricultural sector, contributing roughly 16.67 per cent of the total agricultural exchange earnings of the state in the year 1984-85 as shown in table 8.4.

8.2.8 A comparison of periods 1983-84 and 1984-85 indicates a reduction of 4.56 per cent from the earnings of marine products exports from Kerala.

8.2.9 In terms of quantity the share of marine products exports to the exports from the agricultural sector was only 9.4 per cent in 1984-85. But this 9.4 per cent fetched 16.67 per cent of the total value of the foreign exchange earned through the exports of agricultural commodity as indicated in table 8.5.

8.2.10 Marine products export industry is depending solely on the fish harvesting industry. Its production trends highly influence the exports and the domestic consumption of marine products (Rajasenan, 1986a). The quantity exported in 1984 was only 7.41 per cent of the marine fish landings in Kerala (see table 8.6).

8.2.11 In 1969 Kerala's share of the marine fish landings was 32.3 per cent, i.e., 2,94,787 tonnes in comparison with that of 9,13,630 tonnes for all India. With this 32.3 per cent Kerala

Table 8.4 Commoditywise value of exports

Sl. No.	Commodity	1982-83 (Rs.crores)	Percent-age to total	1983-84 (Rs.crores)	Percent-age to total	1984-85 (Rs.crores)	Percent-age to total
1.	Tea	60.99	9.12	83.16	12.58	150.12	17.25
2.	Pepper	28.16	4.21	37.10	5.61	47.87	5.50
3.	Cardamom	5.39	0.01	2.43	--	15.75	1.81
4.	Cashew kernels	121.70	18.19	149.83	22.67	160.56	18.14
5.	Coffee	70.26	10.50	71.10	10.76	87.97	10.11
6.	Ginger	4.08	--	8.40	0.01	11.06	1.27
7.	Seafoods	143.88	23.50	140.75	21.23	145.05	16.67
8.	Coir products	24.19	3.62	14.70	2.22	21.57	2.58
9.	Miscellaneous	210.46	31.45	153.45	23.22	230.10	26.46
	Total	669.11	100.00	660.95	100.00	870.05	100.00

Source: Kerala State Planning Board, Kerala Economic Review 1984 and 1985.

Table 8.5 Commoditywise exports from Kerala for 1982-83, 1983-84 and 1984-85

Sl. No.	Item	1982-83		1983-84		1984-85	
		Quantity (tonnes)	Percentage to total	Quantity (tonnes)	Percentage to total	Quantity (tonnes)	Percentage to total
1.	Tea	41138	3.3	32067	4.1	57585	14.5
2.	Cashew kernels	32455	2.6	38501	4.3	35776	9.0
3.	Seafoods	42422	3.4	36780	4.1	37413	9.4
4.	Coir products	30070	2.4	28474	3.2	27083	6.8
5.	Spices	28104	2.3	30351	3.4	32625	8.2
6.	Coffee	34365	2.8	292216	3.2	33477	8.4
7.	Miscellaneous	1030170	83.2	701705	77.7	173550	43.7
	Total	1238724	100.0	902094	100.0	397709	100.00

Source: Kerala State Planning Board, Economic Review , 1984 and 1985.

Table 8.6 Marine fish landings and marine products export, India and Kerala--A comparative study

(Value in Rs.'000, Quantity in M.T).

Year	Marine Fish Landings			Exports of Marine Products					
				Quantity			Value		
	India	Kerala	Percentage of Kerala	India	Kerala	Percentage of Kerala	India	Kerala	Percentage of Kerala
1969	913630	294787	32.3	30584	22792	74.5	330734	277226	83.8
1970	1085607	392880	36.2	37175	24077	64.8	355359	275210	77.4
1971	1161389	445347	38.3	34032	21569	63.4	391725	315098	77.0
1972	980049	295618	30.2	38271	25519	66.7	581317	422692	72.7
1973	1220240	448269	36.7	48785	30826	63.2	795763	540839	68.0
1974	1217797	420257	34.5	46629	24529	52.6	763127	433605	56.8
1975	1422693	420857	29.6	53412	32478	60.8	1049063	602963	57.5
1976	1352855	331047	24.5	62151	31155	50.1	1798620	879484	48.9
1977	1254782	345037	27.4	64964	27802	42.8	1797374	746754	41.5
1978	1403607	373339	26.6	77946	31855	40.9	2121574	850184	40.1
1979	1388380	330509	23.8	92184	31988	34.7	2620292	1098703	41.9
1980	1249837	279543	22.4	74542	28472	38.2	2188756	884572	40.4
1981	1378532	274395	19.9	75375	32260	42.8	2867128	1244496	43.4
1982	1420633	325795	22.9	75136	33215	42.9	3422429	1384601	40.5
1983	1587970	385275	24.3	86169	32555	37.8	3623231	1402804	38.7
1984	1760500	424718	24.1	89912	30577	34.0	3854983	1404097	36.4

Source: MPEDA Statistics of the Marine Products Exports , 1981 to 1985.

was able to get a share of about 83.8 per cent of India's export, i.e., 22,792 tonnes in comparison with 30,584 for all India. Even though landings of the marine products have been remaining static for the last 16 years for India and Kerala, Kerala's share of marine products export has been getting reduced. But, after 1976, Kerala's fish production trend showed a very significant declining trend with an exception in the year 1984.

8.2.12 Even though we had a comparatively good production in 1984, our contribution to the national figure was only 24.1 per cent (quantity-wise). With this we are able to earn an export share of 34 per cent (value-wise). If we compare the years 1969 and 1984, our percentage export share has reduced to 54.36%. But the reduction in percentage share of production was only 25.39. Even though we were maintaining almost a constant share in production of marine products, we could not keep up our share in the export of marine products. A comparative analysis of the production and export trends for the last 16 years shows that the declining trend of export is more pronounced compared with that of the production trend.

8.3 Dependency of a single item

8.3.1 The degree of dominance of the shrimp item quantity-wise has, however, suffered a decline of 2.47 per cent in 1984-85 as compared with 1983-84. But, as in other years, it has shown an increasing trend in value terms over the last year. The non-shrimp items also showed a declining trend quantity-wise (13.73) in 1984-85 over the last year. Value-wise this has increased to 11.07 per cent. However, due to price rise, weakening of Indian Rupee etc., the export earnings in terms of rupees have witnessed substantial improvement. This is shown in table 8.7.

8.3.2 Shrimp has contributed 84.85 per cent in quantity and 90.71 per cent in value during 1984-85. The quantity-wise export of the commodity has been rather static for the past ten years ranging from 29,349 tonnes in 1975-76 to 27,108 tonnes in 1984-85. The same static nature of fish production in the economy can also be noticed if we analyse the time series data for the last decade.

8.3.3 It is, therefore, evident that shrimp alone was responsible for the steady rise in value particularly frozen shrimp. The canned and dried shrimps have almost disappeared from the export trade. This is shown in table 8.8.

8.3.4 The export figures of frozen prawn indicate that there is not much scope for increasing the volume of exports since we have almost reached a stagnation in terms of shrimp

Table 8.7 Shrimp and non-shrimp items of export

Year		Shrimp	Non-shrimp	Total
1981-82	Q	26081(82.32%)	5600(17.68%)	31681(100%)
	V	1088988(87.27%)	158885(12.73%)	1247873(100%)
1982-83	Q	26978 (83.42%)	5361 (16.58%)	32339 (100%)
	V	1265159 (89.48%)	148751 (10.52%)	1413910 (100%)
1983-84	Q	27501 (84.04%)	5224 (15.96%)	32725 (100%)
	V	1294596 (91.96%)	113178 (8.04%)	140774 (100%)
1984-85	Q	26612 (84.85%)	4750 (15.15%)	31362 (100%)
	V	1342238 (90.71%)	137514 (9.29%)	1479752 (100%)

Source: MPEDA Statistics of the Marine Products Exports, 1983-84 and 1984-85.

landings from the capture fishery and also the production from the culture fishery continues to be negligible and insignificant (Rajasenan, 1986a).

8.3.5 With the help of the frozen shrimp monthly export data from 1979-80 to 1984-85 seasonal monthly variation indices are calculated for quantity as well as for value and shown in table 8.9.

8.3.6 Quantitywise the lowest seasonal index is found for the month of October. But the export of frozen shrimp index showed a peak tendency in August and March, the indices being 126.91 and 126.53 respectively. The months which are noted below the percentage average are May, June, September, October, November and December.

8.3.7 Valuewise the lowest indice was noticed for November and the highest for June, the indices being 58.38 and 142.51 respectively. This shows that in November there is a reduction of about 41.62 per cent over the average and 42.51 per cent increase over the average for June. But during the peak period of the value seasonal index, i.e., for June, there is a reduction of about 7.16 per cent quantity of the average percentage. This shows that there is wide variation for the unit value realisation for the product during these months. But the lowest quantity seasonal index month is

Table 8.9 Seasonal variation indices for frozen shrimp (quantity and value)

Month	Indices of quantity	Indices of value
April	115.36	104.97
May	99.14	83.46
June	92.84	142.51
July	119.53	130.00
August	126.91	124.56
September	93.13	87.59
October	72.04	77.07
November	64.52	58.38
December	76.80	70.83
January	109.88	102.49
February	103.26	97.18
March	126.53	120.90

also found to be the lowest quantity seasonal index month i.e., November. The graphical representation of both the seasonal varieties indices (quantity and value) for frozen shrimp is given in figure 8.1.

8.4 Non-shrimp items

8.4.1 The non-shrimp items of export include, frozen lobster tails, frozen frog legs, frozen cuttle fish, frozen squid, shark fins, fish maws and all other minor items including frozen clams, sea shells etc. (see table 8.10). Even though there is an increased demand for lobster tails from Japan and other countries, its export has remained almost stable in terms of quantity. But if we extend our fishing ventures to deep-sea through big trawlers, there is ample scope for increasing the export of this item.

8.4.2 For the last several years the export of frozen froglegs has showed a declining trend. When we compare the years 1983-84 and 1984-85 the quantity and value decreased by 12.49 per cent and 8.25 per cent respectively. This is attributed to the recent inclusion of frogs under the purview of the Wild Life Preservation Act which stipulates stringent condition on hunting, processing etc. Our traditional frog hunters find it difficult to comply with them, resulting in falls in catches and export in the preceding years also.

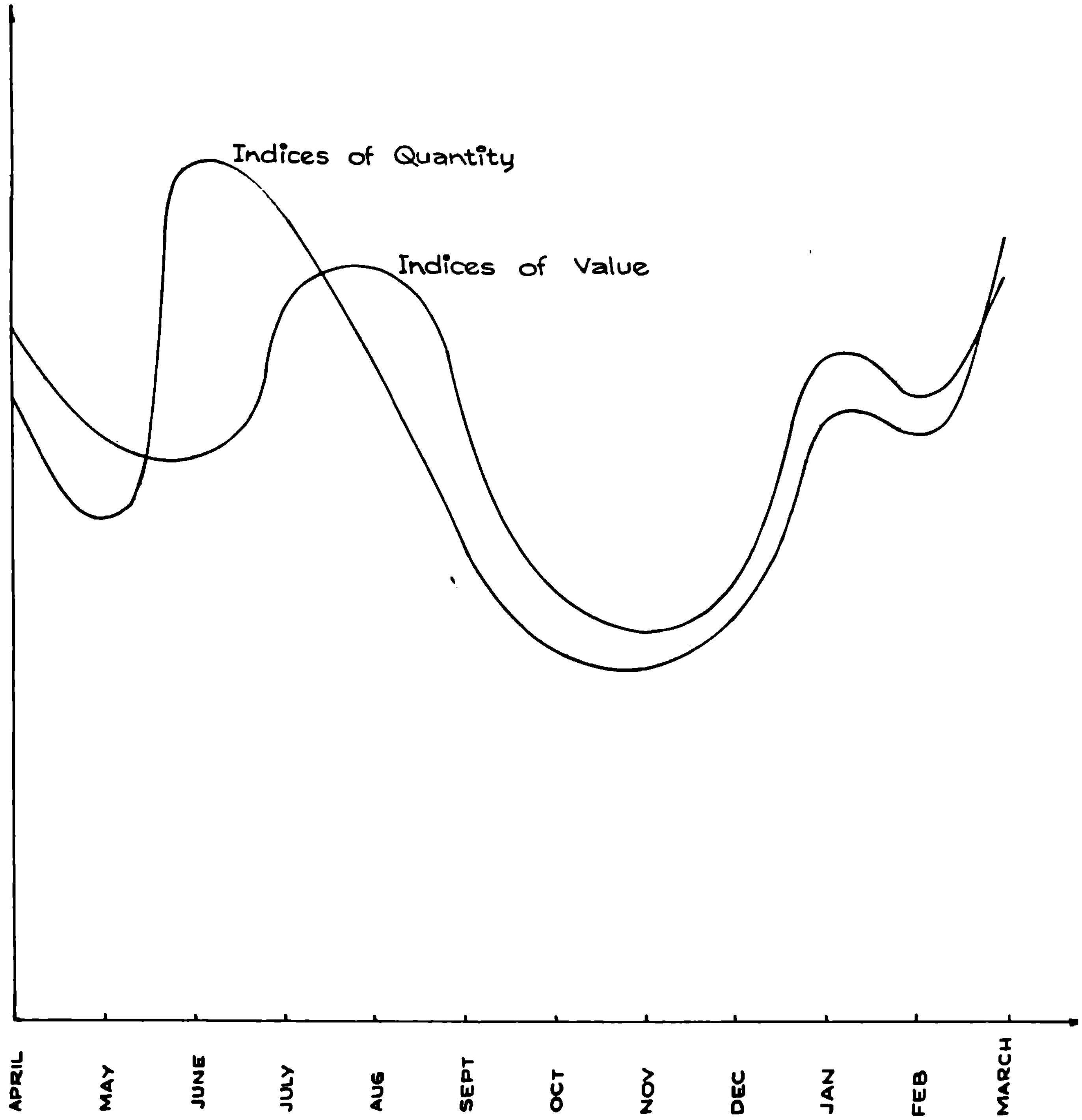


Fig: 8.1 Graphical Representation of the seasonal variation indices (quantity and value) for the frozen shrimp.

Table 8.10 Non-shrimp items of export

Items	1981-82		1982-83		1983-84		1984-85	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Frozen labster tails	423	32386	391	36866	293	21656	496	36172
Frozen frog legs	2962	29583	1284	30881	1450	38245	1269	35090
Fresh & frozen fish	223	2336	936	11124	1582	14925	58	2844
Frozen cuttle fish and fillets	1206	29938	1414	42457	714	17452	1064	33774
Frozen squids	403	6755	714	12333	401	5975	726	11747
Dried fish	62	485	--	--	2	32	5	151
Shark fins	4	758	1	306	2	269	4	151
Miscellaneous	317	56644	616	14655	780	14622	1128	17585
Total	5600	158885	5361	148751	5224	113378	4750	137514

Source: MPEDA Statistics of the Marine Products Exports 1983-84 and 1984-85.

8.4.3 Frozen cuttle fish and squid have acquired a real berth in the export arena only after 1975-76. When we compare the landing of cephalapods in the state and the export of these varieties there is scope for further expansion. Of late, demand has arisen in the Japanese market for squid in the dried form also. Recently some attempts were made by the Marine Products Export Development Authority to promote squid jigging with the help of a Japanese expert.

8.4.4 Fresh and frozen items of fish export entered in the export list marginally after 1971-72, but it got momentum only from 1978-79 onwards. The quantity and value exported in 1976-77 were 5 tonnes and Rs.50,000 in comparison to 1,582 tonnes and Rs.1.49 crores in 1983-84. But the quantity exported showed a decline in the year 1984-85 to mere 58 tonnes. The growth of exports of this item also coincides with the growth of deep-sea fishing projects. The dampening effect of the export quantity of this product in 1984-85 shows that our exploitation of the deep-sea activities is still in its infancy. Since we have almost reached saturation in terms of the availability of resources in the in-shore and off-shore regions it is high time to explore the possibilities of exploiting the deep-sea resources at a greater scale.

8.4.5 With the introduction of modern machinery for processing and canning, the export of dried fish has come down as a result of the low availability of total landings for curing purposes. Simultaneously the export surplus of dried varieties in Kerala has been narrowed down due to high pressures on domestic demand.

8.5 Market concentration

8.5.1 Over the years, the market for seafoods has witnessed significant changes. The U.S.A. was the principal buyer of our frozen seafood for a very long time. But the appearance of two other developed countries in the field of marine products exports as buyers by offering very high price to the products exported, resulted for the steady rise in quantity and value of our exports. Emergence of Japan in 1971-72 removed USA from the top position as buyers of our marine products exports. Recently U.K. emerged as a buyer of our exports. In order to search for new markets the Government of India established the Marine Products Export Development Authority to serve the sea-food industry from fishing through processing, packaging, storing, transporting and marketing--especially to the different markets all over the world.

8.5.2 Frozen shrimp, our mainstay in seafood export, accounts for about 90 per cent of our marine product export earnings. The important market for these products continues to be Japan, closely followed by USA. These two countries jointly lifted 75 per cent of our exports in terms of quantity and 81 per cent in terms of value in 1984-85 as shown in

Table 8.11 Share of frozen shrimp in exports 1984-85

Country	Quantity	Value
Japan	37.59	48.99
USA	37.08	31.32
UK	8.47	9.05
Others	16.86	10.64

Source: MPEDA Statistics of the Marine Products Exports, 1984-85.

8.5.3 In view of the above, it is important to note that our seafood export trade depends mainly on two markets. Hence market diversification is the urgent need of the hour in the current situation (Chidambaram, 1975). But diversification is a very difficult task as it involves identification of the right products for the right market at the right price.

8.5.4 The market concentration is still more intensive if we analyse the export pattern further.

8.5.5 Frozen shrimps are exported in different forms as shown in table 8.12.

8.5.6 Individually quick frozen shrimps are also available for exports. Each of these go to specific market as given in table 8.13.

Table 8.12 Different forms of shrimps processed for exports

Sl. No.	Forms of shrimp exported
1	'Headless shallon' shrimp
2	'Peeled and deveined' shrimp
3	'Peeled deveined and cooked' shrimp
4	'Cooked and peeled' shrimp
5	'Peeled and undeveined' (or peeled round) shrimp
6	'Butterfly' shrimp

Source: MPEDA <u>Statistics of the Marine Products Exports</u>, 1984-85.

Table 8.13 Major markets for frozen shrimp

Sl. No.	Items	Markets
1	Headless shell on	Mostly to Japan, some quantities to USA
2	Peeled and deveined	Mostly to USA, some quantities to Western Europe
3	Cooked and peeled	Mostly to Australia and some quantities to Western Europe
4	Peeled and undeveined	Mostly to Japan
5	Peeled and deveined and cooked	Mostly to USA
6	Butterfly shrimp	Mostly to USA

8.5.7 This market concentration is not favourable for the healthy growth of our trade in the years to come.

8.5.8 The following suggestions are made for the development of seafood export and export market:

i) Product diversification

8.5.8.1 Product development for export is an arduous task, if we are not producing a product acceptable to the foreign buyer. If we try to market a simple variety of fish like sardine, mackeral, cuttle fish, we get into difficulties because of the foreign buyer's taste, preference etc. as he has his own standards for these products and the ultimate consumer is accustomed to the local variaties of these fishes.

ii) Expansion of production base

8.5.8.2 Apart from shrimps, now we have many other items which hold high export potential, but have not yet been exploited for export purposes. Though there is demand for tuna in the international market, we have not been able to enter the world market so far. Same is the case with squid and cuttle fishes and they are at present getting only by-catches of shrimp trawl fishery. Fishing for these varieties is highly capital-intensive and requires specialised operation.

Recently the Government of India has introduced squid jigging with the help of Japanese Aid Programme. So with the help of proper resource data we have to develop our commercial fishery using deep-sea vessels.

iii) Quality control

8.5.8.3 The most important factor in the smooth flow of trade is the agreement between seller and buyer regarding quantity, quality and price. The agreement between buyer and seller is of particular importance in the case of perishable materials like fish, which is likely to undergo rapid changes depending on the method of storage, transport and processing. In the international trade the buyers have no direct control over production, handling and processing of the goods. Therefore, quality standards acceptable to both the consumers and the concerned public health authorities are essential for the free flow of trade.

iv) Impact and need

8.5.8.4 In recent years there is an increasing tendency for many countries to establish and develop fish and fishery-based industries. At present more than hundred developed and developing countries have come to the field of seafood export trade by supplying frozen, canned and dried marine products to world markets. As a result, India is facing severe competiti in the world market. Maintenance of high quality standards, which is in par with international standards alone can help Indian products to hold the ground in the world market.

8.6 The role of MPEDA

8.6.1 The Marine Products Export Development Authority was constituted by the Government of India under the MPEDA Act (Act 13 of 1972) and started functioning in September 1972 with Cochin as its headquarters. The Authority replaced the Marine Products Export Promotion Council which was set up jointly by the Government of India and the exporters of marine products in 1961. Broadly, its functions are in the areas of development in off-shore and deep-sea fishing in general and exports in particular.

8.6.2 MPEDA's specific functions are:

i) Development of off-shore and deep-sea fishing in all its aspects and conservation and management of off-shore and deep-sea fisheries;

ii) Registration of fishing vessels, processing plants, storage premises and conveyance relating to the marine products industry and exports with a view to promoting a healthy development;

iii) Laying down standards and specification for marine products for purpose of export and to introduce comprehensive in-plant inspection to maintain a high quality of the products;

iv) Rendering financial or other assistance and to act as an agency for existence of relief and subsidy as may be entrusted by the Government;

v) Rendering other types of assistance and service to the industry in relation to market intelligence export promotion, trade enquiries and import of certain essential items required in small quantities for the industry;

vi) Regulation of export of marine products

vii) Improve the marketing of marine products overseas by providing market intelligence, market promotion activities, information on types of products in demand in different countries, nature of processing for specific type of requirements, etc.,

viii) Arrange for training in different aspects connected with exports with special reference to fishing, processing and marketing;

ix) Such other measures that will be of importance to the export industry.

8.6.3 The Marine Products Export Development Authority is there to serve the seafood industry from fishing through processing, packaging, storing, transporting and marketing--especially to the different markets all over the world. The Authority is entrusted to ensure a healthy growth of the industry through judicious regulation, conservation and control. The importers and exporters can obtain any information relating to the mark and the products.

8.7 Packaging

8.7.1 The search for diversifying our exports in the area of simply preserved marine products is expected to continue. It is pertinent to observe that in all these products the principle of packaging is stated to be known. Even after three decades of shrimp exports almost the entire quantity exported is still in 2 kg or 5 pounds institutional packs. The same is the case with other major items. Nevertheless, we have made some headway in the production of value added items utilising these traditional products in the form of Accelerated Freeze Dried Shrimps (AFD), Individually Quick Frozen Shrimp (IQF) and head-on shrimps. But these items are yet to catch up with our exporters as well as importers. The Marine Products Export Development Authority has been formulating its policies to encourage exports of such value added products in larger quantities.

8.7.2 The fact that consumer packaged exports are likely to face added freight costs is recognised, but that is expected to be offset by the lower cost of processing in the country which is currently being done at a high cost in the importing destinations abroad (Subramanian, 1982).

Chapter IX

CASE STUDIES ON MECHANISED FISHING AND FISH CULTURE ACTIVITY

9.1.1 In chapter III we discussed the trends in fish production and indicated with reference to fishing industry in Kerala the serious problem of resource stagnation. In a latter chapter we have also showed that concentration of mechanised fishing in few areas and more particularly with reference to a single variety of fish (prawn) resulted in over fishing leading to diseconomies of scale. In this chapter an attempt is made to look into the possibilities of overcoming these difficulties. This chapter concerns itself with two exercises, one a cost-benefit analysis of mechanised fishing in Neendakara-Sakthikulangara belt and the other an evaluation of fish culture activities.

9.1.2 Cost-benefit analysis of mechanised fishing--a case study of Neendakara-Sakthikulangara belt

9.1.2.1 The growth in the number of mechanised boats and their concentration in the Neendakara-Sakthikulangara belt have created some crisis in the mechanised sector of the fishing industry. The crisis arose largely out of a fall in the earnings of the mechanised boat operations. It got aggravated because of the following factors:

(1) Increased cost of hull, engine and other accessories,

(2) acceleration in operating cost owing to hike in diesel price, indiscriminate taxes on oil, spare-parts etc., and

(3) restriction imposed by the Government regarding the area of operation of mechanised boats.

9.1.2.2 Though the mechanised fishing industry started in Kerala somewhere in the early 1950s only very little information is available on the economics of mechanised fishing. In 1982 the FAO conducted a study with reference to cost and revenue (Rao, 1983). This study showed that the mechanised fishing boats did not make profits in comparison with the non-mechanised ones.

9.1.2.3 A detailed study of the mechanised fishing in Neendakara is conducted to make a benefit-cost analysis of this sector. The data were collected directly from the boats which were operating in Sakthikulangara-Neendakara belt. Data regarding the catch, fishing time, cost of fishing operation, cost of repair, insurance and interest costs were collected from the log book of each of the operating vessel. The catch per trip of 15 vessels is given in Appendix VII. The period covered for the above analysis is six quarters beginning from 1st July 1984 and ending on 31st December 1985. In order to estimate the returns from each boat, the average price per tonne of prawn is taken as Rs.16,000/- and that of fish as Rs.1,800/- per tonne.

9.1.3 Area

9.1.3.1 Sakthikulangara-Neendakara belt forms an inlet which connects the Arabian Sea with an extension of the back-water, the so-called Ashtamudi Lake, or 'the eight armed lake' at a latitude of 8°59'N (Klausen, 1968). This inlet is the centre of Kerala's mechanised fishing industry. The southern village Sakthikulangara covers an area of 507 acres and the northern Neendakara about 1,537 acres. The village of Sakthikulangara is of special interest, because it was the first traditional fishing village exposed to the process of modernisation of fishing technology. This process was initiated in the early 1950s by a comprehensive development project known as the Indo-Norwegian Project (Asari, 1969). The induction of mechanised boats in this area resulted in very high catches of valuable species. This coincided with the immense profit opportunities offered by the international market. It in turn, created a situation of high concentration of the mechanised boats in this area for fishing (Platteau, 1984).

9.1.4 Materials and methods

9.1.4.1 Data were collected from 15 trawlers, 9 numbers of 32 feet and 6 of 31.5 feet overall length (OAL). These types of trawlers based on the designs supplied by the Central Institute of Fisheries Technology (CIFT), Cochin are very popular and about 1,500 of them are operating in this region itself. The selected boats are having different engines with varying horse power as given in the table 9.1. There were

Table 9.1 Different aspects of the vessel

Types of engine	No.	Overall length (OAL)		Horse Power		
		32'	31.5'	60-90	47.5-60	43.5
Leyland	7	6	1	7	--	--
Ruston	6	3	3	--	6	--
Meadows	2	--	2	--	--	2

seven Leyland engines having a horse power ranging from 60 to 90, six Ruston with horse power of 45 to 60 and two Meadows with 43.5 horse power. The overall length of these three types of boats were different. There were six leyland boats with a length of 32 feet and one with 31.5 feet. Among the six Ruston boats, three were of 32 feet and the other three 31.5 feet. Both the

Meadow engine boats were 31.5 feet each. One phenomenon noticed in the Neendakara-Sakthikulangara belt was that almost all the boats were of this (OAL) range. Even though there was only a marginal difference in the length between these two types of boats, the catch and operation data showed that there was significant difference in economic efficiency of these two types. The horse power of the engine was also very important in assessing the fishing ability of the boat. High horse power engine boats could reach the fishing and landing places quite fast. This gave an advantage over the other boats in the form of better catch and higher value for their catches. But the diesel consumption of these boats were high compared with that of other boats. Considering factors such as congestion in the landing places and the heavy competition between early landing, it was found that the high horse power engines were generally preferred to others.

9.1.4.2 For working out the economics of the operation, what is called the Banker's criterion is used here. Banker's criterion is defined as,

$$\text{Percentage Return} = \frac{\text{Receipt - Expenditure}}{\text{Capital cost}} \times 100$$

The percentage profit on total expenditure is worked out for all the 15 trawlers on the basis of average catch of fish and prawn and also for the number of trips performed in various quarters. For finding out the variable cost and fixed cost, the model developed by Iyer et.al. (1982a) is used. In judging the comparative performance, catching ability and the economics of operation are to be considered separately. The catch per unit effort (CPUE), which is considered as the fishing ability, is mostly influenced by the size, features of the vessel and its equipments. But the economics of operation depends upon exogenous factors like catch composition, price of fish etc. To work out the economics of operation 'catch per hour' and also 'profit or loss per hour' were considered (See Appendix VIII).

9.1.4.3 Kanda (1962) has used a statistically derived coefficient of fishing ability for comparing catch ability and economic efficiency based on the cost of production of 1 kg of fish by a vessel. The coefficient of fishing ability is given by the equation

$$e = \sum \frac{A_i S_i}{S_i^2}$$

where A_i is the average catch per unit effort (catch/hour) of the boats in the i^{th} quarter, S_i is the average catch per unit effort (catch/hour) in the i^{th} quarter taking into account the total catch obtained by all the selected vessels irrespective of the size operated in the i^{th} quarter divided by the total fishing effort for all the boats in the i^{th} quarter. This analysis of fishing efficiency has also been used to find the efficiency of different engine type boats and also for the boats of 32 feet and 31.5 feet.

9.1.4.4 Rupees 2.20 lakhs was taken as the cost of a boat (cost of hull and engine). Cost can be classified into two categories: fixed and variable. Fixed cost includes expenditures on capital such as interest, depreciation, insurance, repairs on wire rope and nets, repairs on hull, engine, gear and tackle and purchase of spares. Variable costs are costs incurred in the course of generating revenues and include costs for diesel, engine oil, ice and other miscellaneous expenditure. The diesel cost was calculated for a day's actual fishing hours. But generally, an average fishing hour was calculated on the basis of an eight hour/day consuming a total of 120 litres of diesel at a price of Rs.3.95 per litre.

9.1.4.5 The 15 boats, selected for the study, belonged to three owners. The share given to the crew by these owners differ. The share was given on the basis of catch value after deducting the fuel cost. In the present case, the owners of boats with serial numbers 1 to 5 gave 32 per cent of the catch, with serial numbers 6 to 10 gave 30 percent and with serial numbers 11 to 15 gave 31 per cent.

9.1.4.6 From the data collected regarding the landings and receipts, the number of fishing days and the number of trawling hours per day were obtained. From this data the catch/trip, prawn catch as well as fish catch per trip, and the value per trip for both fish and prawn was worked out to find the coefficient of fishing ability. To find out the different levels of profit, the minimum receipt to be obtained per trip was worked out by solving Y from the following equation (Krishna Iyer et.al., 1968).

$$\frac{Y - [F + X + i + 0.35(Y - X)]}{F + X + i + 0.35(Y - X)} = \alpha$$

where

Y - Total receipt (Rs.)

F - Fixed cost (Rs.)

X - Fuel cost (Rs.)

i - Cost of ice (Rs.)

and

α - percentage profit on total expenditure.

Based on the return per trip and prawn to fish ratio in the total catch, minimum quantity of fish and prawn to be landed for different levels of profit for the average vessel in each quarter and also for the average vessel in all the six quarters was worked out.

9.1.4.7 To understand the nature of seasonality of mechanised fishing and its economics of operation, quarterly fish production for an average vessel was analysed and each quarter's profitability position was compared with the total profitability position. From the data collected it was seen that the third quarter (July, August, September) was the most profitable fishing quarter as far as mechanised fishing industry in Neendakara was concerned. The data relating to this quarter were available for two years. We have made an attempt to compare the profitability position between these two quarters. Further, a ocomparison was also made between the profitability of this quarter and the entire period, i.e., all the quarters under study. This kind of comparison is of much importance today to see whether there is any substance in the hue and cry raised by the fisheries scientists, traditional fishermen and the Government regarding the need for imposing seasonal regulations in the case of mechanised fishing in Kerala. Our study showed that most of the vessels could maintain profitability only if they were allowed to operate during the months of July-September. This was because during this season in Neendakara the catch of Parapaenopsis Styliferia, popularly known as 'Karikkadi', was available in quite plenty.

It was precisely due to the profits that were obtained during this quarter that fishing by mechanised boats remained to be profitable throughout the year. In other words, if fishing is banned during this quarter, mechanised fishing becomes a loss.

9.1.5 Results and discussion

9.1.5.1 Data with reference to fixed cost, variable cost and earnings of all the 15 boats studied are given in table 9.2. Fixed cost is calculated on the following basis: it includes *inter alia*, other items insurance 6 per cent, interest on capital 12 per cent and depreciation allowance 10 per cent. The lowest variable cost is observed for boat No.10 (Rs.3,66,714/-), while the highest variable cost is recorded for boat No.5 (Rs.4,94,687/-). It is seen that variable cost, vary positively with the number of fishing days. This is because fuel cost forms the major item in the variable cost. For instance, the highest variable cost is recorded in the case of a boat which performed the largest number of trips (448). Similarly, the lowest variable cost is in the case of the boat which ranks 4th amongst the ones that performed the lowest number of trips, i.e., 398. Profit as a percentage of the total cost is the highest for boat No.9 (41.342) and the lowest for boat No.15 (11.75). Boat No.11 recorded a loss

Table 9.2 Cost-earnings and percentage profitability over total cost of 15 boats for six quarters

Type of engine	No. of trips	Fixed cost	Variable costs: Repairs on wire-rope & net	Repairs on hull, gear & others	Watch & ward & other exps.	Misc. expenses & ice	Oil	Diesel	Crew	Total variable cost	Total cost	Total Revenue	% profit over total cost
L	418	91500	18500	48400	7500	25080	10450	196640	134452	441022	532522	616802	15.82
L	441	91500	20420	43700	7500	26460	11025	20746	154476	471039	562539	690191	22.69
L	413	91500	19100	45410	7500	24780	10325	194288	129096	430498	521998	597712,	14.50
L	416	91500	16250	48650	7500	24960	10400	195699	143455	446914	538414	643996	19.61
L	448	91500	18300	46100	7500	26880	11200	210753	173956	494687	586187	754359	28.69
R	399	91500	15850	48550	8200	23940	9975	187701	121335	41555	507051	592153	16.99
R	379	91500	21600	44750	8200	22740	9475	178293	126788	411845	502445	600919	19.68
R	372	91500	20100	38420	8200	22320	9300	175000	117669	391008	482508	567230	17.93
L	434	91500	18510	41860	8200	26040	10850	204166	188021	497647	589147	830905	41.34
L	409	91500	15675	42490	8200	24540	10225	192406	152596	436930	528430	701055	33.13
M	398	91500	16860	40500	8500	23880	9950	187231	79794	366714	458214	453215	-1.06
M	383	91500	19380	44700	8500	22980	9575	180175	120321	405630	497130	568309	14.52
R	408	91500	17860	41580	8500	24480	10200	191935	133750	428304	519804	623306	20.13
R	422	91500	18240	46760	8500	25320	10550	198521	147565	455455	546955	674536	23.46
R	391	91500	16780	47100	8500	23460	9775	183938	114422	403975	495475	553044	11.75

L - Leyland, R - Ruston and M - Meadows.
Calculated on the basis of field survey.

of 1.06 per cent over total cost. From table 9.2 it is clear that Leyland engine boats are more profitable than Ruston and Meadows engine boats. It is also clear from table 9.2 that the maximum number of operations are done by the Leyland engine boat (448) and the lowest by the Ruston engine boat (372).

9.1.5.2 In table 9.3 sixteen different types of analysis have been carried out to understand the annual efficiency of the average vessel chosen for the study in the year 1985 (last four quarters). Some of these are mentioned below. The cost-benefit ratio which is considered to be a proportion of gross income to total cost, is found to be 1.186. Percentage return on cost is 18.57 which is based on the percentage of net income to total cost. The percentage return on capital employed is 30.03. Such a high figure shows that investment in this field is profitable. Gross earnings per unit of investment (1.917) is also a favourable factor for investment in this sector. It indicates that an investment of Re.1 will fetch a return of Rs.1.917 at the end of the year. Gross profit is found to be Rs.1,27,083/- which shows the relationship between total sales value (total revenue) and variable cost (working cost). Further analysis shows that the payback period (the time taken to recover initial investment) is three years in this case.

Table 9.3 Net present value analysis of an average vessel in the year 1985

I.	**Capital investment**	
		Rs.
	i) Cost of hull and other accessories	98,000.00
	ii) Cost of engine	1,04,000.00
	iii) Cost of fishing gear (3 trawl nets)	18,000.00
	Total	2,20,000.00
II.	**Fixed expenses**	
	i) Insurance (6%)	12,400.00
	ii) Interest on capital (12%)	26,400.00
	iii) Depreciation (10%)	22,200.00
III.	**Repairs**	
	i) Wire rope and nets	12,148.00
	ii) Hull and accessories maintenance	32,600.00
	iii) Miscellaneous expenditure regarding watch and ward etc.	5,376.00
IV.	**Operational expenses**	
	i) Diesel (Average 120 litres at the rate of Rs.3.95/litre)	1,30,779.00
	ii) Engine oil	6,950.00
	iii) Miscellaneous expenses including ice	16,680.00
	iv) Crew share	90,228.86
V.	**Total expenses**	3,55,755.86

		Rs.
VI.	Income from sales	4,21,839.84
VII.	Net income	66,083.98
VIII.	Cost Benefit Ratio	
	Gross Income / Total costs	1.186
IX.	Percentage return on cost	
	Net income / Total cost x 100	18.57
X.	Percentage return on capital employed	30.03
XI.	Gross earnings per unit of investment	1.917
XII.	Gross profit	
	(Income-variable cost)	127083.00
XIII.	Gross profit ratio	
	Gross profit / Net sales	0.301
XIV.	Net Profit Ratio	
	Net profit / Net sales	0.157
XV.	Pay out period	
	Total investment outlays / Gross return per period (Gross profit)	1.73

XVI. Discount present value

$$PV = X_1 \frac{1}{(1+r)^n}$$

Discount rate is 12 per cent

First year	1,13,466.96
Second year	1,01,309.78
Third year	90,455.17

$$R_1 \frac{1}{(1+r)} + R_2 \frac{1}{(1+r)^2} + R_3 \frac{1}{(1+r)^3}$$

Total for 3 years	= 3,05,231.93
PV	= 3,05,231.93
C	= 2,20,000.00
NPV	= 85,231.93

Calculated on the basis of field survey.

9.1.5.3 In the above analysis of cost and earnings, every type of monetary cost is included. In this, the payback period is shorter because for every rupee that is invested, a return of Rs.1.73 is forthcoming which points to the easy recovery of capital costs within a period of three years. The investment decisions like the acceptance or rejection of any project is based on its net present value. The net present value is defined as the difference between the present value (PV) and the cost of investment (C), which is Rs.85,231.92, for three years. Discounted present value is calculated on the basis of the present value equation $PV = X_i \frac{1}{(1+r)^n}$. Discount rate taken is 12 per cent as the interest on capital taken is also 12 per cent. This analysis shows that investment could be made since it gives a positive value on its net present value over the capital invested.

9.1.5.4 Table 9.4 represents the average efficiency of a fishing vessel. The average number of fishing days for the six quarters was taken as 408, but the profitability position was analysed for various trips from 370 to 450. On the basis of the average prawn and fish catch of 64.4 kgs and 304.48 kgs per trip, the ratio to prawn and fish catch is calculated and given in table 9.4. Percentage profitability over total cost has also been analysed for different trips and given in the last column

Table 9.4 Six quarterly analysis of profitability for different trips

No.of trips	Fixed cost	Variable cost	Total cost	Receipt	Profit
370	154386	332600.60	486986.60	584031.68	19.92
390	154386	350579.01	504965.01	615600.96	21.90
400	154386	359568.22	513954.22	631385.60	23.84
408	154386	366759.58	521145.58	644013.31	23.57
410	154386	368557.42	522943.42	647170.24	23.75
420	154386	377546.63	531932.63	662954.88	24.63
430	154386	386535.83	540921.83	678739.52	25.47
440	154386	395525.04	549911.04	694524.16	26.29
450	154386	404514.24	558900.24	710308.80	27.09

Calculated on the basis of field survey.

of profit. It shows that, as the number of trips increases profitability also increases. Here profitability is based on average fish and prawn catch with a given price ratio, so the profitability is increasing at a fixed proportion. It is found that a percentage profit of 23.57 is obtained for six quarters covering 408 trips.

9.1.5.5 The minimum receipt of prawn and fish to be obtained for different levels of profitability, ranging from 0 to 50 per cent, is calculated and the results are given in table 9.5. A quantity of 22.94 tonnes of prawn and 85.56 tonnes of fish are to be landed for zero profitability condition (break-even). This is calculated on the basis of a price of Rs.4,803/- per tonne of catch which is calculated based on the prawn fish ratio of 0.2115:0.7885. As percentage profitability increases, the prawn, fish quantity landed also increases for the same number of t... . When we compare the zero, thirty and fifty per cent prof... ility levels of the 408 trips, for prawn and fish, the minimum quantity are 22.94, 29.84, 34.44 and 85.56, 111.21, 128.31 tonnes respectively. Consider now the case for prawn fish landings when the number of trips are changed. Here for example at zero per cent level of profit per 370 trips, prawn and fish are 21.44 and 91.75 tonnes and for the same percentage profitability level for 450 trips it is 24.61 and 91.75 tonnes respectively. As the number of trips increases the quantity

Table 9.5 Minimum prawn, fish ratio for different trips for varying profit position

No.of trips	0%		10%		20%		30%		40%		50%	
	P	F	P	F	P	F	P	F	P	F	P	F
370	21.44	79.95	23.58	87.95	25.73	95.94	27.88	103.93	30.02	111.93	32.17	119.92
390	22.23	82.90	24.46	91.89	26.68	99.47	28.91	107.76	31.13	116.05	33.35	124.34
400	22.63	84.37	24.89	92.81	27.15	101.25	29.42	109.68	31.67	118.12	33.93	126.56
408	22.94	85.56	25.24	94.11	27.54	102.66	29.84	111.21	31.14	119.76	34.44	128.31
410	23.03	85.85	25.33	94.43	27.63	103.01	29.93	111.59	32.23	120.17	34.53	128.75
420	23.42	87.33	25.76	96.06	28.10	104.79	30.44	113.52	32.78	122.25	35.12	130.92
430	23.82	88.80	26.20	97.68	28.58	106.56	30.96	115.44	33.36	124.32	35.76	133.20
440	24.21	90.28	26.13	99.30	29.05	108.32	31.47	117.34	33.85	126.36	36.31	135.36
450	24.61	91.75	27.07	100.93	29.53	110.11	31.99	119.25	34.45	128.47	36.91	137.65

Calculated on the basis of field survey.

of prawn and fish landed for different profitability position will also increase.

9.1.5.6 Table 9.6 gives the minimum prawn and fish landed for varying profitability for the third quarter of 1984. The average trips performed was 64 with 92.33 kgs of prawn and 344.33 kgs of fish per trip. The break-even price per tonne of catch is Rs.5,606/- which is worked out with the prawn fish ratio of 0.268:0.732. The total receipt and the total cost of this quarter is Rs.1,34,212.74 and Rs.93,551/- respectively and the profit percentage over total cost is 43.46. But a comparison of this quarter's profit percentage (43.46) with the overall profit percentage of all the quarters (23.57), shows that the former is considerably more profitable than the latter. For this profit, the minimum quantity of prawn and fish landed is 6.402 tonnes and 17.486 tonnes respectively. The various quantities of prawn and fish for different profitability condition are worked out and given in table 9.6.

9.1.5.7 The analysis of the third quarter of 1985 is presented in table 9.7. In this quarter the average trip performed by a boat was 70 and the average landings of prawn and fish per trip was 98.56 kgs and 338.33 kgs respectively. The break-even price per tonne of landing is Rs.5,937/- based on the prawn fish ratio of 0.291:0.709. The profit of this quarter is 50.417 per cent over total cost since the cost and earnings of th: quarter are Rs.1,01,728/- and Rs.1,53,016/- respectively. The minimum prawn and fish landed for this level of profitability is 7.50 and 18.273 tonnes respectively. In comparison with the average profit of 23.57 per cent for all the quarters, this quarter's profit of 50.417 per cent shows that this quarter is the best fishing season.

9.1.5.8 A comparative analysis has been made between the two major fishing seasons, i.e., the third quarter of 1984 and also the third quarter of 1985 (tables 9.6 and 9.7). The profit in the third quarter of 1985 (50.417) was higher in comparison with the same quarter (43.46) in 1984. The average trip performed is also the highest for the third quarters of 1985. Prawn landing is the highest (98.56 kg/trip) in the 1985 quarter and 92.33 kg/trip in the 1984 quarter.

Table 9.6 Minimum prawn, fish ratio for different profitability in the third quarter of 1984

Profit	Y = E(1+P) E = 93351	t=Y/cost/ tonne 5606	P (.268)	F (.732)
0	93551	16.688	4.472	12.215
10	102686.1	18.317	4.909	13.408
20	112021.2	19.982	5.355	14.627
30	121356.3	21.647	5.801	15.845
40	130691.4	23.312	6.247	17.065
43.46	134112.34	23.888	6.402	17.486
45	135358.95	24.145	6.470	17.674

Table 9.7 Minimum prawns and fish landed for varying profitability in the third quarter of 1985

Profit	Y=E(1+P) (101728)	t=Y/cost/ tonne (5937)	P (.291)	F (.709)
0	101728	17.134	4.986	12.148
10	111900.8	18.848	5.485	13.363
20	122073.6	20.561	5.983	14.578
30	132246.4	22.274	6.482	15.792
40	142419.2	23.988	6.981	17.007
50	152592	25.701	7.479	18.222
50.417	153016.21	25.773	7.500	18.273
55	157678.4	26.558	7.728	18.830

Calculated on the basis of field survey.

But fish landing is higher in the 1984 quarter (344.33 kg/trip) than in the 1985 quarter (338.33 kg/trip). Because of the higher landings of prawn in the 1985 quarter the break-even price per tonne of fish is Rs.5,937/- as against Rs.5,606/- in the 1984 quarter. For zero profitability the minimum prawn, fish landings needed in the 1985 quarter is 4.986 and 12.148 tonnes in comparison to 4.472 and 12.215 tonnes in the 1984 quarter.

Table 9.8 Minimum prawn and fish catch for varying profitability in the fourth quarter of 1984

Profit	Y=E(1+P) (E=80312.27)	t=Y/cost/ tonne (4342)	P (.179)	F (.821)
0	80312.27	18.496	3.310	15.185
5	84327.88	19.421	3.476	15.945
10	88343.49	20.346	3.642	16.704
10.649	88864.72	20.466	3.663	16.802
15	92359.11	21.271	3.807	17.463

Calculated on the basis of field survey.

9.1.5.9 Table 9.8 represents the fourth quarter of 1985. The average number of trips performed in this quarter is 67 with 37.53 kgs of prawn and 287.867 kgs of fish per trip. The prawn fish ratio is 0.13:0.87 with a break-even price of Rs.3,906/- per tonne. Since the prawn landing per trip is low mechanised fishing in this season is not profitable. This quarter incurred a loss of 2.144 per cent over total cost, since the total expenditure is Rs.76,594/- and the total receipt is Rs.74,952/-. At zero per cent profitability the minimum prawn and fish landed is 2.549 and 17.06 tonnes respectively.

9.1.5.10 The average number of trips performed in the fourth quarter of 1984 is 66 and this is given in table 9.9. Catch

Table 9.9 Minimum prawn and fish required for different profitability in the fourth quarter of 1985

Profit	Y=E(1+P) (E=76594)	t=Y/cost/ tonne (3906)	P (.13)	F (.87)
0	76594	19.609	2.549	17.06
5	80423	20.589	2.676	17.913
10	84253.4	21.570	2.804	18.766
20	91912.8	23.531	3.059	20.472

Calculated on the basis of field survey.

of prawn and fish per trip is 51.73 kgs and 288.20 kgs respectively with a ratio of 0.179:0.821. The break-even price per tonne of catch is Rs.4,342/-. This quarter earned an average profit of 10.649 per cent over the total cost. For this rate of profitability, the total quantity of fish and prawn needed is 3.663 and 16.802 tonnes respectively.

9.1.5.11 When we compare the two tables (9.8 and 9.9) of the same fishing seasons for two years, the quarter of 1985 recorded a loss of 2.144 per cent over total cost, while the 1984 quarter recorded a profit of 10.649 per cent. If it is compared with the profitability of all the six quarters (23.57), the above two quarters are not favourable for mechanised fishing.

The reason for this level of profitability of the 1984 season is that prawn catch per trip, in this season is higher at 51.73 kgs that in the 1985 quarter which is only 37.53 kgs. At the same time the average fishing days are almost the same in both the quarters with 67 in 1985 and 66 in 1985.

9.1.5.12 The first quarter of 1985 is also a lean season for mechanised fishing industry in Neendakara. This is the case for all the first quarters in various years. But one thing is quite noticeable in this season as far as Neendakara is concerned, the majority of fishing vessels go for fishing in distant areas especially to Calicut, Ernakulam etc. Some of the boats studied have also gone for fishing in these areas during the January-February-March months for some days. This quarter's average number of trips is 69 as shown in table 9.

Table 9.10 The minimum prawn and fish required for varying profitability in the first quarter of 1985

Profit	Y=E(1+P) (E=79337.8)	t=Y/cost/ tonne (3957)	P (.1519)	F (.8481)
0	79337.8	20.049	3.045	17.004
3.153	81839.32	20.682	3.141	17.541
5	83304.69	21.052	3.198	17.854
10	87271.58	22.055	3.350	18.705

Calculated on the basis of field survey.

The per trip prawn, fish catch is 42.60 kgs and 280.266 kgs respectively. The prawn fish ratio is 0.1519:0.8481 and the break-even price per tonne of catch is Rs.3,957/-. This quarter's average profit is 3.153 per cent over the total cost with 3.141 tonnes of prawn and 17.541 tonnes of fish. This quarter is also not contributing to the overall profitability of 23.57 per cent for all the quarters. The total expenditure incurred in this quarter is Rs.79,337.80 and the total receipt from sales is Rs.81,839.44, at zero profitability the minimum prawn and fish landed is 3.045 and 17.04 tonnes respectively.

9.1.5.13 The operation of an average vessel in the second quarter of 1985 is explained in table 9.11 with an average trip of 72. The per trip landing of prawn is 63.733 kgs and

Table 9.11 The minimum prawns and fish required for varying profitability in the second quarter of 1985

Profit	Y=E(1+P) (E=89841)	t=Y/cost/ tonne (4837)	P (.2139)	F (.7861)
0	89841	18.573	3.973	14.600
5	94333.05	19.502	4.171	15.331
10	98825.1	20.431	4.370	16.061
20	107809.2	22.288	4.767	17.521
24.70	112031.73	23.161	4.954	18.207
30	116793.3	24.145	5.164	18.981

Calculated on the basis of field survey.

fish 287.932 kgs, with a prawn, fish ratio 0.2139:0.7861. The break-even price per tonne of catch is Rs.4,837/-. The estimated cost in this quarter is Rs.89,841.34 and the return is Rs.1,12,032.40 with a profit of 24.70 per cent over the total cost. The minimum prawn and fish landed for this percentage of profitability is 4.954 tonnes of prawn and 18.207 tonnes of fish.

Table 9.12 Coefficient of fishing ability of different engine boats

Catch	Leyland boat	Ruston boat	Meadows boat
Prawn	0.94174	0.89782	0.86283
Fish	1.03409	0.98451	0.94112
Total	1.03355	0.98361	0.93822

Calculated on the basis of field survey.

9.1.5.14 Table 9.12 gives the coefficient of fishing ability as per Kanda's analysis as discussed earlier. The hourly catch per trip of prawn and fish is worked out from the catch data and given in Appendix VIII. This has been used to estimate the coefficient of fishing ability of the three types of boats, viz., Leyland, Ruston and Meadows. It shows that the fishing ability is the highest for Leyland engine boats with 0.94174 as the coefficient for prawn, 1.03409 for fish and 1.03355 for total landings. This may be compared to the coefficients of 0.89782 for prawn, 0.98451 for fish and 0.98361 for total landings in Ruston engine boats and 0.86283 for prawn, 0.94112 for fish and 0.93822 for total landings in Meadow engine boats. From this it is clear that the Leyland engine boats are more efficient than the Ruston and Meadows engine boats. But the Ruston engine boat's fishing ability is superior to that of Meadow engine boats.

9.1.5.15 A further analysis of the coefficient of fishing ability of the two types of boats of the length of 32 feet and 31.5 feet is also carried out with the same principle of th hourly catch data of all the boats on an average and given in table 9.13. The results show that for prawn, fish and total catches, 32 feet boats are more efficient than 31.5 feet boats.

Table 9.13 Coefficient of fishing ability of 32 feet and 31.5 feet boats

Catch	32 feet boats	31.5 feet boats
Prawn	1.0475	0.9068
Fish	1.0206	0.9688
Total	1.0422	0.9719

Calculated on the basis of field survey.

9.1.6 Conclusion

9.1.6.1 The lesson of above analysis is that the availability of catch, particularly that of prawn, and its price, are very important in earning profits. But the availability of prawn itself is highly varying between seasons. So the profitability position of this industry also varies in each season positively with the availability of prawn catch in the total catch. We have seen that a method to improve the economic efficiency of a boat is to increase the number of fishing days in peak landing seasons since the fixed cost remains fixed whether the boat is fishing or not. If the mechanised boats were getting the right price for prawn and fish in a season, the minimum catch required of fish and prawn could be even less which would be able to ensure the minimum profits or higher levels of profitability. It has also emerged from our study that to increase the economic efficiency of vessels, all the other types of vessels must be replaced with Leyland engines, which are considered to be the best among various engines used for mechanised fishing.

9.2 Economics of fish culture activities--an evaluation study

9.2.1.1 This evaluation is done on the basis of information collected with reference to the experimental fish culture projects implemented at the Fisheries Research Station, Vytila--a research station of the Kerala Agricultural University. These experimental fish projects are financed by the Indian Council of Agricultural Research (ICAR) for the development of culture fisheries. A total of 28 such experimental projects are analysed here to evaluate the economic viability of fish culture in Kerala. Though fish farming has gained considerable importance all over the world, in Kerala only very few studies have so far been carried out on this (Aigner and Chu, 1968), (Sarun and Theodore, 1981), (Shang, 1981), (Divedi, 1985) and (Purushan, 1985).

9.2.1.2 Fish culture is a business activity like other agricultural or horticultural operations which combine the use of land, labour, capital and entrepreneurship (Divedi, 1985). But at present only a small section of the population depends entirely on it as a means of their livelihood. More people are now inclined to take up fishing as a part-time vocation.

9.2.1.3 It is reported that Kerala's inland fish output can be raised manyfold by properly utilising her inland water resources (Purushan, 1985). Kerala is blessed with ample water resources suitable for fish culture. These include the 44 rivers, 550 sq.km of kayal and 2,600 sq.km of coastal waters. Climatic conditions are also conducive for the growth of fishes. In marine landings Kerala tops the country yielding about 4 lakh tonnes of fish per annum. At the same time Kerala is lagging far behind in the inland fish production, its contribution remaining awfully low.

9.2.1.4 Kerala proposes to implement a fish culture project costing Rs.134.7 crores for the large-scale development of shrimp and fish culture with the assistance of the World Bank (Kant, 1985). The scheme, to be implemented over a period of seven years was designed to produce 15,000 tonnes of shrimp, valued about Rs.80 crores per annum.

9.2.1.5 Nearly 15,000 ha.including 5,000 ha. in the public sector would be covered under the programme. This would help rehabilitate about 5,000 families. The project, when completed, is expected to yield an annual fish production of 1,500 tonnes valued at Rs.1.8 crores. Besides, it would give rise to additional income of Rs.9.6 crores for the project period through linkage effects. The project construction would involve 180 lakh man days. The private fish culture farms alone would generate 30,000 man hours of employment (Kant, 1985).

9.2.1.6 In the light of the above proposal it is considered imperative to examine problems of fish culture from the point of view of farm business. Output of an aquaculture production system can be considered as a function of the inputs applied in the production process. Fish yield depends upon several controllable and noncontrollable factors. Such factors relates to stocking rates[1], material inputs, genotype of the species, size at harvesting, managerial expertise, period of rearing, soil and water characteristics, environment and the underlying technology used. It is a combination of many of these variables that ultimately determine the quantum of fish production from a given area of water body.

9.2.1.7 The relationship between inputs and outputs is commonly referred to the production function, and much of production economics dwells on the methods of determining the physical input-output relationship. It is of great significance to know precisely the determinants of fish culture which makes the operations economically viable or nonviable. By examining the complex representation of this relationship, it is possible to establish the link between biological and economic considerations of aquaculture production (Shang, 1981).

9.2.1.8 A production practice will be technically viable, if it is capable of predicting the likely size of the crop with a fair degree of accuracy. A functional form of fish production model here is that of unconstrained Cobb-Douglas production function model (Cobb and Douglas, 1928). This log-linear specified production function is an acceptable representation of the underlying behaviour of the production process. Among the many explanatory variables, only seven important inputs are hypothesised in this study to explain fish production. To analyse the relative importance of these seven explanatory variables, the model is fitted by using the multiple regression technique based on the following equation.

$$Y = A \; X_1^{\alpha_1} \; X_2^{\alpha_2} \; X_3^{\alpha_3} \; X_4^{\alpha_4} \; X_5^{\alpha_5} \; X_6^{\alpha_6} \; X_7^{\alpha_7}$$

When transformed to lagarithmic form, we obtain;

$$\log Y = \log A + \alpha_1 \log X_2 + \alpha_2 \log X_2 + \alpha_3 \log X_3$$

$$+ \alpha_4 \log X_4 + \alpha_5 \log X_5 + \alpha_6 \log X_6 + \alpha_7 \log X_7 +$$

where

Y = output of fish (kg),

X_1 = farm size,

X_2 = stocking rate,

X_3 = cost of seed,

X_4 = labour cost,

X_5 = dewaterisation cost,

X_6 = cost of manure,

X_7 = cost of other inputs

A, = regression coefficients (parameters), and

ε = error term.

9.2.1.9 The production coefficients (α_i) or exponents in the Cobb-Douglas form are the elasticities of production. In other words, these are the transformation ratios of the various inputs used in fish production at different quantities. The above production equation gives only an approximate modelling of the true production process, because many more variables may be responsible for the true production process, but have not been included because of difficulty of measurement and analysis (Aigner and Chu, 1968).

9.2.2 Objectives

9.2.2.1 The objectives of the study are:

i) To estimate the input-output relationship (production function) of fish culture activities in the experimental farms;

ii) To obtain the marginal productivities and returns

iii) To find out which of the inputs are the most important determinants of total output;

iv) To apply the estimated model for predicting production levels from given levels of input application; and

v) To determine which type of fish culture is more appropriate under existing conditions.

9.2.3 Methods

9.2.3.1 A number of indicators are used here for an economic analysis of production. The widely accepted method of production is the use of farm layout consisting of nursery and rearing ponds. The data for the study have been collected from fish farms directly for the period from 1980 to 1985 for different operations in various ponds. The average size of the pond under study is 0.18 hectares. All the experimental culture activities of different types between these periods have been used. As there are only eight monoculture farms, 10 bye-culture farms and 10 polyculture farms, it does not seem to be statistically viable to carry out a separate study for each of these categories. Therefore, the total number of farms are considered irrespective of their type.

9.2.4 Cost structure

9.2.4.1 Costs are classified into two components. They

i) Variable costs, i.e., expenses that are actually incurred and that vary with the quantity of fish produced, such as fingerlings[2], feed and hired labour.

ii) Imputed or opportunity cost of owned inputs excluding that of land and pond construction which may be either fixed or variable.

9.2.5 Economic optima

9.2.5.1 The problem posed here is: Is the production economically efficient? In other words, is the use of inputs optimal in terms of maximising the profit? In order to maintain the net returns, the producers have to find out the rates at which the inputs are to be applied. Based on the prices of inputs and output prevailing in the factor and product market, and also with the help of estimates obtained from the production function, optimum input combination can be worked out (Sarun and Theodore, 1981). For this it is necessary to calculate the Marginal Physical Product (MPP) of each of the variable input and compare it with the input-output price ratio.

$$MPP_{X_i} \lesseqgtr \frac{P_{X_i}}{P_Y}$$

---

2. Fingerlings mean young fishes used for fish culture.

If MPP is greater than the price ratio, the use of inputs should be increased. If MPP is less than the price ratio, the use of the input should be reduced. Equality between the two implies that producers are on an average economically efficient. To calculate the MPP of certain of the inputs (such as stocking rate and fertilizer use which a priori appears to be the major determinants of output) from the Cobb-Douglas production function, the technique of partial differentiation has been used. The other variables are calculated at their geometric mean. We used partial differentiation techniques for two specific inputs because, as will be evident a little later, input output price ratios which are necessary to determine the number of fingerlings are central to such an exercise. On the contrary, input-output price ratios do not have to be used as far as the other variables are concerned and hence the geometric mean is used in their case.

9.2.6 Fit of the model

9.2.6.1 The Cobb-Douglas model is a good fit as is evident from the F values and the R^2; the F value (74.32) is highly significant. The R^2 (0.69) is also highly significant. The main results of the estimation of the fish culture are summarised in table 9.14. In all these cases there are sufficient degrees of freedom for statistical tests.

Table 9.14 Estimated production function (Cobb-Douglas) on a per-farm basis

	X_1	X_2	X_3	X_4	X_5	X_6	X_7
Intercept = 12.62							
Production coefficients	0.332	0.220	0.042	-0.175	0.258	0.167	0.331
T.Value	4.019	2.164	1.782	-1.090	3.002	4.183	5.124
Standard error	0.06	0.03	0.04	0.03	0.02	0.06	0.05
Significance level	0.210	0.001	0.0001	0.640	0.001	0.210	0.310
R^2	69						
Input mean (X)							
GM	0.167	1292.310	160.373	97.073	64.773	58.026	23.170
AM	0.179	1386.780	170.340	104.180	67.560	69.980	31.620
Estimated output at X = 485							
Marginal product	607.85	0.087	0.124	0.856	1.899	1.385	4.834
Average price	--	0.25	--	--	--	1.59	--

Note: GM is the geometric mean. AM is the arithmetic mean. (F-value 74.32).

9.2.7 Fish production function

9.2.7.1 The succeeding discussion focuses on the Cobb-Douglas production function and its interpretation for decision making in the farm. The estimated function is as follows:

$$Y = 12.62\ X_1^{.332}\ X_2^{.220}\ X_3^{.042}\ X_4^{-.175}\ X_5^{.258}\ X_6^{.167}\ X_7^{.331}$$

Of the seven explanatory variables used in the model, five are statistically significant (as in table 9.14). These variables are farm size (X_1), stocking rate (X_2), dewaterisation cost (X_5), manure (X_6) and other inputs (X_7). The other two variables, cost of seed (X_3) and labour cost (X_4) are not significant in explaining the output.

9.2.7.2 All the coefficients, except labour cost (X_4), have positive signs. The summation of the production coefficients ($\Sigma\alpha_i$) in the model is 1.17. This implies that the production function represents increasing returns to scale, i.e., if all the inputs specified in the model are increased by a fixed proportion, the output will increase by a factor more than the increase of the input. In this case, if all the inputs are raised by 1.00 per cent of the output will increase by 1.17 per cent.

9.2.7.3 It is clear from the production function equation that a one per cent increase in the number of fingerlings (X_3)

will result in a 0.22 per cent increase in the output, the other inputs being held constant. The use of manure (X_6), both organic and inorganic, accounts for an increase of 0.167 per cent for a one per cent increase in the input. If the farm size (X_1) is increased by one per cent, the output will increase by 0.332 per cent. The R^2 or the coefficient of determination is 69 per cent and the F-test of the overall regression is significant at the 0.00021 per cent level (F-value 74.32).

9.2.7.4 The sestimated equation gives an intercept or constant value of 12.62 (which is the antilog of the intercept) which shows that the level of efficiency of the production process in converting inputs into output as a whole is rather poor. It is because we have a multiplicative model under consideration and that by the very nature of the model a high value of the intercept is likely to reduce the efficiency of the model in predicting the value of the output.

9.2.8 Optimum stocking rate

9.2.8.1 From the fish production function equation, the stocking rate (X_2) is calculated from the Geometric Mean of all other inputs. For this purpose the price of fingerlings in 1985 (25 paise per seed) and the sale price of market size fish in 1985 (Rs.12/kg of fish) are used.

The partial derivative of Y with respect to X_2 gives the marginal product of X_2,

$$\frac{\partial Y}{\partial X_2} = 2.776 X_1^{.332} X_2^{-.780} X_3^{.042} X_4^{-.175} X_5^{.258} X_6^{.167} X_7^{.331}$$

Such an exercise will help us to determine the value of inputs and output provided we have the price of one kilogram of 'market size' of fish. Since the culture activities are not based on a single specie of fish, the weighted average price of all the species are taken into consideration while determining the kilogram price of output (P_Y). The same is the problem in pricing the fingerlings, however it is resolved by taking the average price of this input (X_2). By taking the ratio of these two prices, we obtain,

$$P_{X_2} / P_Y = 0.75/12.00 = 0.0625$$

Substituting the values of the variables X_i's in the above equation and equating the same with the input-output price ratio (P_{X_2}/P_Y), we obtain,

$$X_2^{-.780}(2.776)(.875)(1.237)(.449)(2.933)(1.970)(2.830) = 0.0625$$

i.e., $22.0633\, X_2^{-.780} = 0.0625$

$$X_2^{-.780} = 0.0625/22.0633 = 0.0028$$

and solving for X_2

X_2 = 1874 pieces of fingerlings in the farm.

Thus the optimum stocking of fingerlings is 1874 pieces in the farm. If the optimum stocking rate is compared with the geometric and arithmetic means of fingerling stocking rate which are 1292 and 1386 respectively, it is clear that the average production can be increased by increasing the present stocking rate. Therefore, the production function for any one particular farm may conceptually be obtained from the above production function in terms of farm's ability to use optimal values of the parameters of the industry (Aigner and Chu, 1968).

9.2.8.2 The same principle can be explained in another way to show the economic gains from increased fingerlings stocking rates. With the help of marginal product and the average prices of inputs and output the result can be interpreted with the inequality

$$MPP_{X_i} \gtreqless P_{X_i} / P_Y$$

i.e., $MPP_{X_2} P_Y \gtreqless P_{X_2}$

Since MPP_{X_2} is 0.087 (see table 9.14) and the average price of output per kilogram is Rs.12/- and the average price of fingerlings for the production of a kilogram of output is Rs.0.75; we obtain the inequality 0.087 $X_2 \gtreqless$ 0.750; i.e.,

$1.044 > 0.750$. Clearly, the left hand side of the inequality is greater than the right hand side as the input output price ratios are determined exogenously. This position can be changed by increasing the stocking rate until the marginal value product (VMP) declines further due to diminishing returns. After a stage we reach the equality condition which implies that the producers, on an average, are economically efficient.

9.2.9 Optimum use of fertilizers

9.2.9.1 There is a view that the production of fish can be considerably augmented by the application of different types of fertilizers at a relatively high doze. In order to verify this the same optimum principle applied in the above case is used here also to understand the use of fertilizers with the help of the average price of one kilogram of fish and the average price of both organic and inorganic fertilizers. Here the average price of fish as above is Rs.12/kg and the average price of fertilizer is Rs.1.56/kg.

The price ratio of fertilizer to fish output is

$$P_{X_6}/P_Y = \frac{1.56}{12.00} = 0.130$$

Taking the partial derivative and substituting in the price ratio

$$\frac{\partial Y}{\partial X_6} = (.167)12.62\ X_1^{.332} X_2^{.220} X_3^{.042} X_4^{-.175} X_5^{.258} X_6^{-.833} X_7^{.331} = 0.130$$

i.e., $= 2.1075\ X^{-.833}(.875)(4.836)(1.237)(.449)(2.933)(2.830)$

$= 0.130$

Therefore, $X_6^{-.833}\ 41.1127 = 0.130$

Solving for X_6

$$X_6^{-.833} = 0.130/41.1127 = 0.00316$$

$$= 1003 \text{ kg of fertilizer per farm.}$$

9.2.9.2 This optimum use of fertilizer of 1003 kilogram per farm can be compared with the geometric and arithmetic means of the use of fertilizers, viz., 59 and 70 respectively. This shows that the fish producers can increase their organic and inorganic fertilizer application very much and thereby increase their output and returns. Thus the optimum fertilizer application rate is 20 times the geometric mean (59) in the farm.

9.2.9.3 Though different methods of estimation of output from the Cobb-Douglas production function are available, we have used only the input means (the geometric mean) method. Based on this the output is estimated at 485 kgs of fish in the farm.

9.3 Production economics of different types of fish

9.3.1.1 The experimental fish culture activities are not confined to a particular type of fish. It consists of mono-culture, bye-culture and poly-culture activities. So it is important to understand the economic efficiency of each of these culture activities.

9.3.2 Monoculture

9.3.2.1 The economics of monoculture activities of an average fish farm is considered purely on the basis of data collected from experimental culture project. The most economic species are Penaeus Indicus and Chanos Chanos. Here the study of monoculture of C.Chanos is given. The objective of the project is rearing of C.Chanos to marketable size as per the technical programme of All India Co-ordinated Research Project of the ICAR. The experiment of this culture was started on 15-6-1984 and ended on 31-7-1985, covering a rearing period of 13½ months. The size of the pond constructed for the purpose is 1,400 square metres. The stocking details are given in table 9.15.

Table 9.15 Stocking details of monoculture of fish

Species	No.	Total length range (mm)	Mean total length (mm)	Weight range (g)	Mean weight (g)	Total weight (kg)
C.Chanos	560	25-35	30	2.0-3.0	2.5	1.4

9.3.2.2 A total of about 560 numbers with an average weight of 2.5 gram is stocked. The total expenditure for the various inputs are given as follows:

Input cost

	Rs.
Seed (Price at the rate of Rs.0.25 per seed)	140.00
Mahuva oil cake (Rs.1.75/kg)	31.50
Lime (140 kg at the rate of Rs.0.50/kg)	70.00
Mussori Phosphate (91 kg at the rate of Re.1/kg)	91.00
Dewaterising charge (Pond preparation)	75.00
Labour charge (Pond preparation and harvest)	250.00
Total	Rs.657.50

The harvest details are given in table 9.16.

Table 9.16 Harvest details of monoculture of fish

Species No.	% retrieval	Total length range (mm)	Mean total length (mm)	Weight range (g)	Mean weight (g)	Total weight (kg)
C. Chanos 351	62.6	350-465	424	340-640	515	180.65

9.3.2.3 The result of this average experimental fish project of mono-culture is remarkable. The C.Chanos reached in good marketable size with a mean weight of 515 grams without supplementary feeding. The price per kilogram of fish is Rs.15/- and the total value realised out of this experimental project is Rs.2,709.25. The profit is Rs.2,052.75. The production and profit would have been much higher if the percentage retrieval was higher. In this experiment the retrieval percentage was only 62.6. So this gives a farm income of Rs.1,824/- per year for 1,400 square metres. If estimated for a hectare, the farm income from monoculture of C.Chanos works out to Rs.13,028/- per year.

9.3.3 Bye-culture

9.3.3.1 The species commonly used in the experimental farm activities are Mugil Cephalus with Chanos Chanos, Penaeus Indicus with Liza Parsa, Penaeus Indicus with Chanos Chanos etc. Here the economic analysis of bye-culture is given on the basis of M.Cephalus with C.Chanos. The programme of this project is culture of marketable size of M.Cephalus and C.Chanos without supplementary feeding but with pond fertilization. The date on which the project started was 22.4.1982; and it was completed on 22.5.1983. The area of the pond was 0.15 hectares. The stocking details are given in table 9.17.

Table 9.17 Stocking details of bye-culture of fish

Species	No.	Ratio	Total length range (mm)	Mean total length (mm)	Weight range (g)	Mean weight (g)	Total weight (kg)
M.Cephalus	450	75	40-62	51	0.7-0.84	0.76	342.00
C.Chanos	150	25	80-90	85	4.0-4.70	4.35	652.50
Total	600	100	--	--	--	--	994.50

9.3.3.2 A total of about 600 seeds have been stocked. Out of this 75 per cent belonged to M.Cephalus and 25 per cent C.Chanos. The size of the seed of the C.Chanos are big compared to that of M.Cephalus. The cost of the operation of the project is:

Cost of production	Rs.
Seed (Rs.20/100)	120.00
Mahuva oil cake (70 kgs)	87.00
Dewaterising	36.00
Rock Phosphate (7.2 kg)	6.50
Urea (16.8 kgs)	38.70
Labour charges (Pond preparation and harvesting)	115.00
Total	Rs.403.50

The harvest details are given in table 9.18.

Table 9.18 Harvest details of bye-culture of fish

Species	No. recovered	Percent-age retrieval	TL range (mm)	MTL (mm)	W.range (g)	M.Wt. (g)	T.Wt. (kg)	Percentage contri-bution
M.Cephalus	398	88.44	320-405	356	330-650	446	177.60	53.94
C.Chanos	144	96.00	440-550	472	550-1500	735	105.80	32.12
Others	--	--	--	--	--	--	46.00	13.94
Total	542	90.33	--	--	--	--	329.40	100.00

9.3.3.3 This experimental farm on bye-culture shows that M.Cephalus and C.Chanos can yield good production without supplementary feeding. The total sales proceeds out of this experiment is Rs.3,240.25 based on the price of Rs.12/-kg of M.Cephalus, Rs.8/-kg of C.Chanos and Rs.5.7/kg of other fishes. Net profit is Rs.2,836.75 for 13 months for 1,500 square metres. This is about Rs.17,457/-per hectare for one year. If the stocking rate of 4,000/ha. is raised to 6 to 8 thousand per hectare the profit of this experiment would have been much higher.

9.3.4 Polyculture of fish

9.3.4.1 Owing to the high value realisation of prawn mixed culture of fish and prawn is considered to be the most profitable culture operation. An evaluation study of the culture of Penacius Monodon alongwith Mugil Cephalus and Etroplus Suratensis is given here to understand the economic implications of culture operations. Here the programme is rearing of prawns and fishes together without supplementary feeding and pond fertilization. The experimental period was from 16.3.1981 to 13.8.1981. The area of the pond is 1,500 square metres. The stocking details are given in table 9.19.

9.3.4.2 The pond is harvested after five months. The harvesting details are given in table 9.20.

Table 9.19 Stocking details of polyculture of fish

Species	No. stocked	Mean total length (mm)	Mean weight (g)	Rate/ hectare	Total weight (kg)
P.Monodon	3600	15	70 mg	24,000	252
M.Cephalus	120	285	215 g	800	25800
E.Suratensis	60	125	50 g	400	3000
Total	3600/180	--	--	2400/1200	352/28800g

Table 9.20 Harvest details of polyculture of fish

Species	No.	Per-cent-age retrie-val	Total length range (mm)	Mean total length (mm)	Weight range (g)	Mean weight (g)	Total weight (kg)
P.Monodon	1491	41.42	110-180	141	15-50	26.65	39.735
M.Cephalus	110	91.70	330-450	376	300-950	500.00	31.40
E.Suraten-sis	60	100.00	--	170	--	129.00	7.3
Others	--	--	--	--	--	--	48.375

9.3.4.3 The production rate of P.Monodon 39.735 kg for 0.15 hectares for 110 days means 878.920 kgs for one hectare in an year. In the same period the production rate of fish alone was 1,926.105 kgs for one hectare in an year. If we take the production rate of prawn and fish together, the rate is 2,805.025 kg/ha. for one year. Following is the cost of production.

Production cost		Rs.
Prawn seed (Rs.17/1,000 - 3600 Nos.)		54.00
Other seeds (Rs.0.20/seed)		36.00
Mahuva oil cake (20 kgs)		25.00
Dewaterisation		122.00
Labour charges		208.00
	Total	Rs.445.00

The total return was worked out on the basis of market value of the different species as:

		Rs.
P.Mondon (Rs.40/kg)		1,589.00
Other prawn (Rs.18/kg)		30.60
M.Cephalus (Rs.12/kg)		376.80
E.Suratensis (Rs.8/kg)		58.40
Other fishes (Rs.2.5/kg)		146.80
	Total	Rs.2,201.60

9.3.4.4 The experimental culture operation gives a net profit of Rs.1,756.60. When considered the net profit per hectare it is as high as Rs.42,743/- per year. The operation seems to be highly lucrative because of the judicious use of the limited availability of M.Cephalus, E.Suretensis with P.Monodon seed. This shows that polyculture activity can be considered a more profitable proposition than the usual agricultural operation.

9.3.4.5 By analysing the comparative importance of different culture operations, the polyculture of fishes is considered to be the most profitable. The study shows that aquaculture activities have very good prospects in Kerala.

9.4 Conclusion

9.4.1 Demand for fish is rising in Kerala; but this has not encouraged aquaculture production. It is expected that with vigorous extension effort coupled with suitable developmental strategy, fish culture is bound to gain a strong foothold in the state in a not too distant future. The benefits of mixed fish farming to the farmers remain unparalleled when compared with any other form of agriculture. Hence on general ground it may be argued that farmers generally do not seem to be aware of the adoptable techniques in this regard.

9.4.2 A technology, if it is to be worthwhile, has to change the production process decisively by disturbing the relationship between input and output. The new process either should result in saving the use of scarce inputs per unit of output or using the abundant input on a relatively larger scale per unit of production.

Chapter X

CONCLUSIONS AND RECOMMENDATIONS

10.1 Conclusions

10.1.1 The study leads to the following conclusions:

10.1.2 Mechanisation of fishing craft has brought about favourable change in the standard of living of the fishermen.

10.1.3 The use of synthetic fibres like nylon fibrillated tape twisted twines, multifilament nylon etc. for the gear materials helped to enhance catch efficiency.

10.1.4 The substitution of knotted webbing of nylon with knotless webbing of nylon for small meshed seine nets has increased the catch and earning capacity. The per day catch shows that the knotless webbing seine nets are 25 per cent more efficient than the knotted seine nets.

10.1.5 The experiments with different category of trawl nets showed that the bulged belly trawl is more efficient for shrimp and six seam and high opening trawls for fish.

10.1.6 One important aspect of the non-mechanised sector is the very low labour productivity compared to the mechanised sector. Labour productivity in the mechanised sector is nine fold to that of the non-mechanised.

10.1.7 The higher price and very high demand for prawn in the foreign markets are responsible for the anarchic growth of the mechanised boats in Kerala.

10.1.8 If we go for fuel efficiency and economy in material cost, then it is attractive to build hull with lighter materials like aluminium and FRP.

10.1.9 The economic species such as oil-sardine and mackeral in the artisanal sector showed a stagnating tendency for the last 10 years. But living standards of the poor fishermen in the state largely depend on the landings of these two species.

10.1.10 Kerala being the prime producer of marine fish, the total variation in the marine fish production in India is largely related to the production rate in Kerala.

10.1.11 The catch data show that the demersal species of the mechanised sector and the pelagic species of the traditional sector have a southward drifting of these fishery resources. This may be partly due to the presence of 'Wadge Bank' and partly due to the predominance of mechanised fishing in the southern region.

10.1.12 The seasonality aspect of fish landing indicates that there is demonstrable seasonal influence in all the major species. Harmonic analysis of time series shows that the seasonal influence is maximum for oil-sardine and prawn.

10.1.13 The third quarter (July-September) is found to be the major fishing season for most of the species in the mechanised sector. The maximum landing is also noticed for this sector in this quarter itself.

10.1.14 The fishery resource forecast based on Auto Regressive Moving Average (ARMA) shows stagnation with reference to most of the species in Kerala. An important aspect in the forecast value is the decreasing trend with reference to certain species and a marginally increasing trend with reference to certain other species in some quarters.

10.1.15 A 36-fold increase in the value of the output is noticed between 1964 and 1984. But this was mainly due to the very high unit price realisation of the export specie of prawn.

10.1.16 The high value realisation of the marine species in the mechanised sector is because of the composition of fish catch in favour of the relatively very high priced specie of prawn.

10.1.17 The value of output has registered a phenomenal increase in the post 1964 period. A combined analysis of the source of growth shows that volume changes and species-mix changes account for only 3.5 per cent of the increase and 96.5 per cent of the increase is due to price changes alone.

10.1.18 Our consumption of fish and fishery products shows that there is large scale 'unmet' demand for fish. This is the basic cause for the escalation of fish prices in Kerala compared with other Indian states.

10.1.19 Trawlnet in the mechanised sector and boat-seine in the non-mechanised sector are the two principal gears contributing volume and value in the fishery economy.

10.1.20 There exists very high idle capacity in the fish processing industry. This has led more than 50 per cent of the processing units to become sick.

10.1.21 A positive relationship is noticed with respect to idle capacity and the number of shifts. As the number of shifts increases, the idle capacity also increases.

10.1.22 An exploitable quantity of about 5.7 lakh tonnes of resources remain untouched beyond the 50 m depth zone in spite of the improvement in skill and technology in the fisheries sector of the state.

10.1.23 The economic spoilage while transporting fish from the harvesting area to the processing and the marketing area is the highest in non-exportable varieties (Rs.7.8 crores) and it is only very little for exportable varieties (Rs.56.03 lakhs), transporting an average distance of 66.78 kms.

10.1.24 Schaefer model presents an alarming conclusion: the prawn resource is overfished in Cochin and Sakthikulangara-Neendakara belt.

10.1.25 The effort required to generate (f_{msy}) for a maximum sustainable yield (MSY) is only 663 boats (at eight hours per day) for landing 27,601.7 tonnes of prawn in Sakthikulangara-Neendakara belt. But more than 1,500 boats are operating in this area leading to very low level of catch per unit effort (CPUE).

10.1.26 The increased export earning from seafood is due to mechanisation and modernisation of the fishing methods, especially shrimp trawling.

10.1.27 Marine products export from Kerala shows very high concentration of a single specie (about 91 per cent) of prawn.

10.1.28 The seafood export earning depends on the market information and the quality control measures adopted by the exporting country.

10.1.29 The availability of catch, particularly prawn and its price are very crucial in earning profits by the mechanised boats. The availability of prawn varies between seasons. Hence the profitability position of the mechanised fishing sector also varies between seasons.

10.1.30 Mechanised fishing is profitable only in certain seasons. But this season comprises of the most controversial months of June through August. So banning of trawling during these months will practically reduce the mechanised fishing industry into a non-profitable proposition.

10.1.31 It is found that on an average one-third of the total catch value is spent on diesel in the mechanised sector.

10.1.32 The case study of mechanised fishing shows that to improve economic efficiency of the boats, the number of trips is to be increased in the peak landing seasons.

10.1.33 The minimum catch (break-even) can be reduced considerably if the producers are assured of the right price for prawn.

10.1.34 The estimated statistical coefficients of fishing ability shows that Leyland engine boats are the best among the various engines used for mechanised fishing.

10.1.35 The estimated coefficients of fish culture activities based on Cobb-Douglas production function (1.17) shows increasing returns to scale. It also presents the economic efficiency of culture fisheries and its scope.

10.1.36 In order to increase the return from fish culture activities, the stocking rate and application of both organic and inorganic fertiliser are to be increased.

10.1.37 An analysis of production economics of different types of culture activities shows that polyculture of fish is more economical and it is suitable to Kerala conditions.

10.1.38 The farmers are generally unaware of the adoptable techniques of different forms of fish culture, which are in general found to be more profitable than any other form of agricultural operation.

10.1.39 There is very high underutilisation of inland fish resources in Kerala. We have ample scope to develop brackish water, fresh water and reservoir fisheries.

10.2 Recommendations

10.2.1 Based on the study the following recommendations are made:

10.2.2 The income of a fisherman depends to a large extent on the shore prices of fish. So attempts should be made to organise marketing of fish by fishermen themselves through Fishermen Welfare Societies so as to ensure better price for their produce, duly eliminating exploitation of the fishermen by the intermediaries.

10.2.3 Specified fishing zones for different categories of fishcraft as envisaged in the Kerala Marine Regulation Act 1980 will have to be enforced to protect the interests of the traditional fishermen.

10.2.4 The fishery data sources are not completely accurate as there are many left out quantities owing to the unorganised nature of the sector and also the deficiency of the compilation of the data. So steps have to be taken for the collection of fishery statistics on a scientific basis in all the parts of Kerala.

10.2.5 The sectorwise, gearwise intercomparison of the income trends for all the years should be assessed for fishery planning and the formulation of plan priorities in this sector.

10.2.6 Measures are to be taken to publish the shore prices of all the species of importance so as to analyse the correct value change in fisheries.

10.2.7 A fuel conservation survey should be undertaken immediately in areas where there are heavy concentration of mechanised boats like Neendakara, Cochin etc.

10.2.8 As a step to reduce fuel cost in the operation of the inboard/outboard in the traditional sector the inboard/ outboard engines must be converted into diesel engines from petrol engines.

10.2.9 Based on resource survey, fishery charts should be prepared indicating productive fishing grounds to induce private capital into such a risky venture as deep-sea fishing.

10.2.10 By considering the demand position and the competition for market, product diversification is very useful for the sound flow of seafood trade.

10.2.11 Two ways are there to solve the idle capacity of the processing plants--(i) to increase the raw material by popularising aquaculture and deep-sea fishing and (ii) to develop new processing techniques with cheap and durable containers and packing materials.

10.2.12 The existing design of the mechanised boats is 30 years old. Based on the technological change taken place in the hull and gear materials and also with respect to the cost of hull the existing boats are to be updated.

10.2.13 The present number of mechanised boats are more than optimum for exploiting commercially important species. So issuing fishing licences for the mechanised boats should be stopped and the existing excess boats should be deployed to diversified fishing activities.

10.2.14 It is necessary to introduce some conservative measures, particularly for avoiding destructive fishing of fry and juvenile shrimp species which can grow to bigger sizes. Methods like closed seasons for prawn fishery, restricting further issue of licences for stake net fishing etc. But this kind of restriction does not cause any hardship to the weaker sections of the society who have been depending solely on small-scale fishery for their livelihood.

10.2.15 Purse-seining is detrimental to the traditional fishing and fishermen. So a ban of purse-seining is necessary in Cochin as in other districts of the state.

10.2.16 Brackish water fish culture has immense scope in Kerala for generating income and employment to the fishermen. This would also help to earn more foreign exchange at a time exportable species are dwindling from the capture fisheries.

10.2.17 To sum up, this is one of the pioneer studies of this kind dealing with the harvest and post-harvest technology of the fishing industry with special emphasis to the resource base and its iterative aspects. It is also one of the first studies focusing the problem of the industry with regard to cost, earnings and management regulations based on seasonality aspects. The findings of this study is expected to help the policy makers to plan and manage better the fishing industry in Kerala.

10.2.18 Since fishing industry is subjected to various kinds of externalities, and are influenced by technological development pari pasu with socio-economic development in the years to come, it will be useful to conduct further studies in this sector. The areas which will have immense scope for further research are (i) the impact of motorisation among the traditional fishermen in getting higher catches and return, (ii) catch and earning aspects of different craft-gear combinations with respect to fishing seasons, (iii) off-shore and deep-sea fishing where large potential resources are available for exploitation and (iv) sharing of cost and earnings based on social profitability.

BIBLIOGRAPHY

BOOKS

Anderson, L.G. (1977), The Economics of Fisheries Management, The Johns Hopkins University Press, Baltimore.

Bajpai, A.C. et.al. (1977), Advanced Engineering Mathematics, John Wiley & Sons, New York.

Bell, F.W. (1978), Food from the Sea, Westview Press, Boulder Colarado.

Box, G.E.P. and Jenkins, G.M. (1970), Time Series Analysis Forecasting and Control, San Francisco, Holden-Day.

Chaston, I. (1983), Marketing in Fisheries and Aquaculture, Fishing News Booklet Ltd., England.

Clucas, I.J. and Sutchliffe, P.J. (1981), An Introduction to Fish Handling and Processing, Tropical Products Institute, London.

Day, F. (1865), The Fishes of Malabar, London.

FAO (1971), Pollution an International Problem for Fisheries, World Food Problems No.14, FAO Fisheries Series No.4, Rome.

Jonston, J. (1963), Econometric Methods, Mc-Graw Hill Kogakusha Ltd., Tokyo.

Kirby, E.S. and Szezepanik, E.F. (1957), Special Problems of Fishermen in Poor Countries, In the Economics of Fisheries (ed.,), Ralph Turvey and Jack Wiseman, FAO, Rome.

Klausen, A.M. (1968), Kerala Fishermen and the Indo-Norwegian Project, Allen & Unwin, London.

Lawson, Rowena, (1984), Economics of Fisheries Development, Frances Pinter Publishers, London.

Mathur, P.R.G. (1978), The Mappila Fisherfolk of Kerala, Kerala Historical Society, Trivandrum.

Mc Hugh, J.L. (1984), Fishery Management : Lecture Notes on Coastal and Estuarine Studies, Springer-Verlag, New York.

Munro, G.R. and Chee, K.L. (1978), The Economics of Fishing and the Developing World--A Malaysian Case Study, Penerbit University Sains, Malaysia.

Rao, S.N. (1983), "Product Development for Export," in Fisheries Development in India--Some Aspects of Policy Management (ed.), Srivastava,U.K. & Dharma Reddy, M., Concept Publication.

Shang, Y.C. (1981), Aquaculture Economics: Basic Concepts and Methods of Analysis, Boulder, Colarodo Press, USA.

Siegel, S. (1956), Non-parametric Statistics for the Behavioural Sciences, International Students Edition, Mc Graw-Hill Book Company, INC, Kogakusha Co.Ltd., Tokyo.

ARTICLES

Aigner, D.J. and Chu, S.F. (1968), "On Estimating the Industry Production Function", American Economic Review, 58, 826-839.

Appukuttan, et.al. (1965), "On the Selective Action of Coded Meshes of a Shrimp Trawl", Fishery Technology, Vol.2, No.2, 220-248.

Asari, T.R.T. (1969), "The Impact of Indo-Norwegian Project on the Growth and Development of Indian Fisheries", Presented at the FAO International Conference on Investment in Fisheries, Rome.

———————— (1981), "Mechanised Fishing in Kerala", Fisherman, Vol.2, April-December, Quilon.

Ayyappan Pillai, S. (1982), "Mechanisation of Traditional Fishing Vessels in the South West Coast of India", Symp. Harvest and Post-Harvest Technology of Fish, 24-27 November, CIFT, Cochin.

Bay of Bengal News (1984), Issue No.13, March.

Bhaskaran Pillai, N. (1981), "Why Trawling During Monsoon Months", Fisherman, Vol.2, No.2, April-December, Quilon.

Bhaskaran Pillai, N. (1983), "Mechanised Boats Economics of Operation", Economic Times, 23rd May.

"Chart on Demersal Fishery Resources", (1985), Indian Express, 26th August, Cochin.

Chidambaram, K. (1975), "Export Marketing of Seafoods", Seafood Export Journal, Vol.VII, No.1 (Annual Number), January.

Choudhury, R.C. (1986a), "Marine Fisheries Management and Development" (Keynote Address), International Seminar on Training and Education for Marine Fisheries Management and Development, CIFT, 28th January, Cochin.

————— (1986b), "Management of Potential Fishery Resources," Seminar on Potential Marine Fishery Resources, CMFRI, 23rd April, Cochin.

CIFT, (1979), "Catalogue of Implements/Machinery for Fish Harvest Technology (Inboard-Outboard Drive)", Special Bulletin No.7, Cochin.

CMFRI, (1985), "Focus on Artisanal Fisherfolk", CMFRI Newsletter, Numbers 27 and 28, January-June, Cochin.

Cobb, C.W. and Douglas, P.M. (1928), "A Theory of Production", American Economic Review Supplement, March.

Dixitulu, J.V.H. (1985), "Towards Development of Deep Sea Fishing", Fisheries Development 2000 AD--International Conference, 4-6 February, New Delhi.

Express Magazine, (1985), "In the Shoes of the Fishermen", Indian Express, 8th September, Cochin.

Galtung, J. (1969), "Development from Above and the Blue Revolution--The Indo-Norwegian Project in Kerala", Peace Research Institute, Working Paper-2-12, Oslo.

George, M.J. (1980), "Prawn Fishery of Kerala State", Fisherman, Vol.1, No.1, February-March, Quilon.

George, M.J. et.al. (1980b), "A Case of Overfishing: Depletion, of Shrimp Resources in Neendakara Coast", Mar.Fish.Infor. Serv. T & E Series (18): 1-7, Cochin.

George, P.C. et.al. (1977), "Fisheries Resources of the Indian Economic Zone", Souv. Integrated Fisheries Project, Silver Jubilee Celebrations, Cochin.

George, V.C. (1986), "Fishing Technology for Increased Marine Production", International Seminar on Marine Fisheries Management and Development, CIFNET, 23rd January, Cochin.

Gopalan, R. (1980), "The Fishing Industry in Doldrums", Fisherman, Vol.1, January-March, Quilon.

Gorden, H.S. (1954), "The Economic Theory of Common Property Resource: The Fishery", J. of Political Economy LXII, No.2, April, 124-42.

Government of India (1976), Exploratory Fisheries Project, "Demersal Fisheries Resources off the South-West Coast of India", Bulletin No.3, Bombay.

Haruta, E. (1983), "Longline Fishing", Industrial Fisheries Annual, University of Cochin, Cochin.

Jacob, T. et.al., (1982), "Impact of Purse-Seine Operation in Traditional Fishery with Special Reference to Oil-Sardine, in Kerala During 1980-1981", Mar.Fish.Inform. Serv. T & E. Ser. No.40, Cochin.

Joseph, K.M. (1982), "Choice of Size and Type of Deep-Sea Trawlers for India", Symp.Harvest and Post Harvest Technology of Fish, 24-27 November, CIFT, Cochin.

Kanda, Kenji, (1962), "Study on the Fishing Ability of Trawl Fisheries on the East China and Yellow Seas", J.Tokyo University Fish., 47, 2.

Kant, A. (1985), "Strategy for Fisheries Development in Kerala", Fishing Chimes, September, 21-23.

Kee-Chai, C. and Manru, S.L. (1981), "Input-Output Relationships of Phillippine Milkfish Aquaculture", Proceedings of a Workshop on Aquaculture Economic Research in Asia, held in Singapore, 2-5 June.

Krishnakumar, S. (1981), "Problems of the Mechanised Sector and their Solution", Fisherman, Vol.2, January-March, Quilon.

Krishna Iyer, H. et.al. (1968), "Comparative Fishing Ability and Economic Efficiency of Mechanised Trawlers Operating along the Kerala Coast", Fishery Technology, Vol.V, No.2, Cochin.

———————— (1982a), "Economics of Operation of Fishing Vessels", Symp.Harvest and Post-Harvest Technology of Fish, 24-27 November, CIFT, Cochin.

———————— (1982b), "Idle Capacity Utilisation of the Processing Plants in Kerala", Symp.Harvest and Post Harvest Technology of Fish, 24-27 November, CIFT, Cochin.

———————— (1983), "The Effect of Increase in the Number of Trips and Economic Efficiency of Mechanised Trawlers Operating Along the Kerala Coast", Fishery Technology, Vol.20, Cochin.

Kurien, C.K. et.al. (1962), "Design and Operation of the so Called Tanguvala--A Single Boat Seine", IPEC Occasional Paper, 63/9: 1-17.

Kurien, J. (1978a), "Towards the Understanding of the Fish Economy of Kerala State", Centre for Development Studies Working Paper No.68, Trivandrum.

———— (1978b) "Entry of Big Business into Fishing: Its Impact on the Fish Economy", Economic and Political Weekly, Vol.13, No.36.

———— (1980), "Fishermen's Co-operatives in Kerala: A Critique", FAO/SIDA, Bay of Bengal Programme, Working Paper

Kurien, J. (1984a), "Trawling and Bans: Economics and Politics", Indian Express, 27 June, Cochin.

———— (1984b), "The Marketing of Marine Fish in Kerala State: A Preliminary Study", Centre for Development Studies, Special ICSSR Study, Trivandrum.

———— (1984c), "Marine Fish Production in Kerala: Past Trends and Perspectives for the Future" (mimeo), Centre for Development Studies, Trivandrum.

———— (1985), "Technical Assistance Projects and Socio-Economic Change-Norwegian Intervention in Kerala Fisheries Development", Economic and Political Weekly, Vol.XX, Nos.25 and 26, Review of Agriculture, 22-29 June.

Kurien, J. and Mathew, S. (1982), "Technological Change in Fishing: Its Impact on Fishermen", Centre for Development Studies, Special ICSSR Study, Trivandrum.

Kurien, J. and William, R. (1982), "Economics of Artisanal and Mechanised Fisheries in Kerala: A Study of Cost and Earnings of Fishing Units", FAO/UNDP Small Scale Fisheries Promotion in South Asia, Working Paper No.34, Madras.

Kuruvilla, P.D. "Inland Fishery no Fable", Indian Express, 28th July, Cochin.

Madhupradap, M. et.al., (1979), "Toxity of Effluent from Titanium Dioxide Factory in Some Marine Animals", Indian J. of Marine Sciences, 8: 41-42.

MFIS, (1979), "Synopsis of Marine Prawn Fishery of India; Mar.Fish.Infor.Serv. T&E.Ser. No.13, August, Cochin.

Nair, K.N. (1978), "Milk Production in Kerala--An Analysis of Past Trends and Future Prospects", Centre for Development Studies Working Paper No.76, Trivandrum.

Noble, A. (1974), "Fishery and Biology of Mackeral Rastrellinger Kangurta at Cochin", J.Mar.Biol.Ass.India, 16(B), 819.

Noble, A. and Narayanankutty, V.A. (1978), "Economics of the Indigenous Fishing Units at Cochin--A Case Study", CMFRI Special Publication No.4, Cochin.

Panikkar, K.K.P. and Sathiadas, R.S. (1982), "Fisherman's Share in Consumers One Rupee--A Case Study", Symp.Harvest and Post-Harvest Technology of Fish, 24-27 November, CIFT, Cochin.

Pillai, V.K. et.al. (1983), "Fish Mortality", Mar.Fish Inform. Serv. T&E Ser.No.53, Cochin.

Platteau, J. Ph. (1984), "The Drive Towards Mechanisation of Small Scale Fisheries in Kerala: A Study of the Transformation of Traditional Village Societies", Development and Change, Vol.15, London.

Platteau, J.Ph. et.al. (1979), "A Study on Credit and Indebtedness Among the Marine Fishermen of Southern Kerala", Preliminary Report, Namur University of Belgium, Belgium.

Platteau, J.Ph. et.al. (1981), "Interlinkage of Credit Labour and Marketing Relations in Traditional Marine Fishing", Social Action, Vol.31, New Delhi.

Purushan, K.S. (1985), "Reflections on Scientific Fish Farming in Kerala", Seafood Export Journal, Vol.XVII, No.6, June, Cochin.

Radhakrishnan and Gopalan Nair, (1982), "Fishing Experiments with Newer Materials", Symp.Harvest and Post-Harvest Technology of Fish, 24-27 November, CIFT, Cochin.

Rajasenan, D. (1982), "Optimum Planning and Resource Mobilisation in Fisheries", Matsya'82, College of Fisheries, Kerala Agricultural University, Panangad, Cochin.

———— (1985), "Chemmeen Valarthal Chila Sankethika Sampathika Prasanangal", Yojana (Malayalam), Vol.13, No.13, 16-31 Jan., Trivandrum.

———— (1986a), "Changing Pattern of Kerala's Seafood Export Trade", Indian Manager, Vol.XVI, No.1, Jan-March, Cochin.

———— (1986b), "Management of Externalities of Trawl Fisheries in Kerala", Indian Manager, Vol.XVI, No.2, April-June, Cochin.

Rajiv, R.P. (1979a), "Fishes and Their Migration", Seafood Export Journal, Vol.XI, No.9, September-December, 9-12, Cochin.

Ramachandran Nair, (1981), "Aquaculture and Pollution", CMFRI Bulletin, 30-A, March, Cochin.

Remani, K.N. et.al. (1981), "Sediments of a Retting Yard", Indian J. of Marine Science, 10, 41-44.

Rao, D.S. et.al. (1973), "Proceedings of Symposium on Living Resources of the Seas Around India", Marine Biological Association (India), p.400.

Rao, P.S. (1983), "Mechanised Fishing Cost and Earning from Boat", Economic Times, 23rd May.

Royrvik, J. (1982), "Handling and Transportation of Fish", Symp.on Harvest and Post-Harvest Technology of Fish, 24-27 November, CIFT, Cochin.

Sankaranarayanan, V.N. and Qasim, S.Z. (1969), "Marine Fishery in Cochin", Bull.Nat.Inst.Sci.India, 38, 846.

Sarun, W. and Theodore, P. (1981), "The Economics of Aquaculture: The Case of Catfish in Thailand", Proceedings of a Workshop on Aquaculture Economic Research in Asia, held in Singapore, 2-5 June.

Sathiadas, R. (1982), "Mechanisation of Indigenous Crafts with Outboard Motors in Tamil Nadu--An Impact Study", Mar.Infor. Serv. T&E Ser. No.38, Cochin.

Schaefer, M.B. (1957), "Some Considerations of Population Dynamics and Economics in Relation to the Management of the Commercial Marine Fisheries", Journal of the Fisheries Research Board of Canada, April

SIFFS, (1984), "An Approach to Small Scale Fishermen's Development During the Seventh Five Year Plan", Prepared by South Indian Federation of Fishermen Societies, Trivandrum.

Subramanian, M.R. (1982), "Packaging Holds the Key for Boosting Exports", The Economic Times, 15th December.

Sudhindra, R. et.al. (1985), "Temporal Behaviour of Marine Landings in Karnataka, ie--Seasonal Patterns", Fishery Technology, Vol.22, No.2, April.

Swaminath, M. (1983), "Is There Need for a New Generation of Mechanised Boat", Industrial Fisheries Association, University of Cochin Annual.

Turvey, Ralph, (1964), "Optimisation and Sub-optimisation in Fishery Regulation", American Eco.Review, LIV, No.2, Part I (March), 64-76.

Unnithan, R.V. et.al. (1974), "Organic Pollution in Cochin Backwaters", Indian J.of Marine Sciences, 4, 39-42.

Vijayan, V. and Remani, R.S.V.S. (1982), "Six Beam Trawl", Fishery Technology, 19(2), Cochin.

Vincent, (1984), "Fish Resources: Profits and Accountability", Indian Express, 23rd November, Cochin.

William, R. (1980), "General Description of Marine Small Scale Fisheries in Kerala", A Regional FAO/UNDP Project, Working Paper No.30, Madras.

REPORTS

AMCRR, (1980), Working Party on the Scientific Basis of Determining Management Measures, Fisheries Report, 236, FAO, Rome.

Anon, (1981), Results of Exploratory Survey of Fisheries Resource of Wadge Bank, Progress Reports 1 and 2, Exploratory Fisheries Project, Bombay.

Babu Paul, D. et.al. (1982), Report of the Committee to Study the Need for Conservation of Marine Fishery Resources During Certain Seasons of the Year and Allied Matters, submitted to the Government of Kerala, Trivandrum.

Government of India, (1976), Report of the National Commission on Agriculture, Part VII, Fisheries, Ministry of Agriculture and Irrigation, New Delhi.

Kalwar, A.G. et.al. (1985), Report on the Expert Committee on Fisheries in Kerala, submitted to the Government of Kerala, C/o Central Institute of Fisheries Education, Bombay.

Krishnakumar, S. (1980), Strategy and Action Programme for a Massive Thrust in Fisheries Development and Fishermen Welfare in Kerala State (1980-83), Special Secretary, Ports and Fisheries, Government of Kerala, Trivandrum.

MPEDA, (1981), A Status Report on the Marine Products Processing Industry in Kerala, MPEDA, Cochin.

APPENDIX-II LANDINGS OF FISH AND OTHER CRUSTACEANS BY SPECIES AND MONTH (1984)

(Qty. in tonnes)

Species	JAN	FEB	MAR	APL	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	TOTAL	in % of total landings
Sardine	32871	24544	17313	9710	7174	6349	5000	2670	12153	11715	22631	21593	173724	40.90
Anchoviella	1160	310	618	344	1308	5233	20098	3336	2702	9086	1634	795	46624	10.97
Prawn & Other Crustaceans	3046	4230	1364	1911	3259	6029	3869	3137	3610	2568	1669	2687	37379	8.80
Mackeral	628	444	671	1533	1895	900	416	461	7152	5266	866	632	20864	4.91
Catfish	952	1063	345	1166	1275	2497	248	2203	2243	820	739	377	13928	3.28
Scieanid	435	507	230	301	228	109	574	1271	1175	1924	323	51	7128	0.04
Elasmobranch	1374	594	465	536	364	89	194	83	123	316	576	322	5036	0.03
Tunnies	119	184	263	344	412	206	245	368	247	857	956	514	4714	0.02
Others	13914	10270	5860	7201	6115	8148	7463	13651	17117	11541	7525	5787	114653	27.00
Total	54500	42148	27111	23046	22034	29560	38107	27303	46522	43593	38031	32763	424718	100.00

(In percentage)

Species	JAN	FEB	MAR	APL	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	TOTAL
Sardine	18.92	14.13	9.97	5.59	4.13	3.65	2.89	1.54	6.99	6.75	13.03	12.43	100.00
Anchoviella	2.49	0.01	1.33	0.01	2.81	11.22	43.11	7.16	5.80	19.49	3.50	1.71	100.00
Prawn & Other Crustaceans	8.15	11.32	3.65	5.11	8.72	16.13	10.35	8.39	9.66	6.87	4.47	7.19	100.00
Mackeral	3.01	2.13	3.22	7.35	9.08	4.31	1.99	2.21	34.28	25.24	4.15	3.03	100.00
Catfish	6.84	7.63	2.48	8.37	9.15	17.93	1.78	15.82	16.10	5.89	5.31	2.71	100.00
Scieanid	6.10	7.11	3.23	4.22	3.19	1.53	8.05	17.83	16.48	27.00	4.53	0.01	100.00
Elasmobranch	27.28	11.80	9.23	10.64	7.23	1.77	3.85	1.65	2.44	6.27	11.44	6.39	100.00
Tunnies	2.52	3.90	5.58	7.29	8.74	4.37	5.19	7.81	5.24	18.18	20.28	10.90	100.00
Others	12.14	8.96	5.11	6.29	5.33	7.11	6.51	11.91	14.93	10.07	6.56	5.05	100.00
Total	12.83	9.92	6.38	5.43	5.19	6.96	8.98	6.43	10.95	10.26	8.96	7.71	100.00

Source: Government of Kerala, Department of Fisheries, Survey of Marine Fish Landings, Numbers I to VI, 1984-'85.

APPENDIX-III QUARTERLY FISH PRODUCTION OF IMPORTANT SPECIES

(Qty. in tonnes)

	Species	$Q_1$1978	$Q_2$1978	$Q_3$1978	$Q_4$1978	$Q_1$1979	$Q_2$1979	$Q_3$1979	$Q_4$1979	$Q_1$1980	$Q_2$1980	$Q_3$1980	$Q_4$1980
A(i)	Seerfish	647	311	635	1698	865	174	1513	3589	1112	571	359	1721
A(ii)	Pomfret	711	250	221	448	651	268	608	355	82	230	119	476
A(iii)	Oil-Sardine	19169	7292	16836	71219	19043	10584	25404	53806	23766	14401	5952	25548
A(iv)	Other Sardines	1011	3161	1949	5908	1290	2733	1193	10316	2642	1586	2147	4642
A(v)	Elasmobranches	1540	2585	1158	3948	1925	1277	2502	1562	1992	1332	1668	1761
	A Total	23078	13599	20799	83221	23774	15036	31220	69628	29594	18120	10245	34148
B(i)	Ribbion Fish	1533	3418	17984	1612	218	2537	20765	2297	48	1175	11577	137
B(ii)	Perches	1007	669	22332	2349	2215	531	17370	481	905	1247	15246	408
B(iii)	Lactarius	50	260	1157	59	22	141	88	22	84	127	618	32
B(iv)	Cephalapods	699	163	3821	1982	167	146	1799	808	835	228	1561	1618
B(v)	Anchovies	4308	1024	8319	7283	2155	1529	462	2413	1606	1174	2123	2869
B(vi)	Soles	1841	2664	2698	620	1429	692	2298	432	899	1099	1757	639
B(vii)	Siaenids	2838	2863	6703	877	1860	1403	1308	1098	1877	1659	1976	652
B(viii)	Catfishes	1107	3604	2858	1434	665	3566	4926	2219	943	5110	5104	2626
B(ix)	Other Clupeids	124	192	579	65	23	316	245	61	142	190	223	19
	B Total	13507	14857	66451	16281	8754	10861	49561	9831	7339	12009	40185	9000
C(i)	Tunnies	1010	2653	1554	1338	1162	10342	2912	1271	1111	8479	329	692
C(ii)	Mackeral	7507	2836	2868	5033	6560	9583	500	1401	3852	6074	2203	6345
	C Total	8517	5489	4422	6371	7722	20925	3412	2672	4963	14553	2532	7037
D	Prawns	5345	11747	27489	1226	7075	5851	14373	2522	4868	12833	34750	1924
E	Other Crustaceans	1201	162	179	1134	1980	1102	421	4075	1741	3108	13	2442
	Grand Total	51648	45854	119340	108233	49305	53775	98987	88728	48505	60623	87725	54551

(contd..)

APPENDIX-III QUARTERLY FISH PRODUCTION OF IMPORTANT SPECIES

(Qty. in tonnes)

	Species	$Q_1$1981	$Q_2$1981	$Q_3$1981	$Q_4$1981	$Q_1$1982	$Q_2$1982	$Q_3$1982	$Q_4$1982	$Q_1$1983	$Q_2$1983	$Q_3$1983	$Q_4$1983	$Q_1$1984	$Q_2$1984	$Q_3$1984	$Q_4$1984
A(i)	Seerfish	465	216	216	1826	1550	399	600	3010	1150	219	1696	3945	1338	151	616	1883
A(ii)	Pomfret	234	131	238	788	282	160	520	3160	263	161	256	912	446	155	521	301
A(iii)	Oil-Sardine	19768	9225	29520	58464	45000	19000	28600	50570	61285	20977	6456	66154	58384	8841	6595	28024
A(iv)	Other Sardines	1557	1736	369	3950	1010	1485	4000	870	1060	5532	25059	23379	16345	14392	13228	27915
A(v)	Elasmobranches	1363	969	833	1667	1905	1022	949	2411	1167	1510	1627	4166	2433	989	400	1214
	A Total	23387	12277	31176	66695	49747	22066	34669	60021	64925	28399	35094	98556	78946	24428	20160	59337
B(i)	Ribbion Fish	27	577	6177	269	15	1280	9200	520	25	42	871	171	20	643	1520	259
B(ii)	Perches	1086	684	6260	420	1725	1078	7756	598	1288	1127	6176	1232	127	139	1688	854
B(iii)	Lactarius	9	331	415	129	60	190	1220	120	45	245	1060	64	293	365	643	111
B(iv)	Cephalapods	467	960	1362	880	590	480	1030	1400	475	363	985	1230	310	153	2196	2251
B(v)	Anchovies	142	1373	1073	1705	520	7470	3535	2040	2114	1299	779	1123	2088	6885	26136	11515
B(vi)	Soles	1000	1470	1711	866	700	1010	6670	3100	1050	1651	1920	902	1303	278	1132	3741
B(vii)	Siaenids	1187	1042	878	1919	3442	3831	1313	4067	2643	2056	4718	632	1172	638	3020	2298
B(viii)	Catfishes	1049	3695	2228	2417	835	2553	2750	3350	1225	1867	3803	8265	2360	4938	4694	1936
B(ix)	Other Clupeids	196	81	23	673	133	300	420	222	392	93	85	520	710	382	477	322
	B Total	6163	7113	20127	9278	7990	18192	33894	15417	9287	8743	20397	14139	8383	14422	42006	23287
C(i)	Tunnies	477	2910	628	1490	1902	2600	1650	1010	930	1194	2107	1519	566	962	860	2327
C(ii)	Mackeral	6938	3530	3666	2065	3520	4100	1280	1814	2079	2997	3529	4070	1773	4328	8029	6764
	C Total	7415	6440	4294	3555	5427	6700	2930	2824	3009	4191	5636	5589	8389	5290	8889	9091
D	Prawns	3269	4216	12753	2030	2830	4583	14398	4996	8391	5703	13690	1968	8277	11023	7447	4392
E	Other Crustaceans	58	47	55	140	860	872	800	1805	640	860	892	1615	23	23	8	9
	Grand Total	40292	30093	68405	81698	64304	52413	86691	85063	86252	47896	75709	121867	103968	55186	78510	96116

Source: 1) Government of Kerala, Kerala Fisheries: Facts and Figures, Directorate of Fisheries, Trivandrum, 1977 and 1982.

2) Central Marine Fisheries Research Institute, Mar. Fish. Infor. Serv. T&E Ser., No.52, 1983.

3) Government of Kerala, Department of Fisheries, Survey of Marine Fish Landings, Numbers I to VI, 1984-'85.

APPENDIX IV

The model identification procedure of a seasonal time series is based on,

i) Check whether the given series is stationary or not. If the given series is stationary go for the second step. If the given series is not stationary, transform the series into stationary series by taking simple differencing or differencing with respect to seasonality (Box and Jenkins, 1970).

ii) Let $[\rho_1, \rho_2, \ldots]$ be the autocorrelation function of the stationary series. The order p,P,q and Q is obtained by using the autocorrelation function (Box and Jenkins, 1970)

$$\phi_p(B)\,\Phi_P(B^s)\,\nabla^d\nabla_s^D\,x_t = \theta_q(B)\,\Theta_Q(B^s)\,a_t$$

where d and D are the order of differencing, which is obtained from the first step.

iii) After obtaining the order (p,d,q) x (P,D,Q) proceed to the spectral density function of the model, which then is used to obtain the estimates of the parameters.

Let $W_t = \nabla^d \nabla_s^D x_t$

be the multiplicative model can be written as

$$\phi_p(B)\,\Phi_P(B^s)W_t = \theta_q(B)\,\Theta_Q(B^s)a_t$$

whose spectral density function is of the form

$$s(\lambda) = 2\sigma_a^2 \frac{|\theta_q(B)\ \ \Theta_Q(B^s)|^2}{|\phi_p(B)\ \ \Phi_P(B^s)|^2} \qquad (1)$$

which, on simplification, becomes a ratio of polynomials in cos λ (Box and Jenkins, 1970). By using the R- pec procedure we get the estimate of the rational form of the spectral density function which is of the form

$$\hat{s}(\lambda) = \frac{2\ \ a_o + a_1 \cos\lambda + \ldots\ldots + a_{q+Q_s} \cos(q + Q_s)\lambda}{1 + b \cos\lambda + \ldots\ldots + a_{p+P_s} \cos(p+P_s)\lambda} \qquad (2)$$

From (1) and (2) we obtain the nonlinear equation in θ's and ϕ's using the iteration procedure to these non-linear equations. From this we get the estimates for the parameters as well as for σ_a^2.

iv) By substituting the estimated parameters and $W_t = \nabla^d \nabla^D x_t$, the original multiplicative seasonal model is derived which is used for forecasting.

APPENDIX V - ITEMWISE SHARE OF KERALA'S EXPORT

(Quantity in tonnes).

Years	1977			1978			1979			1980			1981			1982			1983		
Items	Kerala	India	Kerala's Share	Kerala	India	Keral's Share	Kerala	India	Kerala's Share	Kerala	India	Kerala's Share	Kerala	India	Kerala's Share	Kerala	India	Kerala's Share	Kerala	India	Kerala's Share
Frozen Shrimp	24717	47239	52,3	26616	51223	52,2	26742	53511	49,9	23665	47762	49,5	26760	54538	49,1	27169	54625	49,7	27221	53602	50,8
Frozen Froglegs	1119	2834	39,5	1449	3570	40,6	1922	3764	51,1	2305	3095	74,5	2877	4368	65,9	1699	2271	74,8	1173	1871	62,7
Frozen Lobster Tails	309	596	51,8	326	691	47,2	319	752	42,4	256	501	51,1	366	636	57,5	398	724	55,0	314	676	46,4
Fresh & Frozen Fish	12	3765	0,3	503	9931	5,1	592	24126	2,5	33	11195	0,03	184	8565	2,1	829	9884	8,4	1666	19094	8,7
Frozen Cuttle Fish (Including Fillets)	714	1089	65,6	669	979	68,7	946	1339	70,6	728	1603	45,4	1119	1488	75,2	1537	2127	72,3	807	1807	44,7
Canned Shrimp	104	128	81,3	188	204	92,2	134	139	96,4	343	365	94,0	94	100	94,0	73	73	100,0	10	29	34,5
Dried Shrimp	3	235	1,3	1	4	25,0	10	19	52,6	26	124	21,0	Neg	56	-	-	86	-	4	28	14,3
Dried Fish	-	4221	-	-	6311	-	Neg.	3728	-	1	4340	Neg	64	1523	4,2	5	2762	0,20	2	4873	Neg
Shark Fins	1	143	0,7	-	154	-	Neg.	190	-	5	163	3,1	-	212	-	5	112	4,50	1	141	0,70
Fish Maws	-	144	-	-	269	-	-	182	-	Neg	169	-	Neg	194	-	Neg	103	-	-	112	-
Others	180	4570	3,9	2103	4610	45,6	968	4434	21,8	1127	5225	21,6	1887	3695	51,1	1567	2417	64,8	1625	3945	41,2
T o t a l	27757	64964	42,7	31652	77946	40,6	31633	92184	34,32	28136	74542	37,7	31901	75375	42,3	32946	75138	43,8	32514	86189	37,7

Source: MPEDA, Statistics of the Marine Products Export, 1981 to 1984.

APPENDIX VI - ITEMWISE SHARE OF KERALA'S EXPORT

(Value in Rs.'000)

Years	1977			1978			1979			1980			1981			1982			1983		
	Kerala	India	Kerala's Share	Kerala	India	Kerala's Share	Kerala	India	Kerala's Share	Kerala	India	Kerala's Share	Kerala	India	Kerala's Share	Kerala	India	Kerala's Share	Kerala	India	Kerala's Share
Frozen Shrimp	672424	1562208	43.0	742244	1790644	41.5	973376	2231273	43.6	1093132	2485210	44.0	767807	1833661	41.86	1224929	3009783	40.70	1282172	3103724	41.0
Frozen Froglegs	29042	65967	44.0	35692	84251	42.4	44721	87150	51.3	77933	119570	65.2	56137	73200	76.69	39936	55453	72.02	30846	49590	62.2
Frozen Lobster Tails	19380	38804	49.9	23441	45668	51.3	27381	53465	51.2	28330	47003	60.3	15901	27886	57.02	33749	59470	56.75	27077	61271	44.2
Fresh & Frozen Fish	118	38706	0.3	1210	63395	1.9	3226	115581	2.8	1775	94526	1.9	339	111939	0.30	9148	156331	5.85	16670	241276	6.9
Frozen Cuttle Fish (Including Fillets)	11405	17315	65.9	12216	16591	73.6	27968	35310	79.2	27727	32525	85.2	14658	30326	48.33	43940	56505	77.76	21302	43212	49.3
Canned Shrimp	4570	5221	87.5	8694	9149	95.0	6043	6428	94.0	4546	4900	92.8	14747	15794	93.37	4740	4740	100.00	887	1408	63.0
Dried Shrimp	67	1711	3.9	27	75	36.0	174	222	78.3	26	809	3.2	753	1349	55.82	-	726	-	301	454	66.3
Dried Fish	-	22730	-	-	32135	-	5	18934	-	502	14408	3.5	15	20802	0.07	130	21950	0.59	32	41038	0.10
Shark Fins	87	10703	0.8	-	13796	-	75	11825	-	-	21033	-	702	15145	4.64	907	15221	5.96	152	20526	0.70
Fish Maws	-	11766	-	-	20800	-	-	17517	-	6	17779	0.03	6	17382	0.03	8	5086	0.16	-	11331	-
Others	9661	22245	43.4	26661	44990	59.3	15723	42587	36.9	10520	29365	35.82	13699	41269	33.19	25098	37164	72.96	23116	49401	47.1
Total	746632	1797374	41.5	848982	2121574	40.0	1098692	2620291	41.93	1242952	2867126	43.4	883122	2188756	40.35	1383385	3422429	40.42	1402609	3623231	38.7

Source: MPEDA, Statistics of the Marine Products Exports, 1981 to 1984.

APPENDIX-VII TOTAL NUMBER OF TRIPS PERFORMED PRAWN CATCH, FISH CATCH AND TOTAL CATCH PER TRIPS OF 15 VESSELS

	Number of Trips performed						Prawn Landings (Kgs.)/trip						Fish Landings (Kgs.)/trip						Total Landings (Kgs.)/trip					
Vessel No.	Q_3	Q_4	Q_1	Q_2	Q_3	Q_4	Q_3	Q_4	Q_1	Q_2	Q_3	Q_4	Q_3	Q_4	Q_1	Q_2	Q_3	Q_4	Q_3	Q_4	Q_1	Q_2	Q_3	Q_4
1.	64	66	75	69	78	66	80	45	36	72	81	33	390	252	226	281	416	253	470	297	262	353	497	286
2.	70	77	58	79	79	78	77	59	41	74	86	38	465	256	192	259	357	291	542	315	233	333	443	329
3.	68	69	66	69	76	65	92	38	45	56	76	42	297	300	337	267	244	263	389	338	382	323	320	305
4.	67	63	72	79	66	69	84	43	31	62	107	41	451	353	351	252	263	347	535	396	382	314	370	388
5.	68	77	74	80	78	71	96	56	38	73	129	36	357	318	257	311	315	395	453	374	295	384	444	371
6.	65	62	69	71	65	67	81	49	29	67	88	34	311	246	347	257	343	359	392	295	376	324	431	393
7.	58	53	68	74	67	59	108	51	39	55	108	26	407	253	252	281	392	258	515	304	291	336	500	284
8.	60	62	61	57	64	68	97	81	34	61	92	25	358	239	244	282	269	252	455	320	278	343	361	277
9.	67	73	75	76	76	67	118	66	61	92	105	44	386	287	251	411	371	346	504	353	312	343	476	390
10.	65	69	74	72	65	64	85	49	56	81	109	51	218	281	382	346	355	318	303	330	438	427	464	369
11.	62	65	64	80	66	59	91	57	42	59	78	28	358	245	335	362	266	263	449	302	377	421	344	291
12.	55	66	63	68	67	64	111	37	36	55	106	32	213	266	276	284	343	251	324	303	312	339	449	283
13.	67	63	78	58	69	73	102	54	48	46	88	44	255	362	257	313	277	255	357	416	305	359	365	299
14.	64	68	73	73	75	69	99	56	53	64	114	50	347	313	251	256	362	284	446	369	304	320	476	334
15.	65	69	65	66	61	65	74	35	50	49	96	39	357	252	246	247	352	253	431	287	296	296	448	292

APPENDIX-VIII HOURLY LANDINGS OF PRAWN, FISH AND TOTAL OF 15 VESSELS ON AN AVERAGE

Prawn Landings (Kgs.)/hour						Fish Landings (Kgs.)/hour						Total Landings (Kgs./hour					
Q_3	Q_4	Q_1	Q_2	Q_3	Q_4	Q_3	Q_4	Q_1	Q_2	Q_3	Q_4	Q_4	Q_3	Q_1	Q_2	Q_3	Q_4
10.00	5.63	4.50	9.00	10.12	4.12	48.75	31.25	28.25	35.12	52.00	31.62	58.75	36.88	32.75	44.12	62.12	35.74
0.63	7.37	5.12	9.25	10.75	4.75	58.12	32.00	24.00	32.37	44.62	36.37	67.75	39.37	29.12	41.56	55.37	41.12
11.50	4.75	5.62	7.00	9.50	5.25	36.50	37.50	42.12	33.37	30.50	33.00	48.00	42.25	47.74	40.37	40.00	38.25
10.50	5.37	3.87	7.75	13.37	5.12	56.32	44.12	43.87	31.50	31.87	43.37	66.82	49.89	47.74	39.25	45.24	48.49
12.00	7.00	4.75	9.12	16.12	4.50	44.62	39.75	32.12	38.87	39.37	41.87	56.62	46.75	36.87	47.99	55.49	46.37
10.13	6.13	3.62	8.37	11.00	4.25	38.87	30.75	42.25	32.12	41.87	44.87	49.00	36.88	45.87	40.49	52.87	49.12
13.50	6.37	4.88	6.88	13.50	3.25	50.87	31.62	31.50	35.12	49.00	32.25	64.37	39.99	36.35	42.00	62.50	36.50
12.13	10.12	4.25	6.37	11.50	3.12	44.75	42.37	30.50	35.25	33.62	31.50	56.88	52.49	34.75	41.62	45.12	34.62
14.75	8.25	7.62	11.50	15.62	5.50	48.25	35.87	31.35	51.37	46.37	42.25	63.00	44.12	38.97	62.87	61.99	47.75
10.63	6.13	7.00	10.12	13.62	6.37	27.25	35.12	47.75	42.25	44.37	38.50	37.88	41.25	54.75	52.37	57.99	44.87
10.13	7.12	5.25	7.37	9.75	3.50	44.75	30.42	41.87	45.25	33.25	31.87	54.88	37.54	47.02	53.60	43.00	35.37
13.98	4.62	5.40	6.87	13.25	4.00	26.62	33.25	34.50	35.50	42.87	31.37	40.50	37.87	39.00	42.37	56.07	35.37
12.75	6.75	6.00	5.75	11.00	5.50	31.87	45.25	32.12	39.12	34.62	31.87	44.62	52.00	38.12	44.87	45.62	37.37
11.95	7.00	6.63	8.00	14.25	6.25	43.37	39.12	31.37	32.00	45.25	45.50	55.22	46.12	38.00	40.00	59.50	51.75
9.25	4.38	6.25	6.12	12.00	4.87	44.62	31.50	30.75	30.87	44.00	31.62	53.87	35.88	37.00	36.99	56.00	36.49