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Processing of Sea Products

Moscow, Russia, 28-29 October 1993

REPORT*

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Introduction

The Regional Consultation on the Fisheries Industry for Asia and the Pacific held in Vienna in December 1991, recommended, inter-alia, the need to foster participation of Asian fisheries specialists in international gatherings and fora with a view to enable them to exchange experience and information with fisheries specialists from other regions of the world.

The International Conference on Processing of Sea Products, organized jointly by the International Union of Scientific and Technical Societies for the Food Industry (IUFOST), the Russian Ministry of Science and Technology Policy, the Russian Committee of Fisheries and the Russian Research Institute of Marine Fisheries and Oceanography (VNIRO), in which UNIDO was invited to participate, offered the opportunity to implement the above recommendation. It was also an occasion at which fisheries specialists from various parts of the world could get together and benefit from each others experience as well as from the experience of the hosts.

Background

1. Asia is the region with the highest level and widest range of fishery activities on the part of developing countries. It is also a region which has one of the highest per capita fish consumption rates in the world. In addition, this region plays an active role in the international trading in fish products, and the Asian countries, taken as a whole, are net exporters. Compared to those of other developing regions, the fish industries of Asia and the Pacific have many advantages: a few of these advantages are abundant resources, large and strong internal markets, infrastructure and services such as ports, fishing fleets, on- and off-shore facilities and, last but not least, traditional skills married to appropriate modern technologies.

2. However, like many other regions Asia also faces a number of problems. One of the common and increasing concerns is environmental arising mainly from a lack of adequate means to dispose off waste from the fish processing industry. The Asian region is also concerned about the need to produce larger amounts of fish protein supply required by the end of the century to maintain present levels of consumption. Besides, the fisheries industry faces a number of problems in the area of packaging technology, both for domestic and international markets and new import regulations, in the form of tariff and non-tariff barriers, of major markets such as Europe, USA, Canada and Japan.

3. The International Conference on Processing of Sea Products which had the purpose of bringing together fisheries specialists from Asia and other industrialized countries, was attended by 32 participants from 8 countries. Three Asian countries

(Bangladesh, Sri Lanka, Thailand) were represented among which one Least Developed Country. (See Annex I.)

4. The Conference, originally planned to take place in 1992 at Murmansk (Russian Federation), had to be postponed to 1993 because of financial constraints. Also its venue had to be changed to Moscow and its duration reduced to two instead of four days. This left no time for the technical visits to fisheries industries and institutes and also affected the attendance of some fisheries specialists from Europe and Asia who, shortly before the start of the Conference, declined the invitation previously accepted.

5. The main national counterpart which was responsible for the scientific management of the Conference, the Russian Research Institute of Fisheries and Oceanography (VNIRO), was established in 1933 as a result of unification of two institutes: the Central Scientific Institute of Fisheries and the State Oceanographic Institute.

6. In the area of seafood processing technology, VNIRO's activities encompass the following areas:

- theoretical basis for preservation of seafood raw materials and its practical applications;
- new kinds of food production with preestablished properties on the basis of surimi made from various species of fish, seaweeds and crustaceans;
- ecologically clean methods of fish smoking;
- physical and chemical methods for examination of raw materials and final products;
- development of improved forage processing technologies;
- processing technology for biologically active substances from hydrobionts;
- wasteless technologies for krill processing;
- new processing technologies of hydrobiont oils for medical, food, forage and technical purposes;
- revealing of pollutant priorities for aquatic organisms;
- detection of trace amounts of supertoxicants characterized by high bioaccumulative activity and development of analytic methods for their determination;
- determination of the background pollution levels of toxic substances in aquatic organisms of different

trophic chains (PCB, COP, POP, PAH, heavy metals, phenols, dioxine).

Considering the above activities and experience, VNIRO has the potential for providing assistance to developing countries particularly in research, product development and training.

Opening session

7. At the opening ceremony representatives of the International Union of Scientific and Technical Societies for the Food Industry (IUFOST), of the Russian Ministry of Science and Technology Policy, of the Russian Committee of Fisheries and of the Russian Research Institute of Marine Fisheries and Oceanography gave welcome speeches to the participants.

8. The UNIDO representative also thanked the host organizations for the kind invitation to UNIDO to participate in the Conference and for the opportunity offered to representatives of Asian developing countries to gather with fisheries specialists from other regions.

9. The representative of Bangladesh spoke on behalf of the Asian fisheries specialists and expressed their gratitude for the invitation received.

Plenary sessions

10. At the plenary sessions the following lectures were given on main areas of fish processing:

Lecture I

Fish processing in relation with long-term changes in raw material

11. Fish production in the main fishing areas of the world ocean may depend on the global climatic changes. These changes are of a cyclic pattern with a period of 50-60 years.

12. New approaches to the analysis of the relationship between fisheries and climatic changes give the possibility to forecast large-scale and long-term fish abundance fluctuations.

13. The last maximum of the total world catch was observed in the late 1930s. First indications of new fish productivity rises were observed in the early 1970s. By the end of the 1980s the total world catch increased by 26 million tons and reached a maximum of 100 million tons in 1989.

14. The major part of the total catch increment (22 million tons) comes from the Pacific and from the main 5 commercial

species: Alaska pollack, Far East sardine, Peruvian sardine, Chilean jack mackerel and Peruvian anchovy. In the late 1980s, for the first time in the last 20 years the total world catch of marine fish decreased by 3 million tons. At the end of 1992, the total world catch dropped approximately by some 8 million tons.

15. A high correlation between the climatic index and commercial catch dynamics allows us to forecast a considerable decrease in abundance of a number of commercial species: Alaska pollack, Far East sardine, Peruvian sardine, and Chilean jack mackerel. These species are mainly used for surimi and fish meal production. The number and commercial catch of Peruvian anchovy, on the contrary, will increase.

16. The data obtained make it possible to optimize the functioning of the fish processing industry in the countries where the economy to a large extent depends on the high sea fisheries: Japan, Chile, Peru, Russia and others.

Lecture II

Theoretical foundation for creating food products of secondary forms based on surimi

17. Modern rise in scientific and technical level of development and requirement of the industry calls for the elaboration of fundamentally new promising technologies based on the use of non-traditional methods in processing of fish raw material.

18. Proceeding from the known, rational and wasteless technologies of processing of raw fish, dimension and quantity composition, most interesting seems to be the process for obtaining minced fish (surimi). It is characterized by a number of unique features for developing completely mechanized technological processes of obtaining food products with predetermined properties.

19. The production process mainly depends on the biochemical characteristics of fish raw material when producing so-called products of new or secondary forms and structure, particularly, that of fish muscle tissue. When obtaining minced fish adequate for production of formed products it is necessary to provide a high relationship between salt- and water soluble proteins (protein coefficient). For well formed minced fish the protein coefficient is to exceed 1.0.

20. Structure formation, i.e. creation of laminated structure which imitates fish muscle tissue, is characterized by a structure formation coefficient representing a relationship between the contents of nitrogen of the saltsoluble protein fraction and the total nitrogen in the fish muscle tissue.

21. Studies and their theoretical ground indicate convincingly that using meat and bone separators it is possible to obtain minced fish (surimi) practically from any aquatic organism followed by creation of food products of secondary forms.

Lecture III

Quality of water environment and commercial aquatic organisms from the ecological point of view

22. The problem of quality of water environment and commercial aquatic organisms are usually interpreted and investigated on radically different scientific grounds aimed at protecting either water ecosystems or human health. This is a reason for elaborating in Russia, as in a number of other countries, two independent systems of natural water quality standards (hygienic and ecological), while the quality of commercial aquatic organisms as a source of human food is regulated mainly by medical approaches and criteria.

23. This lecture presents an attempt to give an ecotoxicological description and analysis of large-scale water pollution as the main factor affecting the quality of commercial aquatic organisms. It was revealed that in spite of great variability in the concentration levels of the most widely distributed pollutants (artificial radionuclides, heavy metals, chloro-organic compounds, etc.) there is a general direct relationship between these concentration levels and the pollution ones of the water environment. This trend is manifested by increased concentrations of the typical pollutants in water and aquatic organisms in the direction from pelagic ocean parts towards neritic and coastal zones, estuaries, inland seas and freshwater basins. Some traits of this general scheme are revealed and a comparative analysis of accumulation of pollutants in commercial aquatic organisms is accomplished taking into account national and international quality standards of food products.

Lecture IV

Present status and prospects for developing technology of aquatic organisms

24. A review is given of the present status and trends in the world development of processing of aquatic organisms (fish, invertebrates, sea weeds) typical of the last decades. Particular features of the processing of raw material in the countries of the Pacific Region and in the Russian Federation are considered. Main achievements in the processing of aquatic organisms in Russia are shown both from the scientific and commercial points of view.

25. A draft of an international programme with participation of scientists from developing countries is proposed for joint studies of aquatic organisms (fish, invertebrates, sea weeds) as raw material for complete wasteless processing aimed at obtaining diversified food, forage, technical and medicinal products with due regard to the ecological aspects.

Forage: Feeding meal including granulated and starting feeds, hydrolizates, chemically preserved feeds, feeding paste, protein and mineral additives.

Technical: Chitin, chitosan and their derivatives, sorbents, enzymic preparations.

Medicinal: Carotenoids, desoxyribonucleic acid, medicinal preparations based on chitin, chitosan, etc.

Lecture V

Raw material for the fish industry and integral processing of aquatic organisms

26. During the recent 30 years VNIRO and other research institutes in Russia have studied composition and characteristics of new fish species from the Atlantic, Indian and Pacific Oceans based on the same methods accompanied by medical and sanitary evaluation performed by the Institute of Nutrition in Kiev. As a result of accumulated data it became possible to publish in 1972 in Russia a guide book with the title "Technical characteristics of oceanic fishes" and in 1983 it was published abroad in English by the American-Indian Publishing House "Amerind Publishing Co.Pvt.Ltd.". This guide book shows systematic descriptions of 452 marine fish names by families, genera and species. Every description includes contour drawings of fish, its scientific and common name in Russian and Latin, commercial value, distribution area, size, characteristics, weight ratio of different parts of the body, chemical composition of meat and other parts of the body, a short analysis of organoleptic properties of meat and recommendations with respect to its processing.

27. In recent years a study has been made on summarizing the technological information in the form of a guide book on all the sea and oceanic fish species (713 names) caught by the Soviet fishing fleet prior to 1990. This guide book will be published in Russian and English at the end of 1994 by the Publishing Department of VNIRO.

28. Consideration is given to the basic trends of complex processing methods of Antarctic krill developed by the scientists of VNIRO and other organizations of the former USSR.

29. As a result of comprehensive studies of chemical composition and properties of raw krill it became possible to develop multiple approaches to its processing on board and on shore aimed at obtaining food, forage and technical products.
The following products can be obtained from krill:

Food: paste "Ocean" (coagulate), meat, minced krill, isolate, concentrates, hydrolizates, carotenoids and various culinary products on their base, as well as a wide range of canned food, structurized and formed products.

Lecture VI

Theoretical and practical aspects of sensory analyses of fish products

30. Nature has endowed people with outstanding abilities to perceive and appraise the environment including peculiar features of food products.

31. Sensory estimation dates back to the ancient times and at present it is known as a branch of science based on achievements within the field of psychology, psychometry, physiology and statistics.

32. Sensory methods are used as a basis for the technological designs of flavour, odour, colour and texture of food products.

33. Sensory estimate refers to personal methods, i.e. it requires objectivity. There are three main sources of objectivity: a person appearing in the role of an instrument, methods used by him, and a subject under study, i.e. food products. The tasks are predetermined for each of the three cases and their solution makes it possible to obtain reliable and reproduced results.

Lecture VII

The use of instrumental methods for the determination of quality of food products

34. Advanced industrial production and increased amounts of effluents containing toxic organic and inorganic substances lead to the pollution of all groups of the environment: air, soil, water and food products.

35. Various aspects of quality and necessity in obligatory certification of food products on their safety are discussed. Instrumental methods for the determination of toxic substances in food products are given.

Lecture VIII

Modern smoking techniques in the processing of fish

36. Smoking of food products is potentially hazardous for the environment because of harmful ejections and for the people as noxious carcinogenic compounds penetrate into the ready product. In this respect the technology and equipment used for smoking of food products including fish, must be primarily considered from the standpoint of human and environmental safety.

37. The following basic solutions can be proposed to reduce the smoke emission from smoking units: optimization of smoking processes in the units under operating conditions; degasification of smoke ejections; designing of new equipment and technological

processes taking into account ecological requirements imposed upon the environment and smoked food.

38. Technology is to show how to achieve ecologically pure smoking. It can be done by various methods. The first way depends on changes in the equipment and sources of smoke formation, on retention of all the traditional quality characteristics of smoked product and its ecological purity.

39. The second way means a change in requirements imposed upon smoked products by reducing their basic characteristics: colour, flavour, odour and increasing their ecological safety. This direction is consistent with the trends in the development of smoking within the international standards and claims of the World Health Organization.

40. The third way means a change in smoking principles and maintenance of all the ecological demands. It became possible to add smoking flavour, odour and colour without subjecting fish to smoking process by traditional methods.

41. Among the most promising processes it is necessary to mention a technology of slightly smoked fish products with low amounts of salt. It should be stressed that a smoking process based on the use of smoking additives is prospective from the ecological point of view. This practice is inexpensive and ecologically pure. Besides, its use practically means exclusion of purifying facilities.

42. The following lectures[1] were given by other participating organizations, such as the Fisheries Research Institutes located in Kaliningrad, Murmansk, Vladivostok, Astrakhan, Minsk (Belarus) and the company Atlas Industries S.A. from Denmark, as follows:

- **"Technological studies on the products of nutritive value based on aquatic organisms and vegetable raw material"** (AtlantNIRO, Kaliningrad);

- **"Producing a comprehensive range of food, feed ingredients and medical products of northern aquatic organisms"** (PINRO, Murmansk);

- **"Scientific grounds for the use of ozone in handling of raw fish"** (Institute of Photobiology, Minsk, and Alfa-Omega Co., Moscow);

- **"Modern fish meal technology for animal feed - How to optimize the production of high quality fish meal and oil without harming the environment"** (Atlas Industries S.A. Denmark) (Text available in English);

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[1] Texts available only in Russian.

- "Feeding products based on wasteless technology and utilization of affluent waste from the fish processing industry" (MGARF, Murmansk);

- "Prophylactic and medicinal food products for ecologically unfavourable areas" (Institute of Food Products, Moscow);

- "Medicinal preparation citochom C from hearts of Pinnipedia" (TINRO, Vladivostok);

- "Theory of emulsion products based on protein and polysaccharinde structure producers" (TINRO, Vladivostok);

- "The use of aquatic organisms for meat products" (VNIIMP, Moscow);

- "Processing of fish skin" (CaspNIRKh, Astrakhan).

43. The representatives of the Asian developing countries presented to the audience their country papers (see Annexes II, III and IV). In each paper the status of development of the fisheries industry is analysed. In particular, areas such as supply of raw materials, fish processing, conservation methods, waste utilization, technology, packaging as well as domestic and export markets are presented in detail.

44. In the following discussions the participants exchanged information on several areas of fish processing in their respective countries such as utilization of crustacean shell, equipment and materials for joint-ventures, quality control of fish products for exports, fish skin utilization, aquaculture, shrimp production, irradiation techniques, certification of sea products for exports, processing of fish for surimi.

Conclusions

45. The participants to the Conference formulated a proposal for a joint international project entitled "Utilization of Marine and Ocean Resources for the Production of Clean and Ecological Food Products". A working group composed of representatives of participating countries, IUFOST and the organization "People to People International" was requested to prepare and submit the above project to the Russian Ministry of Science and Technology Policy, to the Committee of Fisheries and to UNIDO for their consideration.

46. The main counterpart organization, the Russian Research Institute of Fisheries and Oceanography has a large technical potential for providing assistance to developing countries in several areas of fish processing. However, due to limited experience in closely cooperating with international organizations such as UNIDO, a thorough briefing on UNIDO activities (technical assistance, sub-contracting, field experts, training, transfer of technology) would be essential to enable the Institute to become an efficient counterpart for developing

countries. It was, therefore, agreed that possibilities to foster cooperation between the Institute and UNIDO would be explored.

47. The participating Asian countries expressed interest in hosting workshops or seminars for fisheries specialists from other developing countries. Thailand indicated the area of quality control of fish products for the domestic and export markets as a priority issue for a possible workshop in 1994.

48. The participant from Sri Lanka mentioned small-scale fisheries as a possible area for a seminar.

Annex I

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STATUS OF DEVELOPMENT OF THE FISHERY INDUSTRY IN BANGLADESH

Introduction

Bangladesh is a small country of 143998 Sq. Km. It is located at Lat.20 34 N-26038'N and longitude 88 01' E-92 41'E. Its present population is almost 120 m. It is bounded by India on the West, North and North East, by Burma on the East and South East and by the Bay of Bengal on its south

By virtue of its geographical location at a close proximity to the great Himalayan ranges on its north and the Bay of Bengal on its south, Bangladesh has the unique advantage of having possessed the World's largest deltaic regions-the Ganges Delta. It is a country criss-crossed by innumerable rivers, tributaries, Canals, Lakes, Ox-bow lakes, Land depressions,huge flood plains during the monsoon. All these,have been naturally formed in the course of drainage of rain waters from the Himalayas. There are also about 1.47 m. man-made ponds and tanks for house-hold purposes where fish culture is an economic activity for the rural fish farmers. Besides, Bangladesh has a 380 Km long coast line on its South and South-East which offers an excellant fishery resource in its littoral, territorial and EEZ Waters. Bangladesh was once a fish surplus country about half a century back when the population was less than 20 m. But with the rapid population growth fishing efforts increased greatly while culture and conservation was very insufficient to keep pace with population explosion.

In the meantime due to high demand in the world market for shrimps, prawns and other crustaceans, Bangladesh stepped into a new era of sophisticated industrial processing development. The evolution of the shrimp processing industry in Bangladesh dates back to 1959 when the first fish and shrimp processing and freezing plant was installed in Chittagong to usher in an industrial processing revolution in the country. By 1971, there were nine such processing plants in the country with a total production capacity of 58.5 MT per day. All these plants were mostly engaged in processing and export of fresh water headless shellon shrimps to Europe and U.S.A. During the Bangladesh War of Liberation in 1971, there was a short pause in processing, exporting and in the development of the sector. From 1977 onwards the trend of development of the industry started regaining its momentum and by the end of 1992, there were ninety seven processing plants in the country with a daily freezing capacity of about 700 tons per day. All these plants were primarily designed for processing of shrimps and froglegs. The processing of fin-fishes were not taken into consideration at the begining in view of the national requirements. But due to the rapid development of the industry, raw material constraints in shrimp and froglegs were felt very much thus forcing many of the plants to diversify products in favour of fin-fishes also.

A new technology for the production of salted and dehydrated fish specially for sea-water jew fish was also introduced in collaboration with Hongkong and Singapore buyers which helped the country earn a good amount of foreign exchange.

The developments in the fish and shrimp processing sector helped the country's export to boost up from a meagre US$ 3.06m in FY 1972-73 131m to in FY 1992-93 an increase of 4281% in 20 yea Export of shrimps and fishery products stands fourth to Ready-made Garments, jute and jute goods and Leather only. It contributed to 6.50% of the total export earnings of US$ 1994.00m in 1991-92.

Inspite of all these developments, the export-oriented sea foods processing industry of Bangladesh has been passing through a severe crisis due to acute shortage of raw materials suchas fish, froglegs and shrimps. The industry has grown at a much faster rate than that of the growth of the raw material sources.

To overcome this situation, topmost importance and priority have to be given for the development of fisheries resources specially of the aquaculture resources of fish, shrimps and other crustaceans for which Bangladesh has a great potential.

2. Present Status

Present status in respect to the growth of the Fish and Shrimp Processing Industry vis-a-vis the availability of raw materials which are the living aquatic resources suchas freshwater fish, marine fish, frogs, prawns, shrimps and other crustaceans, deserves a brief explanation in this context.

2.1 Fishery Resources:

The Bangladesh Fisheries can broadly be divided into (i) Inland or Fresh Water Fisheries and (ii) Marine Fisheries.

2.1.1 Inland Fisheries

The inland fisheries of Bangladesh are considered to be extremely formidable in terms of natural water areas and its potential for shrimp and fish culture. Inland fisheries contributed to 74.90% of the total fish catch of the country in 1992-93 and can be defined into the following categories.

2.1.1.1: Open Inland Water Fisheries

It includes innumerable rivers and their tributaries, baors, haors and the estuaries. The main river systems in Bangladesh include the Meghna, the Padma, the Jamuna, the Brahmaputra and the Karnaphuli and their tributaries - the total water area of which is over one million ha. There are many ox-bow lakes locally called 'Baors' formed due to silting up of old rivers in the districts of Jessore, Jenaidah, Court Chandpur, Kustia and

Faridpur with a total water are of about 5,488 ha. The natural depressions of land are used partially as agricultural lands in dry seasons and seasonally or perennially filled with water from adjacent rivers during rainy season. Most of these haors are located in the greater Sylhet, Mymensing and Faridpur districts. Some of the haors are very big. Hakaluki haor and Tangua haor in the greater Sylhet district have water areas of about 36,437 and 25,506 ha.respectively. The total water areas of the haors in Bangladesh are about 1,14,161 ha. The Kaptai Lake one of the largest man-made lakes consists of 68,800 ha. Besides there are about 2.83 million ha.of seasonal flood-plain areas. The total open water areas of the country is about 4.05 ha. from which a total of 4,42,000 MT of fish is caught. This is a very low production which may be increased a few-fold easily with proper policy planning and serious efforts.

2.1.1.2 Closed Water Fisheries:

It includes large-sized ponds called dighis, ponds and tanks. In most of the areas of the country, almost every homestead has one or more ponds or tanks used for bathing and cleaning as well as for fish culture. There are about 1.29 million ponds covering over 1,46,800 ha. of water areas of which about 76,632 ha. are presently under fish culture, 48,814 ha. culturable and 25,450 ha. of derelict ponds. Of the total water areas of the ponds 52.17% are now under fish culture, 30.51% easily culturable but now idle and 17.32% are derelict which can be turned into good fish ponds after remodelling them. Out of the total number of 1.29 million ponds about 46.48% are under culture, 29,90% culturable and rest 23.62% are derelict ponds. The estimated fish production of all these ponds were only 1,42,876 MT (1986-87 data) which means an average of 1.32 MT/ha of cultured ponds which is quite low as compared to any international standard. By improvement of all types of ponds fish production may be improved a few times. Even freshwater shrimp (M. Rosenbergii) can be cultured greatly to meet the demand of the processing industry. Total production of fish from fresh water fisheries were 5,99,000 MT in 1988-89 which increased to 7,52,750 MT in 1992-93. This may be doubled or trippled with concerted efforts of the public and private sectors by introducing modern technology and scientific aquaculture.

2.1.2 Marine Fisheries:

Bangladesh has a coastline of 480 km along the North and North-East part of the Bay of Bengal. It has an internal estuarine water area of 7,325 sq.nautical miles upto 10 fathom depth baseline, territorial waters of 2,640 sq. nautical miles from the baseline, EEZ of 41,040 sq. nautical miles and the continental shelf of 2,480 sq. nautical miles. The total of marine water areas in about 48.365 ha. miles which is almost as big as the country itself. All these water areas have great potential for seawater fishes and shrimps. The coastal area has a great potential for seawater black tiger, white and brown shrimps. Based on different surveys and reasearch works in the

Bay of Bengal, it is estimated that the standing stock of fish is around 2,64,000 to 3,73,000 MT and that of shrimps around 9,000 MT. The seawater catch of fish increased from 95,000 MT in 1975-76 to 2,52,000 M in 1992-93 an increase of about 265%. This has been possible due to Government's encouragement for the introduction of a deep sea fleet of 70 trawlers (out of which 56 are in operation now) and over 6,000 mechanaised boats in the Bay of Bengal, yet, there remains much unexplored areas for development of off-shore pelagic fishing suchas tuna and skipjack fishing, lobster fishing, squid and cuttle fish fishing, sea-weed culture and production. A great potential remained untapped as yet for which immediate actions are needed.

Bangladesh water-bodies were surveyed by the Bangladesh Space Research and Remote Sensing Organisation (SPARSO) by using aerial photographs and satellite imagery under the Fisheries Resource Survey System Project of DOF and FAO/UNDP during 1981-85. The water area statistics together with respective catches of fish are shown in Table-I. The trend of yearwise development in production of fish in Inland and Marine Waters in Bangladesh is shown in Table-2.

2.1.3 The Shrimp Fisheries

Shrimps have been playing an important role in the economy of Bangladesh. From time immemorial fresh water prawns and shrimps used to be caught as a wild product of the rivers, canals and flood-plains which is still predominant. The aquaculture technology was totally unknown to the farmers till very recently.

In the coastal areas of the Satkhira and Khulna districts, people used to make dykes or embankments along the banks of estuarine rivers and allow sea waters carrying shrimp fry or juveniles to enter into it wherein shrimps used to grow under natural conditions without any supplementary food or stocking. As a result production output had always been very poor. Shrimp production in the area rotates with paddy cultivation in a systematic manner. During pre-Ibieration period (1971) there were only 2500 ha. of land under cultivation in the Knulna/Satkhira Region with a production of 20-50 kgs per ha. Culture of shrimps by applying sciertific and technological developments is rather new here. It is still in the preliminary stage. The Government of Bangladesh have taken up many schemes for the modernisation of the shrimp culture in the country from the mid- 1980's as a result of which the stone started rolling and there have been some improvements during the last decade. According to the Fisheries Survey of 1983-84 and subsequent surveys, the number of shrimp farms and areas in hacteres under Shrimp Culture production/ha, annual production and average sizes of culture ponds are shown below.

Year	No. of Farms	Areas in ha.	Cultured Shrimp Production in MT	Production kg/ha.	Pond-Size(Ha)
1983-84	3171	51,834	7,750	150	16.35
1986-87	3778	87,300	11,500	167	23.10
1989-90	5250	100,000	22,000	220	19.04
1991-92	6540	108,205	28,080	260	16.52

From the above data it appears that the average size of ponds is very big and not upto the international standard. Such ponds offer bad management. Per ha. production is also too low as compared to many Asian countries. Farmers are operating their farms on extensive Culture methods and donot or very little apply artificial feed and modern methods of Shrimp Culture. Modern shrimp Culture methods are being practiced by a handful of industrial farms who have been able to produce upto 3000 kg/ha. annually. Govt.of Bangladesh is stepping up measures to increase per ha. production of shrimp to 1000 kg, in which case the total culture based production of sea water may exceed 100000 MT within a few years.

With the introduction of coastal shrimp culture and deep sea fishing trawlers in the country, shrimp production has been steadily increasing during the last few years. In 1984 the total shrimp production was 61080 MT which increased to 74,000 MT in 1987. The trend of development of shrimp catches (live weight) is given in Table-4.

Out of trawler catch of shrimps in 1987., species-wise composition was 17.00% of Black Tiger, 8.00% of White, 53.00% of Brown & 22.00% were mixed varieties of smaller sizes. Catch Composition of coastal aquaculture is mostly Black Tigers.

Recent information indicate that China, Indonesia, Thailand, Malaysia, Philippines have been producing over 1200-1500 kg/ha by the application of semi-intensive method of culture. All these developments were possible due to technological improvements for production of shrimp fry through hatcheries and feed manufacturing. Bangladesh is far behind in artificial propagation of shrimps as a result of which it is still dependent on collection of wild fry from the coastal estuaries. The Govt. of Bangladesh have taken up few projects for establishment of hatcheries for P. Monodon and M. Rosenbergii. These hatcheries have very recently gone into test-production. One private hatchery is already in production in Cox's Bazar. Projects such as establishment of demonstration farms; expansion of improved culture techniques, upgrading of about of existing shrimp farms in Cox's Bazar and 1430 ha in Khulna region etc.. have already been approved by the Govt. and are now at the final stage of implementation. All these projects, if implemented properly, may

help shrimp production improve substantially. But one thing is almost certain that by expansion of the shrimp culture harizontally, the country will derive no tengible result unless availability of shrimp seeds and feed together with other facilities are made available to the farmers for an urgent switch over from the traditional extensive towards semi-intensive or intensive shrimp culture.

2.1.4 Potential for Culture of Shrimps:

From the statistics given at Table-3, it is very clear that Bangladesh has a great potential for shrimp culture. Its coastal lands offer a readily available over a hundred thousand hectares of shrimp ponds where P.Monodon and other sea water species can be cultured. There are also over one hundred and twenty thousand hectares of fresh water culturable ponds where M.Rosenbergii and other fresh water species can easily be cultured.

2.1.4.1 Potential for coastal cultured shrimps:

According to recent surveys, there are about 100000 ha. of brackish water coastal lands under shrimp culture for Black Tiger, white and brown shrimps. Present average production of about 260kg/ha being too low, there are enough scopes to improve this a few-fold. Intensifying the hatchery technology and simultaneously by improving the collecting system of wild fry and manufacturing of balanced shrimp feed in the country, average production through semi-intensive culture and that of limited-scale intensive culture may be increased to 1000 kgs to 2000 kg/ha, if not more, within a period of 4-5 years. According to my estimates the potential for coastal shrimp culture is to the minimum of about 75,000 MT and a maximum of 1,50,000 MT worth 600m to 1200m US dollars by the year 2000. A 10 year growth projection (1991-2000) for the improvement of coastal cultured shrimp is given in Table-6(my personal estimate).

2.1.4.2 Potential for Fresh Water Cultured Prawn

Bangladesh inland open waters have been producing best quality fresh water giant prawn locally known as 'Golda" (M. Rosenbergii) and other fresh water species from rivers, canals and paddy fields as wild catch only. Artificial propagation of the freshwater prawn is still being experimented with limited success. In the meantime, enthusiastic farmers have gone for mono-culture of the giant prawn in their backyard ponds by collecting wild fry and have reported encouraging results.

There are about 1.29 million culturable ponds. These ponds have an water area of 120000 ha, where giant prawns may be cultured without remodelling the ponds. A 10 year (1991-2000) projection for utilising these water areas and raising prawn culture production have been prepared by me on consideration of the capabilities of the country(Table-7). It may be seen from the projections that in addition to the present wild catch of approx.

44,000 MT of fresh water prawns, the country is capable of producing 1,25,000 MT of cultured fresh water prawns worth 875m US dollars by 2000 at 1990 constant price.

2.1.4.3 Total Potential of Cultured Shrimp/Prawns

From 2.1.4.1 and 2.1.4.2 (Table 6 and 7), it is evident that Bangladesh has the potential of increasing its shrimp and prawn production, setting aside other crustaceans, to 67,500-1,05,000 MT by 1995 and 2,00,000-2,75,000 MT by 2000, worth of US$ 500m to 900m and 1400-2100 million dollars during the same period. Even if 50% of this projection can be attained, the country will be able to produce 50,000 MT worth 400m and 1,00,000 MT worth 800m US dollars by 1995 and 2000 respectively.

2.2. The Processing Industry:

2.2.1 Number of Fish and Shrimp Processing Plants(shore-based)

Bangladesh has developed a very impressive sea food processing and freezing industry over the last 10-15 years. There were only 9 processing plants in the country with a total freezing capacity of 58 MT daily in 1971. From 1972 to 1976 only 4 plants with a combined capacity of 44 MT were commissioned. The trend of installation of freezing plants speeded up since 1977 and reached its climax during 1986-1989 period when 39 plants were commissioned in 3 years' time. Year-wise installation and commissioning of the freezing plants in Bangladesh with capacity is shown in Table-8.

2.2.2 Capacity Utilisation(Shore-based Plants)

The utilisation of the rated capacity of all plants has always been unsatisfactory. During 1960s most of the plants used to run at 40-50% capacity. Gradually, the capacity utilisation has decreased due to unplanned growth of the industry and scarcity of raw materials. Percentage of capacity utilisation is shown in Table-9. It has been assumed that processing plants in Bangladesh may operate for a maximum of 200 days a year on the basis of Shrimp seasons. It is observed from the data given herein that percentage utilisation of plants capacity have decreased gradually from 24.10% in 1985-86 to 16.68% in 1989-90 and to 19.00% in 1992-93.

2.2.3 Overgrowth of Processing Plants(Shore-based)

From the records given at 2.2.1 and 2.2.2 and the existing exportable raw materials which may be estimated at 21-25 thousand metric tons of shrimps, froglegs and fish, one thing becomes very clear that only 15-20 units of processing plants can handle the product and the export business at 80-100% capacity, 30-40 units at 60% capacity and the rest of the plants are overgrowths and have grown in a very unplanned and haphazard manner. The industry has grown at 500% higher capacity as compared to the available raw materials and as such has become a very sick industry.

According to export statistics, only 52 units were in production during FY 1988-89 and the rest were simply out of production, only 20 of 52 units did just well.

2.2.4 Reasons for Overgrowth:

The main reason for overgrowth of the industry are (i) unplanned sanctioning of loan without any feasibility study (ii) keeping the industry in the free-list for a long period of time (iii) liberal financial support from the financial institutions (iv) too hurried and haphazard approach for earning foreign exchange by many (v) to get bank loans easily and to get richer by making a plant rather that running the plant on profitability.

2.2.5 Development of Trawler-based Processing Plants(Shrimp Trawlers)

Modern shrimp trawling was first intoduced in 1979 by using deep sea freezer Shrimp Trawler. Before that Govt. trawlers of the Bangladesh Fisheries Development Corporation used to catch Shrimp by employing its refrigerated(Iced) trawlers. By 1992 there were as many as 48 shrimps trawlers in operation almost all in the Private sector except 2 of the public sector. The trend of development of shrimp trawlers, their freezing capacity, Average annual catch is 4000-5000 MT is shown in Table-10.

2.2.6 Raw Materials Situation.

The Shore-based Plants are dependent mostly on Brackish water cultured shrimps or wild fresh water prawns suchas M. rosenbergii. There are 20000 MT tons of headless exportable shrimps available in the country, though the demand for raw materials (shrimps mainly) is 1,36,000 MT. The present supply of shrimps is only 15% of the plants' requirement.

Shrimp potential out of the existing brackish water shrimp culture farms of 100,000 ha. is about 1,00,000-1,50,000 MT at a modest semi-intensive rate 1000-1500 kg/ha.

2.2.7 Major problems for shrimps and Fish culture:

Major problems retarding the growth of fish industry by culture of Shrimps and fish in farms, ponds and tanks are as follows:

i. Acute shortage of shrimps feed and fish feed. The country needs about 1.92 lac MT of shrimp & fish feed, against which only 6000 MT are available locally. More Shrimp Feed Mills are urgently needed.

ii. Acute shrotage of Shrimp fry. More and more modern shrimp hatcheries and nurseries are needed.

iii. Lack of modern technology.

iv. Lack of funds/Loans from financial institutions.

2.2.8 Waste Utilisation:

At present about 25000 M.T. of trash fishes are thrown overboard by the fleet of 67 trawlers, thus destroying fishing grounds and polluting the environment. If this quantity can be collected the country will be greatly benefited. There is no system of waste utilization from the processing plants, fish markets, poultry farm, Cattle Farms and slaughtering house. A few modern waste processing plants are needed for making feed for the fish culture projects, especially for African or Thai catfishes which are going to make a major break through in near future.

2.3. Contribution to GDP

Contribution of fisheries sector to GDP is around 5.0%.

2.4. Employment

The whole of the fisheires sector employs about 1.20m people who are directly or indirectly dependent on fishing, fish farming, fish processing etc. This figure is about 10% of the total population of the country. Out of the total about 6,95,000 are inland fishermen for wholetime fishing or subsistance fishing, 4,12,000 are marine fishermen, about 5000-6000 are in the processing industry (both regular and casual) and about 87,000 in shrimp farming, fry collection, crab and frog collection, dry and dehydrated fish industry and in fish carrier boats.

3.0. Review of Govt. Policy Towards Development of Fishery Sector

There has been no Govt policy for development of the fisheries sector so long. As a result, the sector suffered much in respect to a balanced development. For instance, the fish and shrimp culture sub-sector is still in an infant stage, though there is a great potential for improvement. On the other hand, the processing industry withnessed such a faster growth that today about half of the total number of processing plants are out of production and the rest are under-utilised. This has so happened due to the absence of a sound national policy for the sector.

Recently Govt.of Bangladesh drafted a "Fishery Development Policy" for co-ordinated development of the sector. The salient features of the policy are as follows:

Objectives of Fishery Development Policy

- To reduce the gap between supply and demand of animal protein by increasing fish production.

- To create additional employment in fish and fish related

industries for the improvement of socio-economic conditions of fisherman-community in rural areas.

: To earn more foreign exchange by increasing export of fish and fish by-products.

. To develop public health and environmental conditions.

Legal Status of Fishery Development Policy

Govt, semi-Govt. Multinational Organisations, Private, Voluntary Organisation, Individual or Groups of Individuals those situated within the geographical area of Bangladesh and are related to fishery development, export, import or fish business must abide by the Fishery Development Policy.

Jurisdiction of Fishery Development Policy

. General Policy.
: Inland Fish Culture Development Policy.
. Inland Open Water Fish Production Policy.
: Sea Fish Development Policy
: Shrimp Culture Policy.
: Research Policy.
: Training Policy.
: Organisational Policy of Fishery Sector.
: loan policy.
: Miscellaneous Policy.

Under the new fishery development policy, private sectors are given priority to develop shrimp culture and fish processing industries. Foreign investors are allowed to undertake joint venture with the Bangladeshi counterpart. At present, a few joint venture projects in the field of trawling, shrimp culture are in operation. More investment in this sector except the processing industry may be of immense help to the country.

3.1. Encouragement to Private Sector

The sectoral infrastructural development had been very rapid during the last decade, specially during 1985-90 period. This has been possible due to the Govt. policy for declaring this sector under free list.

As a result, to-day there is a strong infrastructure of (i) 48 deep sea shrimp trawlers, (ii) 19 fin-fish trawlers, (iii) 97 processing plants, (iv) Over 6000 mechanised fishing boats and (v) 100000 ha of water areas under coastal shrimp culture etc.

: The Govt.has declared Fisheries as an industry.

The Govt. financial institutions and commercial banks provided funds to loan for processing units. For encouraging the private sector, Govt.of Bangladesh has taken the following measures:

: Bank loan at reduced rate of interest(9%) for purchase of raw materials.

: Included frozen foods in thrust sector.

: Liberal allotment of foreign exchange for exporters for foreign travels for market study.

: Introduction of credit cards to exporters for foreign travels.

: Formation of Export Development Authority soon.

: Simplification of shipment procedures.

: Provides cash subsidy to exporters at the rate of 5-13% to recover the loss incurred by the industry due to sudden fall of prices in the international market.

3.2. Public Sector Situation in Sectoral Development

Out of 97 processing plants in the country, only 5 are operating under the public sector, with a combined freezing capacity of 48 tons of blast freezing mainly for white fish freezing for local market and 22 tons of plate freezing for processing of shrimps for export. Out of these 5 plants, 4 belongs to the BFDC (Bangladesh Fisheries Development Corporation)- an organisation under the Ministry of Fisheries. The BFDC plants are mostly used for freezing of its own trawler catch and freshwater fin-fishes for international marketing. Shrimps processing in these plants are also carried out in a limited way for export. All the 5 plants are in operation but their utilisation in terms of shrimp processing is very poor. These are utilising only 10-15% of their plate-freezing capacity.

3.3. Foreign Investment in the Sector

The growth of the processing industry have long before reached an over-saturation point since at no stage the country's processing plants could afford to run at 50% capacity. Present utilisation of the plants are extremely poor. More than 50% of the plants are already idle and the rest are working at 20-50% capacity.

Assuch, foreign investment in this sub-sector will not be fruitful. There is as yet no foreign investment in the processing industry.

Foreign investment in joint-venture trawling fin-fish, tuna fishing etc.is allowed by the Govt. though the Govt.has already limited the number of shrimp trawlers in the Bay of Bengal to prevant over-fishing.

Requirement of foreign investment both in financial and technical terms may be there in the field of shrimp and fish

culture. Unless we can improve our production, we have no way to save the existing plants. However, foreign investment or joint-venture collaboration in the following fields deserve consideration:

: Shrimp Farming
: Shrimp Feed Plants:
: Shrimp Hatchery & Nursery
: Fish Feed Plants
: Fish Farming
: Fish Canning
: Tuna Fishing
: Introduction of Modern Purseine Fishery.
: Introduction of FRP Boats.
: To conduct research on the off-shore pelagic fishery.

4.0. PROBLEMS AND ISSUES:

The problems facing the fish and shrimp processing industry are few but very serious. The major problems are listed as follows.

4.1 Supply of Raw Materials

From the descriptions of the foregoing chapters at 2.1, 2.2 & 2.3. it may be observed that the main crest of the problems is the supply position or shortage of raw materials which consists mainly of shrimps. The processing industry needs over 1,36,000 MT of raw materials at 100% capacity for 200 working days or 81,600 MT at 60% capacity. This figures will be 40% more in terms of live-weight of shrimps, frogs or fish etc. The present supply position being around 22,000 MT - the crises and the internal haemorrage that the industry is witnessing, can easily be understood by all concerned. The fish processing industry do not need mine-based raw materials sothat it can be imported easily. It needs aquatic biological resources as its raw materials which takes a considerable time for breeding, nursing, rearing and harvesting before they are made available to the plants as raw materials. To alleviate this situation most urgent and whole-hearted efforts from both public and private sectors is a prerequisite. Other problems of the industry are high procurement prices, lower international price, lack of frozen food container facilities, timely shipment, higher rate of interest on bank loans, lower export performance bonuns, nigh rate of eletricity, non-allotment of lands to processing plants for shrimp culture etc.

4.2 Intitutional Support System

Infrastructural facilities are very well developed as compared to capacity utilisation. No more infrastructural facility may be required probably till the turn of the century in the processing sub-sector.

Location of the plants are mainly distributed into three

very well-defined zones such as Khulna Zone, Chittagong Zone and Cox's Bazar Zone. All these locations are very important for shrimp cultures. There are a few non-localised plants in Dhaka, Barisal and Sylhet districts to cater for the needs of wild freshwater shrimp catches.

4.3 Financing New Industries

The processing industry being already over-developed, there is no need for any further financing in any such new industry, or no need of any further expansion of the existing industry till raw material position improves to atleast 60% capacity utilisation of the existing plants.

4.4 Technology

Fish handling and processing technology plays a vital role in the production of high grade fish and fish by-products. At present almost all the fish processing plants in Bangladesh are mainly engaged in processing & freezing of exportable shrimps, froglegs and fish. The fish processing plants established during recent years are of international standard. But some times lack of proper knowledge and negligence towards plant sanitation and personal hygiene of the workers may give rise to a quality problem. This problem can be resolved by proper supervision and vigilance. The group training of supervisors and workers may yield positive results.

Solar dried salted and dehydrated jewfish is now being produced mainly in Cox's Bazar for exporting to Hong Kong and Singapore. The dried jewfish is produced under the direct supervision of Chinese technicians and as a result no quality problem is normally encountered.. Dry fish and fermented fish are produced for local consumption by traditional methods.

Fish meal and fish products are produced mainly by BFDC for local consumption.

Fish meal is produced from trash fish from trawler catch and from small mixed dry fish from off-shore inslands. Fish products suchas burger, finger, cuttlet, cake, balls and minced fish are produced in a limited scale from low-cost under-utiliseo fishes by BFDC trawlers and have become popular to the city dwellers.

In order to go ahead with the latest developments being made in the field of fish processing and fish food manufacture in the highly developed countries, diversification of products by the industry in respect to the following fish foods have been indantified for immediate attention. The technology transfer in these fields may be usful to Bangladesh. Cooked & peeled shrimps, cook-freeze fish products, fish paste and spreads, marinated fish products, fish protein concertrate (FPC), fish sausage from minced fish, ready to eat cooked fish food packed in ovenable pouch or try, canned fish in edible oil, brine or tomato sauce, smoked fish, chilled fish, fillet and fish steaks under modified

atmosphere packing (MAP which means replacement of air by a mixture of CO and N in the plastic packets), processed shark-fins, meat and Liver oil etc.

The industrial uses of fish are also of great importance. The possible fields are listed below for consideration and development through modern technology transfer from developed nations: leather from shark skins, fish liver and body oil for industrial and pharmaceutical uses, fish silage, animal and pet foods, ornamental and decoration items from fish skin, shells scales, bones, teeth etc., pearl essence from scales of mainly pelagic fish, gelatin and isinglass from fish air-bladder, liquid fish glue from fish skins and heads, shrimp feed etc.

4.5 Skilled Manpower

At present Bangladesh has enough trained manpower for operation, repair and maintenance of fish freezing plants, iceplants, cold storage, net factory, fishing trawlers and mechanised fishing boats. All refrigeration plants in Bangladesh have been and are being errected by local consultants, engineers and contractors. Marine Fisheries Academy in Chittagong provides professional training facilities to fishing trawler personnel. Many of them also work in shore-based processing plants. Marine Fisheries Academy produced about 600 cadet officers in the following fields of fisheries sector from 1973-74 to 1992-93:

Field of Study	No. of Cadets Passed-Out
Marine Engineering ..	250
Navigation ..	175
Fish Processing Technology -	75
Gear Technology ..	50
Refrigeration Engineering -	24
Radio Electronics ..	17
Electronics Engineering -	15
Total:	606

Besides BFDC also trained up 1800 skilled fishermen/sailors/mechanics for manning the trawlers, mechanised boats and ice-plants and freezing plants. Govt-run Polytechnique Institutes produce diploma engineers and technicians for operation and maintenance of processing and refrigeration plants. Wereas both public and private-owned vocational training centres produce refrigeration operators and mechanics in huge numbers. Fisherman's Cooperative Society provides training facilities to the fishermen of mechanised boats. Marine Science Institute of Chittagong University produces marine biologists. Marine biologists are capable of undertaking modern fish/shrimp culture as well as various research works. Mymensing Agricultural University provides higher studies in Fish Aquaculture, Fish Processing and Handling technology. But practical short-term training for management and operation of different types of fish food and by-products processing plants may be needed in future in

terms of foreign technical assistance.

4.5. Packaging Industry:

The Packaging Industry in Bangladesh mainly produces simple types cardboards for Master Cartons and duplex papers for mini-cartons. Materials for the packaging is not of international standard. Foreign collaboration in this field will be of immense help.

TABLE-1

The Water Area Statistics & Catch of Fish:

Sector of Fisheries	Water Areas (Ha)	Catch (Production) in M.ton			
		1983-84	1984-85	1985-86	1986-87
A. Inland Capital Fisheries					
(i) Capture Fishery					
1. Rivers & estuaries	1031563	207766	213057	199600	19511[illegible]
2. Sundarbans		7783	6825	7112	6055
3. Beels	114161	51373	45893	43258	42077
4. Kaptai Lake	68800	4057	2700	2433	3951
5. Flood Lands.	2832792	200616	194130	187396	1837[illegible]
Total Capture Fishery	4047316	471595 (62.6%)	462605 (59.8%)	441799 (55.7%)	431[illegible] (52.[illegible]%)
(ii)Closed Water Fishery					
1. Ponds	146890	107944	111567	123804	142[illegible]
2. Baors	4588	862	962	967	21[illegible]
3. Shrimp Farms					
(83-84)	51812	8219	11282	19951	220[illegible]
(84-85)	64246				
(85-86)	87300				
Total of Closed Water Fishery	204190	117025 (15.5%)	123811 (16.0%)	144723 (18.2%)	166[illegible]
Inland Total(Ai+Aii)	4251506	588620 (78.1%)	586416 (75.8%)	586522 (73.9%)	597[illegible] (73.[illegible]%)
B. MARINE FISHERIES					
(i)Industrial Fisheries		14500	12440	11898	12352
(ii)Artisanal Fisheries		150382	175123	195503	205222
Marine Total(Bi+Bii)		164882 (21.9%)	187563 (24.2%)	207401 (26.1%)	217574
Country Total (A+B)		753502 (100%)	773979 (100%)	793923 (100%)	811689 (100%

TABLE-2

Trend of Fish Production in Bangladesh(in 1000 MT)

F.Y.	Marine	Inland	Total	F.Y.	Marine	Inland	Total
1970-71	85	729	814	1987-88	229	598	827
1974-75	89	733	822	1988-89	232	599	831
1979-80	122	524	644	1989-90	239	616	855
1984-85	188	586	744	1990-91	242	654	896
1985-86	207	587	794	1991-92	244	702	946
1986-87	218	597	815	1992-93	252	752	1004

TABLE-3

Trend of Development in Utilisation of Land Under Shrimp Cu

Area/Districts	Land Under Shrimp Culture (in Ha.)		
	1983-84	1985-86	Existing(Approx)
1. Khulna Area	32252.59	6244.13	67543
	8001.21	15673.64	26119
Khulna	12816.99	20823.04	19673
Bagerhat	11012.53	25623.62	21426
Jessore	421.86	327.83	325
2. Ctg-Cox's Bazar Area	19585.84	24851.69	32457
Cox's Bazar	18668.84	24114.53	24755
Chittagong	874.49	640.45	
Bhola		45.54	122
Patuakhali	42.51	25.57	64
Noakhali		25.6	25
Total :	51834.43	87299.82	100000

Source : DOF

TABLE-4

Trend of Shrimp Catches in Bangladesh

Year	Source-wise catch of shrimps (in 1000 MT)				Total
	Marine		Coastal	Freshwater	
	Trawler Catch	Mech & Non Mech Boats	Aquaculture	Capture	
1984	4.50	(8.00)	11.50	(37.00)	61.00
1985	3.14	(9.06)	12.50	(45.30)	70.00
1986	4.03	(11.34)	13.50	(44.13)	73.00
1987	4.50	(12.10)	14.50	(42.90)	74.00

Sources: Data on Aquaculture Catch & Total Catch are taken from the Conference Proceedings of Shrimp '88, held in Bangkok, Thailand from 26-28 January, 1988; data on trawler catch from DOF.
Data within parentheses are estimates of the author.

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TABLE-6

Potential for Coastal Aquaculture Shrimp Prod...tio.

(Total area remaining constant at 1,30,000 ha.)

Year	Area under culture (in 1000 ha) Exten-sive	Semi-exten-sive	Inten-sive	Estimated Shrimp Production (in 1000 M Extensive (100-200 kgs) Min	Max	Semi-Intensiv (500-1000 kgs per ha) Min	Max	Intensive (1000-2000 kg Min	Max	Total Min	Max	Estimated Value in million US$ at 1990 constant price Min	Max
1991	90	10	-	9	16	5	10	-	-	-	26	-	224
1992	80	17	3	8	16	8.5	17	3	6	19.5	39	156	312
1993	70	25	5	7	14	12.5	25	5	10	24.5	49	196	392
1994	60	30	10	6	12	15	30	10	20	31	62	248	496
1995	50	35	15	5	10	17.5	35	15	30	37.5	75	300	600
1996	40	40	20	4	8	20	40	20	40	44	88	352	704
1997	30	45	25	3	6	22.5	45	25	50	50	101	404	808
1998	20	50	30	2	4	25	50	30	60	57	114	456	912
1999	10	55	45	1	2	27.5	55	45	90	74.5	147	596	1176
2000	-	50	50	-	-	25	50	50	100	75	150	600	1200
				Estimated Average Production/						750 kgs	1550 kgs		

TABLE-7
Potential for Fresh water Shrimp Production in Ponds
(Total Culturable Pond Nos. 9,84,000 and Water Area 1,20,000 ha)

Year	Area under culture (1000 ha)				Estimate Production (1000 MT)				Estimated Value in millionm US$ at 1990 constant price of $7,000 per MT
	Extensive	Semi-Extensive	Intensive	Total	Extensive 100 kg/ha	Semi-Extensive 500 kg/ha	intensive 2000kg	Total	
1991	5	3	2	10	0.5	1.5	4	6	42
1992	10	5	5	20	1	2.5	10	13.5	94.5
1993	15	10	5	30	1.5	5	10	16.5	115.5
1994	20	15	5	40	2	7.5	10	19.5	136.5
1995	25	15	10	50	2.5	7.5	20	30	210
1996	20	25	15	60	2	12.5	30	44.5	311.5
1997	15	35	20	70	1.5	17.5	40	59	413
1998	10	40	30	80	1	20	60	81	567
1999	5	45	40	90	0.5	22.5	80	103	721
2000	-	50	50	100	-	25	100	125	875

Table-8
Growth of Processing plants in Bangladesh(Shore-based)

Period	No.of Years	No. of Plants	Capacity MT/Day	Average Unit Capacity (MT)
1959-71	13	09	58.50	6.50
1972-76	05	04	44.00	11.00
1977-80	04	16	135.00	8.44
1981-85	05	25	150.50	6.67
1986-88	04	39	260.00	6.67
1989-92	03	04	29.00	7.25
Total :	34	97	680.00	7.00

Table-9

Percentage of Capacity Utilisation of Plants in Bangladesh national average (For Shore-based Plants)

Year	No. of Freezing Plants in Operation	Total Capacity per day (MT)	Total Annual Capacity in 200 working days(MT)	Export during the yr(MT)	% of capacity utilisation
1975-76	14	88.5	19,700	3,620	18.38%
1979-80	29	203	40,600	10,480	25.81%
1984-85	54	378	75,600	17,071	22.59%
1985-86	59	431	86,200	20,777	24.10%
1986-87	70	490	98,000	22,134	22.58%
1987-88	81	567	1,13,400	21,576	19.02%
1988-89	93	651	1,30,200	20,489	15.74%
1989-90	93	651	1,30,200	21,718	16.68%
1990-91	96	672	1,34,400	24,000	17.85%
1991-92	97	680	1,36,000	20,000	15.74%
1992-93	97	680	1,36,000	21,000	19.00%

Table-10
Development of Trawler-based Processing plants
(shrimp trawlers)

Year	No.of Trawlers		Freezing Capacity(in MT)	
	Introduced	Total No.	Introduced	Total/day
1979	01	01	01.50	1.50
1980	07	08	15.80	17.30
1981	04	11	05.40	22.70
1982	10	21	23.80	46.50
1983	13	34	29.60	76.10
1984	06	40	11.10	87.20
1985	01	41	03.00	90.20
1986	02	43	05.00	95.20
1987	-	43	-	95.00
1988	03	46	06.00	101.20
1989	-	46	-	101.20
1990	01	47	03.00	104.20
1991	01	48	03.00	107.20
1992	-	48	-	107.20

DEVELOPMENT OF THE FISHERIES INDUSTRY IN SRI LANKA.

1.0 Introduction

Sri Lanka is located in the Bay of Bengal in the Indian Ocean, South East of India, between latitudes 6 - 10 degrees North and longitudes 80 - 82 degrees East. The island has an area of 65600 sq. km. coastline of 1770 km. The continental shelf, which average about 15 natural miles, rarely extends beyond 25 miles. The total area of the shelf is about 28,000 sq. km. Sri Lanka declared her 320 km. Exclusive Economic Zone (EEZ) in 1977 and about 400,000 sq. km. of sea came under her national jurisdiction. In addition, there are inland fresh water reservoirs and brackish water lagoons, estuaries and mangrove swamps, suitable for aquaculture. (Please see Annex 1)

The estimated population was 17.4 million in the year of 1992. Fishing population in marine sector was 412,200 in 1992. No.of active fisheries was 98444. In inland fisheries sector was 55909 and 12891 respectively. And Fishing population is 2.69% out of the total population in the country and active fishermen is about 23.78% from the fishing population.
(please see annexe ii)

Being an island state, the fishing industry is important and it provides essential animal proteins for Sri Lankans as majority of them prefer fish due to religious and cultural background. In pact, 60% of the total animal protein requirements and about 13 % of the total protein in the diet are supplied by fish. The per capita consumption of fish is about 16 kg. at present. With the declaration of the EEZ, vast and valuable fishery resources which are under national control are available in the new legal regime. Therefore, the industry should be developed in such a manner so as to rationally exploit the fish resources. This could be achieved only through a planned approach for the development of the industry. Planned development of fisheries had been attempted by the state since 1920s.

In the recent years especially after 1978, attempts have been made with success to develop fisheries through a comprehensive plan. For instance, the programme for motorization of fishing craft along with the use of synthetic fishing nets had been greatly responsible for increased fish production from late fifties. Although the fish production has increased, studies have shown that there is a decline in the catch per unit effort in certain areas. Therefore, it is essential to have proper planning systems, processes and institutions to develop the fishing industry in Sri Lanka. In this context, conservation-oriented fisheries in integrated development should get high priority, especially in coastal waters.

2.0 Capacity Utilization.

Fisheries sector in Sri Lanka has a relatively important place in the economy. It is also a major source of employment, fulfilling an important social function in generating economic activities in rural areas. Over 111,000 persons are engaged directly in marine and inland fishing, a considerable number of others are employed in ancillary activities. The effort to motorized fleet were identified during the period of 1952 to 1958. Experiments had been undertaken long before an early as 1937. But it was in the 1950s that motorization was timely established with about 100 motorized boats by 1958. The fishing fleet strength at present is as follows.

*	Marine sector	-	Inboard craft	2357
		-	Outboard craft	9028
		-	Non mechanized craft	15136
*	Inland sector	-	Orus	4058
				------ 30579

(See the Anexture iii for Information on Fish Processing Plants.)

The peak production of fish in Sri Lanka was reached in 1983, when 220, 806 tons was harvested. Thereafter there has been a decline in producing predominentely on account of the civil disturbances in the two major fish producing areas in the North and the East of the country which account for nearly 60% of the total coastline of Sri Lanka. In 1992 fish production in Sri Lanka account 206,000 mt.

Fish Production in Sri Lanka 1989 - 1992

Year	Coastal	Off-shore Deep sea	Inland	Total
1989	157,411	8155	39720	205286
1990	134,132	11666	31265	177063
1991	159,151	15080	23832	198063
1992	163,168	22000	21000	206168

During the period 1991-1992 on an average 79% of the total production came from the coastal marine fishery. However during this period there has been an increase in the relative shares of sectors.

3.0 Government Policy

The main tasks of the Ministry of Fisheries & Aquatic Resources are to developed the Fisheries Industry in Sri Lanka, Fisheries Management, Streamline the fishing activities and promote Welfare of the fisheries community engaged in fisheries. The objectives of the Fisheries Development Programme for 1990 - 1994 period are as follows :

(i). Step up production of fish and raise per capita consumption

(ii). Raise fishermen's income and living standards.

(iii). Maximize employment opportunities in the fisheries sector.

To reach the fish production level called for in above programme the following strategies will be adopted.

(i). Introduction of more fishing vessels and proper design and outboard engines for greater mechanization of traditional craft.

(ii). Introduction of larger vessels of new designs with modern facilities.

(iii). Increase of fishing times and operation efficiency of fishing fleet by assuring them adequate supply of fishing gear.

(iv). Promotion of investment for upgrading fishing industry infrastructure ensuring adequacy of finance for these investment through subsidies, craft and incentive to private investor.

4.0 Processing of Seafood in Sri Lanka.

Fish, the main sea food in Sri Lanka, is consumed mostly in the form of fresh fish. Some of the fish harvested are processed in to various products, by traditional and non-traditional methods. Shellfish such as shrimp, lobster, crab, mussel and cuttle fish are also harvested from the sea. Apart from the fish and shellfish, processing of sea plants such as sea weeds is also carried out on a small scale.

Traditional Seafood Processing

There are three methods of traditional processing of fish. They are namely drying smoking - drying and fermentation. In Sri Lanka,drying is the most important processing methods of fish and shellfish. The best known smoked-dried product is Maldive fish,which is used as a condiment. Hot smoking of fish is carried out on a very small scale. "Jaadi",the only fermented fish product,is quite unique to Sri Lanka.

Processing of Dried Fish.

Small varieties of fish such as sprats,silverbelly are dried with out prior salting. The small,medium sized fish and the larger varieties are salted before drying. The small varieties are dried whole,but the larger fish are split in to two or three (depending on the size) before salting and drying.
common salt is used and salting is carried out either by dry salting,bringing or mixed salting. The fish is washed and dressed (if necessary) and mixed with salt (1:3 ratio of salt : fish) or immersed in brine solution for at least 24 hours. The excess surface salt is washed prior to drying in the sun. The fish is dried to a moisture content of about 30% (with salt added) and less is unsalted.

Processing of Maldive Fish.
Maldive fish has been used as a condiment in Sri Lankan foods for many years. Local production, which is carried out as a cottage industry, is restricted to the Southern costal regions. Only certain selected species of scombroid fish are used in maldive fish production. They are mainly skipjack,frigate mackerel and mackerel tuna.

The fresh fish is cleaned of gills,viscera,fins etc.,and washed thoroughly. It is then partition in to loins and boiled in salted

water (3% salt), or sea water. The excess water is squeezed out of the loins and the product is then smoked. Coconut husks and leaves are used for smoking. Then it is dried in the sun with alternative smoking,if necessary.

An improved method using a baking,smoking and sun drying process has been developed by the Institute of Post Harvest Technology, NARA. In this method the fish is baked (instead of boiling) as a whole fish,after eviscerating and washing. While baking the smoke flavor is infused simultaneously into the fashioned thus may not require further smoking. The baking technique gives a loin which is much lower in moisture content than the boiled loin. Thus shortening the drying period. As the peak season for these varieties of fish coincide with the monsoon,causes problems,as the producers depend entirely on the sun for their drying. The improved technique therefore has an advantage over the traditional process.

Processing of "Jaddi" or Colombo curing of fish

This traditional product is also carried out on a cottage scale. The product is made by using Malabar tamarind or 'Goraka' as it is known locally. The fish is mixed with Malabar tamarind and salt and packed in layers in earthen ware pots. The top layer should consist of a salt and tamarind mixture. It is thus left to ferment.

Non-traditional Seafood Processing.

There are a few product which are non-traditional. They are frozen seafood and minced fish product. The majority of the export seafood product from Sri Lanka, are processed as frozen products. These include frozen fish, shrimp, lobster, cuttle fish and crab flesh. A few minced fish products such as fish sausage and fish fingers are process for the domestic market.

Processing of Seaweeds.

The gel extracted from the seaweed Gracilaria is used in the preparation of food. Traditionally this seaweed was collected and dried and salt in this form. It is known commonly as "China moss". The extraction of the gel was carried out, in the homes by the housewives, by a time consuming method of boiling (for a long time) and straining.

This gel, or agar as it is known universally, can be extract and dried as sheets or freeze dried to form a powder. This extract product dissolves on boiling and is much easier to used. Studies on extraction of agar which can be done as a small scale industry is being carried out presently, by the Institute of Post Harvest Institute, NARA.

5.0 Raw Material

The Raw Material for the shrimp industry is supplied both by wild catchers and farmed shrimp. Farmed shrimp supplies about 70% of the total quantity exported from Sri Lanka. Lobsters and cuttle fish are harvested from the wild. The main fish varieties that are exported are Tuna and Sword fish, and other varieties such as Barracuda and Rock fish are also exported. The factories receive the raw material which is preserved with ice.

6.0 Institutional Infrastructure

The overall development promotions and management of fisheries have been the responsibility of a separate Ministry since 1971. At present this responsibility lies with the Ministry of Fisheries and Aquatic Resources. The Ministry directly engages it self with the formulation of lands, policies and strategies for all areas and subjects relating to Fisheries and Aquatic Resources. In this it is assisted by two divisions viz. Planning division and Development division. The implementation of Development plans, project and managements measures are under taken by the Department of fisheries and Aquatic Resources which has the network of field officers Island wide. The training of fisheries manpower is under taken by the National Institute of Fisheries Training (NIFT).

The Ministry has three statutory bodies viz. The Ceylon Fisheries Corporation, The Ceylon Fishery Harbours Corporation and the National Aquatic Resource Agency (NARA). The first two have been setup by incorporation orders within the frame work of the "State Industrial Corporation Act" of 1959. While the National Aquatic Resource Agency has been setup under separate act of parliament. In addition Cey-nor Development Foundation which originated as a NGO is now functioning as a public company under the supervision of the Ministry of Fisheries & Aquatic Resources.

In addition to the line agencies co-operatives and Non-governmental Organization are activate in fisheries sector development in Sri Lanka. Most of the fisheries co-operatives are Government sponsored. Majority of the fishing communities who represented 82% of the fishing population in Sri Lanka are below the poverty line. They are organized and directly involved with NGOo like Small Fisheres Federation of Sri Lanka.

7.0 Technology

The most widely used technology in the fish industry are freezing and drying. Most of the exports are processed as frozen product, but a limited quantity of chilled fish is also exported. Sum of the fish available for the domestic market is also processed as frozen products. Salting and drying of fish is the traditional technology used in fish preservation. Apart from dried fish, the other products are cured fish and smoked and dried fish.

8.0 Man Power.

A census of fisheries conducted in 1972 showed that there were about 43,000 house holders with total membership of 250,000 persons and an active fishermen membership of 50,000 engaged in the coastal fisheries at that time. On the boats of the annual rates of population increase,the total fishing population in 1981 is estimated at 308000 and the number of active fisherman at about 72407. The number of persons employed in activities to fishing such as marketing fish curing Boat building etc. is estimated at about 18500 with about 42,000 dependents in 1981. The employment in auxiliary activities in 1991 is shown in the Annexe as follows.

Employment in Auxiliary Activities - 1991

Activity	No. of employed
Marketing	7850
Boat Building	640
Net Making	410
Ice Making	1340
Fish/Prawn Processing	1680
Fish Curing	6600
Manufacturing of Fish Meal, Maldive Fish etc.	1080
Total	19600

9.0 Waste Utilization

The waste from the processing plants are used mainly for the production of fish meal or manure. A very small quantity of shrimp waste is used by cottage scale industry of shrimp cracker production.

10.0 Packing

Some of the product meant for the export market are frozen in blocks and packed in polythene and waxed cartons, which are then boxed in master cartons. Others are processed as vacuum packed frozen or chilled products. Frozen packed consumer fish, product is available in the domestic market.

11.0 Domestic and Export Markets.

The per capita gross domestic production (G.D.P.) for 1989 Factor cost price was Rs. 13,237.00. Percentage of contribution of fishery in GDP was 1.65% in 1980 and 2.13 1988. Per capita annual consumption was14.84 kg. in 1980 and 15,71 in 1987. In other hand approximately .041 g. per day in 1980 and .043 g. in per day 1987. After diduction the wastages of fish it was about .030 g. per day and .010 g. per month per person.

The export earnings by the fisheries sector through export of marine products, such as, shrimps, lobsters, cuttle fish, beche-de-mer, shark fins, sea shells, tropical fish, etc., increased from Rs. 453.04 m in 1985 to 855.54 m in 1991. (See anexture IV)

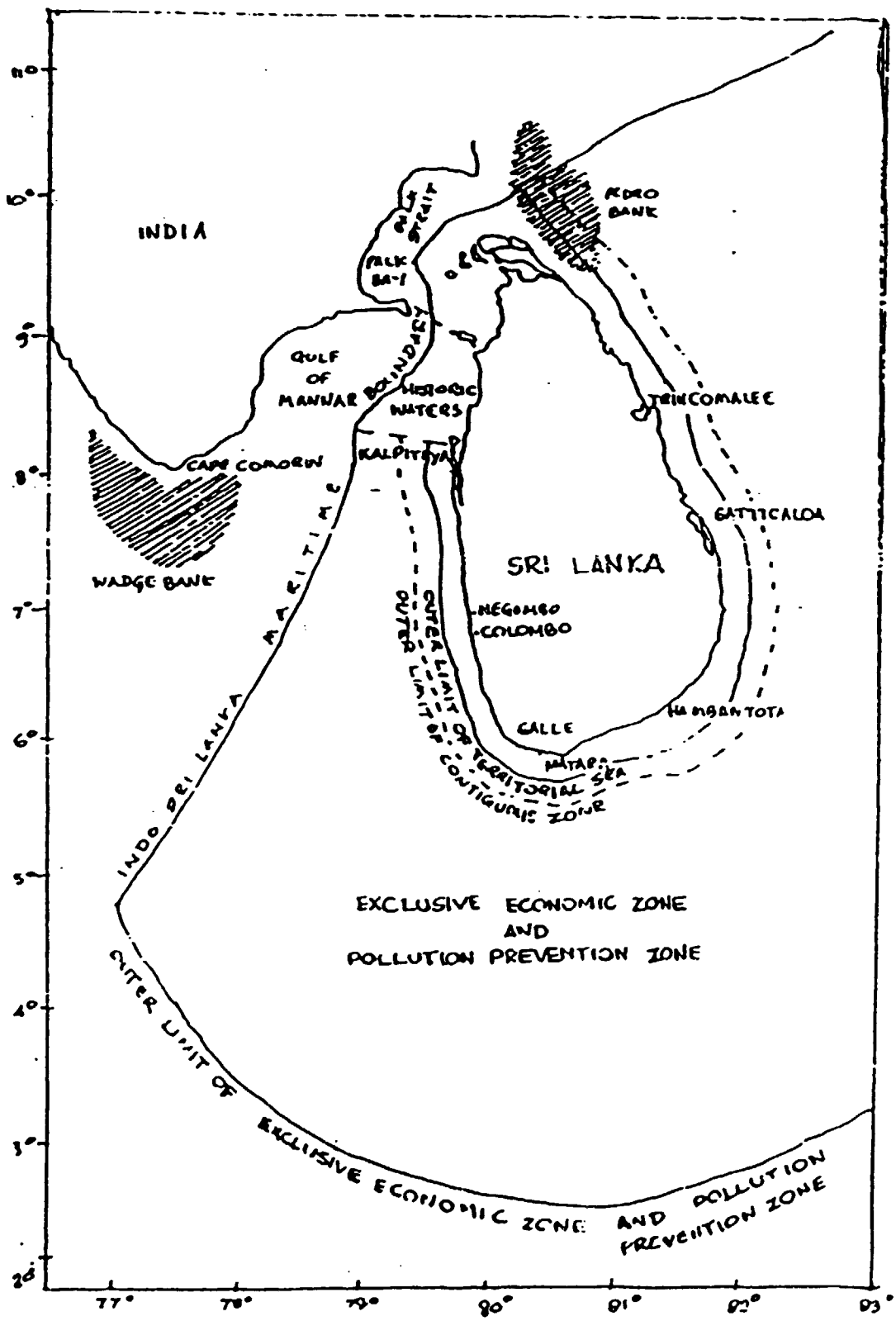

FIG. 1 - THE EEZ AND MARITIME BOUNDARY OF SRI LANKA

FINDINGS FROM THE FISHERIES SURVEY CONDUCTED BY THE MINISTRY OF FISHERIES & AQUATIC RESOURCES - 1989

RELATIVE POSITION OF FISHERY IN SRI LANKA - 1989

Fishing population	-	Marine Sector		412200
1989	-	Inland Sector		55909
	-	Total		468109
Projected population of Sri Lanka in 1989 (in '000)				17,433.20
Fishing population as percentage of total population				2.78
Active Fishermen	-	Marine Sector		98444
1989	-	Inland Sector		12891
	-	Total		111335
Fishing Households	-	Marine Sector		87808
1989	-	Inland Sector		11451
	-	Total		99259
Fleet Strength	-	Marine Sector	- Inboard Craft	2357
1989			- Outboard Craft	9028
			- Non Mechanized craft	15136
	-	Inland Sector	-	4058
	-	Total	-	30579
No of Fishing Villages	-	Marine Sector	-	1050
1989	-	Inland Sector	-	1289
	-	Total	-	2339

Gross Domestic Product (GDP) in current prices

Contribution of fishery in GDP	-	Rs. million 5677.4
% Contribution of Fishery to the GDP of Sri Lanka	-	2.2

COLD ROOM AND ICE PLANT FACILITIES OF GOVERNMENT SECTOR

DISTRICT/ PLACE	CEYLON FISHERIES CORPORATION		CEYLON FISHERIES HARBOURS CORP.	
	COLD ROOM	ICE PLANT	COLD ROOM	ICE PLANT
	TEMP:& CAP:(M.T)	CAPACITY:(M.T)	TEMP:& CAP:(M.T)	CAPACITY:(M.T)
COLOMBO/GAMPAHA	1160 (-20 C)&(+4 C)	10	50 (-20 C)	10
KALUTARA			400 (-20 C)	10
GALLE		2.5	2700 (-20 C)	16
MATARA		5		5
HAMBANTOTA	5 (+4 C)	5	30 (-20 C)	5
BATTICALOA	200 (-20 C)	25		
TRINCOMALEE	10 (-20 C)	10	200 (-20 C)	
MULLAITIVU				
JAFFNA	10 (-20 C)	15		
MANNAR	220 (-20 C)&(+4 C)	10		
PUTTLAM	25 (-20 C)	15	10 (-20 C)	10
POLONNARUWA	5 (-20 C)	5		
ANURADAPURA	10 (-20 C)	10		
KURUNEGALA	5 (-20 C)	5		
KANDY	10 (-20 C)			
RATNAPURA	10 (-20 C)	10		
BADULLA	2.5 (-20 C)			
TOTAL	1672.5	127.5	3390	56

C:\ L:\COLD

SOURCE: MINISTRY OF FISHERIES & AQUATIC RESOURCES

QUANTITY & VALUE OF EXPORTS OF MAJOR FISHERY PRODUCTS, - 1985 - 1992

DESCRIPTION	1985		1986		1987		1988		1989		1990		1991		1992	
	QUANTITY	VALUE	QUANTITY	VALUE	QUANTITY	VALUE	QUANTITY	VALUE	QUANTITY	VALUE	QUANTITY	VALUE	QUANTITY	VALUE	QUANTITY	VALUE
PRAWNS	1648.03	303.31	1973.03	427.93	1231.39	339.13	1826.00	526.80	2597.92	767.17	1855.27	485.86	942.64	454.60	1246.25	613.09
LOBSTERS	64.23	6.38	138.74	20.17	168.56	31.13	223.30	28.40	228.47	98.92	164.62	50.00	187.77	139.60	153.96	125.14
CRABS	26.17	10.24	34.46	13.81	50.23	25.40	45.40	30.70	100.65	64.02			322.89	39.28	533.33	66.91
BECHE DE MER	23.23	6.40	41.14	9.76	12.66	3.55	54.10	24.03	51.26	26.91	36.47	27.13	18.53	14.40	21.01	24.52
ORNAMENTAL FISH	104.38	30.53	123.56	29.63	119.42	35.61	161.80	74.20	259.59	105.58	153.75	68.11	98.03	40.66	246.27	142.93
OTHER CRUSTACEANS	151.14	5.53	165.55	7.55	145.79	7.61	310.00	23.00	-	-	821.44	174.64	70.22	22.85	93.08	12.30
OTHER DRIED, SALTED OR CHILLED,MOLLUSCS etc.	1219.65	89.83	933.96	99.60	648.81	133.45	575.40	106.30	729.42	69.71	1.42	13.28	182.24	108.62	252.24	178.47
FROZEN FISH	3.74	0.89	0.37	0.03	0.12	0.04	0.93	0.08	1.95	0.38	78.25	28.85	5.07	29.31	1130.04	116.14
FISH FILLETS AND FISH ME	0.02	0.00	-	-	0.01	0.01	300.00	10.90	12.98	4.50	51.38	35.13	0.56	5.78	55.10	12.37
TOTAL	3240.61	455.11	3410.81	608.48	2376.79	575.93	3496.93	824.41	3982.24	1137.19	3162.60	885.00	1827.95	855.10	3731.28	1291.87

Quantity in metric tons, value in Rs Millions

The Development of the Fisheries Industry in Thailand

Status Of The Thai Fishery Industry

The fish processing industry of Thailand is economically important as it provides job opportunities, incomes and foreign currency and the Government has put strong emphasis on the development of this sector in the National Economic and Social Development Plans. The processing industry and related sector, e.g. fish production and processing sectors, have progressively grown and developed through the plan.

The capture fisheries have a tendency to be stagnant. aquaculture production has grown dramatically to serve the demand of the country (Table 1). Fish supply for local consumption is decreasing because of population and export growth. The fish processing industry, especially factories of export scale, has became one of the top world exporters despite trade barriers and competition. and Thai exports are recognized as quality products. The country's exports has grown dramatically (Table 2). Lack of supply seems to be a major problem of the industry. The government has been trying to offset the problem by promoting freshwater and coastal aquaculture as well as joint-venture fisheries However, the industrial sectors have had to import supplementary raw material. Support from the government has also taken the form of technical services to maintain self-sufficiency in the supply of fish by reducing post-harvest losses and maximizing utilization. In the Seventh Nation Economic and Social Development Plan these activities remains in focus. The government realizes that the collaboration between the government and private sector is the key factor in the development of the industry Thus, the improvement and strengthening of service and assistance to the people involved in fish processing are included as specific in the Plan.

Table 1. Fisheries production in quantity by subsectors

Unit : 1,000 tonnes

Year	Total	Capture		Culture	
		Marine	Freshwater	Coastal	Freshwater
1988	2,629.7	2,337.2	81.5	108.9	102.1
1987	2,779.1	2,540.0	84.7	61.9	89.8
1986	2,356.3	2,309.5	98.4	39.1	89.3
1985	2,225.2	1,997.2	92.2	60.6	75.2
1984	2,134.8	1,911.5	111.4	61.5	50.4

Source : Fisheries Record of Thailand, 1990.

Table 2. Thailand : International trade in fishery commoidities

Quantity : tonnes
Value : million bahts

Year	Import		Export	
	Quantity	Value	Quantity	Value
1988	347,666	14,713	798,572	44,437
1987	227,327	7,016	603,650	32,654
1986	268,089	7,590	602,486	26,829
1985	152,707	3,857	466,219	18,527
Average growth 85:88: %	127.7	281.4	71.28	139.8

Source : Fisheries Record of Thailand, 1990.

Fish Supply Situation

Total fish production in 1988 was 2,629,700 mt of which 88% was from the marine capture fisheries, 3.1% from fresh water fisheries, 4.1% from coastral aquaculture and 3.9% from freshwater aquaculture (Department of Fisheries, 1990).

Marine Fisheries production

In 1988, the total production of marine fisheries including coastral aquaculture was 2,446,100 mt. This quantity can be classified as fish 1,867,700 mt, shrimp 137,300 mt, cephalopods 114,200 mt and molluscs 227,200 mt (Table 3).

Freshwater Fisheries production

In recent years total freshwater fish production has grown slowly but freshwater aquaculture growth has risen more than 50% above the level of 1984. Total production of freshwater fish in 1988 accounted for 183,600 mt (Table 4). The major freshwater species are Tilapia, catfish, local carp, sepat Siam etc.

Fish Utilization

Fish are mainly consumed fresh and cured (salted, dried, streamed, smoke and etc). Canned products are consumed locally in smaller quantities compared with export volume and most of the frozen products are for export. Table 5 and 6 illustrate the utilization of marine and freshwater fish. Cured products produced from marine fish included dried salted fish, fish sauce, dried shrimp, dried squid, smoked fish steamed fish, fishball, dried mussel, fish crackers and budu sauce. Most freshwater fish is utilized domestically, 78% of it, in fresh form.

Table 3. Marine fish landings - major species

Unit : 1,000 tonnes

	1988	1987	1986	1985	1984
Total	2,446.1	2,601.9	2,362.2	2,057.7	1973.0
Fish	1,867.7	2,017.4	1,798.9	1,570.4	1514.1
Pelagic	638.0	629.6	570.1	588.1	572.7
Dermasal	141.2	152.7	131.5	97.5	88.5
Other food fish	132.4	129.4	121.1	108.4	95.3
Trash fish	956.1	1,105.7	976.2	776.4	757.6
Shrimp	137.3	127.7	141.2	151.6	165.9
Tiger	41.2	10.8	1.2	0.5	0.5
Banana	18.9	19.1	19.7	19.1	19.9
School shrimp	12.9	14.1	13.5	14.0	13.5
Sergistid shr.	23.0	20.0	19.4	18.8	18.8
Others	41.3	63.7	97.4	99.2	113.2
Crab	41.9	40.4	35.6	26.8	27.0
Swimming	37.1	34.7	30.4	22.2	22.4
Mud	4.5	5.0	4.6	4.5	4.3
Other	0.3	0.7	0.6	0.1	0.3
Cephalopods	114.2	132.5	134.4	116.0	129.3
Squid	67.2	75.4	71.3	64.0	66.3
Cuttlefish	45.3	45.7	51.6	42.8	56.4
Octopus	6.6	9.2	12.0	11.4	11.7
Molluscs	227.2	217.8	164.3	188.5	153.6
Baby clam	115.4	131.2	101.2	83.7	50.5
Green mussel	66.8	46.8	31.8	61.0	62.2
Horse mussel	30.7	15.7	8.4	8.0	14.3
Other	14.3	24.1	22.9	30.8	26.6
Seaweed	0.8	1.7	1.2	4.3	0.7
Other	18.4	40.5	76.1	29.0	153.6

Source: Fishery Record of Thailand, 1990.

Table 4. Freshwater species production

Unit : 1000 tonnes

	1988	1987	1986	1985	1984
Total	183.6	177.1	187.8	167.5	161.8
Tilapia	27.6	27.3	23.3	15.41	21.5
Other food fish	27.6	21.1	35.5	24.1	26.9
Catfish (Swai)	25.4	16.5	15.8	18.2	11.3
Local carp	21.9	16.9	21.8	16.0	20.1
Sepat siam	17.6	20.2	23.0	23.1	18.9
Catfish (Duk)	17.2	16.8	18.9	18.0	14.9
Snakehead fish	15.8	19.6	23.5	21.8	20.4
Freshwater prawn	13.1	13.0	6.4	7.2	4.7
Climbing pearch	7.7	7.4	7.9	9.6	9.2
Common carp	4.7	6.4	4.0	3.6	4.6
Swamp eel	1.6	6.4	1.6	2.6	2.4
Other	3.4	5.5	6.1	7.9	6.9

Source: Fisheries Record of Thailand, 1990.

Table 5. Utilization of marine fish

	1988		1987		1984	
	Tonnes	%	Tonnes	%	Tonnes	%
Marketed	488,002	19.95	497,749	19.13	560,900	26.3
Frozen	349,307	14.28	325,501	12.51	201,000	9.4
Cured	236,051	9.65	279,447	10.74	346.700	16.21
Canned	324,845	13.28	318,476	12.24	181,300	8.5
Other	1,047,920	42.84	1,185,178	45.55	844,900	39.6
Total	2,446,125	100.00	2,601,929	100.00	2,314,800	100.00

Table 6. Utization of freshwater fish

	1988		1987		1984	
	Tonnes	%	Tonnes	%	Tonnes	%
Total	183,607	100	177,142	100	161,819	100.0
Marketed	144,498	78.7	152,342	86.6	117,555	72.7
Frozen	-	-	-	-	-	-
Cured	39,108	21.3	24,827	14.0	44,264	27.3
dried/salted	22,583	12.3	11,542	6.5	21,022	13.0
steamed/smoked	6,242	3.4	4,960	2.8	6,669	3.5
fermented	8,630	4.7	7,617	4.3	13,455	8.3
fermented paste	184	0.1	354	0.2	212	0.1
fish sauce	1,469	0.8	177	0.1	2,583	1.6
dried shrimp	-	-	177	0.1	166	0.1
other	-	-	-	-	1,157	0.7

Source : Fisheries Record of Thailand, 1984, 1987 and 1988.

Table. 7. Number of fish processing factory

Type of plant	1987	1986	1985	1984
Cold storage	80	84	80	78
Canneries	41	41	39	38
Fish sauce	110	111	114	113
Fish meal	95	93	92	95
Shrimp paste	nd	nd	2,725	2,860
Salted fish	671	943	978	800
Dried shrimp	176	165	148	284
Dried squid	711	828	879	865
Dried mussel	580	613	674	776
Steamed fish	78	94	115	138
Smoked fish	86	180	171	184
Fish-shrimp cracker	65	107	76	78
Fishball	79	69	54	64
Budu sauce	23	30	33	37

Source : Statistics of Fisheries Factory 1989.

Fish Processing Industry

Since 1984 the number of fish processing plants has not substantially increased but their capacity has increased, except for plants processing certain traditional products (Table 7).

Freezing Plants and Cold Storage

In 1987, there were 80 registered freezing and cold storage plants. Their main activities were preparing, freezing and holding products including fresh products destined for local consumption. Many of these plants have increased their production capacity in response to demand in the international markets between 1988 and 1990.

During 1989, there were shortages of cold storage holdings as shrimp aquaculture products dramatically increased. Since then, the Board of Investment has regranted investment privileges to investors in this area, including those producing value-added products. This has contributed to a great expansion of cold storage holdings, production capacity and to diversification of processing.

Major species utilized by this industry are miscellaneous fish, cephalopods, and shrimp, The processors normally produced block frozen products, e.g. shrimp are processed in the form of head-on, headless, peeled, deveined, un-deveined. Cephalopods are processed in the form of whole squid, squid tube, squid rings and tentacles. Fish , for the most part, are processed into fillet form.

A major industrial development in this line is the production of battered and breaded products using various seafoods as base, and the introduction of some other value- added products in terms of new product development and packaging diversification.

Canneries

The number of canneries has not increased in recent years because the existing factories have not reaches their full capacity. Canned tuna are the main production, the

rest are engaged in the production of canned shrimp, crabmeat, baby clam, cephalopods, sardine and mackerel.

The industry has made efforts to increase production yield and efficiency, improve product quality, styles of pack and packaging. On the production line, new equipment has been extensively used to increase production efficiency. Most companies have hired well-trained production and quality control personnel. In addition to conventional packing media, various new packing media have been developed to add value to the products. The traditional three-piece can has been replaced by two-piece cans and by easy-open end-cans. Some canneries produce their own cans.

A large-scale cannery has already invested in technology for the utilization of the processing wastes, for example, the processing of sauce from tuna cooking water. Canned petfood is another way to utilize waste from the canneries. (But 50% of canned petfood is made of fresh sardine.)

Surimi And Surimi Based Products Processing

There are, at the moment, nine active surimi processors. Among these are three plants that process imitation crabmeat. Total surimi production capacity is 50,000 mt/year . Most of the surimi plants produce secondary products such as fishball, breaded fish cake and cuttlefish ball.

Value-Added Products Processing

Production of value-added seafood products started with the production of surimi in 1967 and cooked and peeled shrimp at about the same time (Suwanrangsi, 1991). Later major developments in value-added products were consumer-pack frozen seafood, surimi product (e.g., fishball, imitation crabmeat and Japanese-style fish jelly products) and semi-processed products (e.g., spring roll, battered and breaded products). Currently shrimp is value-added into the following forms: cooked and peeled shrimp, cooked whole shrimp, peeled butterflied, tail-on, peeled tempura, battered and breaded shrimp, shrimp skewer and processed products.

Traditional Products Establishments

Most of processing of traditional products is done by small entrepreneurs. To date, even though they do not use much modern technology, they have made progress in upgrading quality standards and are packing more and more in response to their customers' requirements for quality. However, there is still much room for improvement in processing practices, equipment and hygiene. It is estimated that 275,159 mt of raw material or 10.5 % of total fish production were utilized in producing traditional products in 1988. Improvement in any of the above mentioned areas would resulted in better utilization of resources, and, indirectly increase fish supply for local consumption.

Export of Fish and Fishery Products

Thailand is currently one of the world's major exporters of fish and fishery products, and seafood is one of the country's most important and successful industries. Frozen shrimp and canned seafood have been among the leading fishery exports and ranked 9th and 10th among Thailand's major export earners.

Exports of fishery products accounted for more than 50,000 million bahts in 1989 (Department of Business Economics, 1991). There are now 17 major fish and fishery products which earn foreign currency income. These include frozen shrimp, canned tuna, canned seafood, frozen tuna loins, frozen cephalopods, frozen fillet and surimi and others. the present status and prospects of some major items are described below :

Frozen Shrimp

The species of economic importance are black tiger shrimp (estimated to be 56% of the total shrimp export), white shrimp and freshwater prawn. The popular product forms among traders are raw headless shell-on, constituting 70% of the total world trade, and head-on shrimp which account for about 10%. About 10-15% consists of peeled shrimp and breaded shrimp. Thailand has increased production of frozen shrimp

with the expansion of its aquaculture, which is dominated by black tiger shrimp, and with increased demand from the market. In 1988, Thailand was able to hold a strong market share in Japan, USA and even in the EC countries which have now become familiar with cold water shrimp (Suwanrangsi, 1991).

A particular problem faced by the industry in major markets has been competition from suppliers in other development countries. To offset this, processors have intensified efforts to build a quality image and to diversify markets and product forms. New ready-to-cook products and packing styles have been developed along with new chemical and drug-free products.

Canned Tuna

Thai processors use both domestic and imported tuna for canning, and the domestic catch consists of tonggol and little tuna. The majority of tuna that Thailand imports are skipjack (approximately 85-90%), followed by yellowfin (8-12%) and some albacore (2-3%). Imports now account for over 70% of the tuna used in the processing.

The country now holds 70% market share in the USA, 50% in the EC countries including Britain, West Germany and Switzerland, and 60% in Canada. Exports rocketed from 1,854 million bahts in 1984 to close to 13,800 million bahts in 1989 (Department of Business Economics, 1991).

Frozen Cephalopods

In 1989, exports accounted for 69,054 mt and were valued at 5,238 million bahts. The principal markets for these species are Japan and south Europe. Thailand is a major supplier of cuttlefish and octopus to both markets to which it shipped 15,600 mt.

For the past five years, Thai processors have suffered from limited supply of squid and octopus, a situation which has resulted in high prices, uncompetitive products, and decreased export quantities and values. Consequently, since 1989, export volume has fallen and this trend is expected to continue. In addition to shortage of raw material, the industry faces the problem of poor-quality raw material , particularly that

supplied by trawlers. Import regulations, quotas and inspection procedures have also retarded the expansion of the market.

Fish

Chilled fish have been major export items over the past five years. Prepared fish products, particularly surimi and frozen fillets, are increasingly important. Fish fillet is a standard item of the international trade and with a high potential for growth, and many processors have diversified into this area.

Another interesting items is frozen tuna loins. Thai processors acquired new processing techniques which allow fish to be cooked and frozen in way that retain odour and flavour. Under this system, labour-intensive gutting, cleaning and initial cutting of tuna will be done in Thailand. The output - frozen tuna loins will then be shipped to the US and Europe for the capital-intensive packing operation. The volume of trade has greatly expanded from 118 mt valued at 8.2 million bahts in 1989 to 33,000 mt valued at 2,500 million bahts in 1990.

Value Added Seafood Products

The trade volume of value-added products has increased substantially; it is estimated that value-added products trade in 1990 accounted for 56,000 mt, valued at 3,700 million bahts(Department of Business Economics, 1991). This figure includes imitation crab meat, breaded fish and fishball and excludes cephalopods and shrimp products. To penetrate new markets and to increase the export of value-added products, both government and the private sectors have carried out a programme of continuous product development, product adaptation, technology development and quality control as well as a packaging development programme.

Problems of The Industry

As the fishery industry expands, the industry faces the following problems:

a) The sourcing of raw materials for further processing is a major problem facing both the exported factories as well as the domestic traditional fish processors. In addition, the industry cannot fully control the quality of raw material, especially from capture fisheries. Even though it has applied strict standards in the purchase of raw material, competition among processors has forced them to be more flexible to maintain their share of supply. Control of the quality of aquaculture products is easier.

b) Trade competition among developing countries is becoming intence. As a result these countries need to embark on new products which will give higher profit

c) Packaging technologies are needed for the further development of the industry. At the moment, the industry depends on imported technology in the area of processing techniques and equipment acquired from joint-venture and equipment suppliers. Self-developed technologies are also employed but progress is slow in this area. Faster progress is being made on technology adaptation. Improved packaging is crucial, not only to protect the products but also to market the products.

Future Development

The government will embrak on a programme to modernise the fish processing industry and also ,introduce improvement to the traditional processing sector. The department of Fisheries has future plans for the development of the processing industry by development and management, in co-operation with the industry, of the processing and quality assurance techniques needed to secure optimum and economic benefits for the nation and to promote the export of quality fish and fishery products. Specific objectives are to:

- improve the income of small-scale fisherman and fish processors, achieve and maintain self-sufficiency in the supply of fish to the domestic market, by reducing wastage and spoilage losses and increasing utilization,

- maximize the participation of rural population in commercial fish processing activities, assist the industry in controlling the quality of fish and fishery products, and

increase export earnings from the sale of fish and fishery products.

In the industrial sector, future plans for development include:

- diversification of fish and fishery product exports to new markets,
- implementing quality management program based on HACCP principles, and
- utilization of industrial waste.

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