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The New Economic Policy and Perspective for Marine Fisheries Research and Development in India

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Abstract

The paper deals with the present status of marine fisheries in India, the R & D issues that need to be addressed effectively and the required policy supports in the context of the New Economic Policy of the Government of India. The marine fisheries scenario in the country warrants adequate supports for the: (1) effective implementation of the regulatory measures for the optimum exploitation of the resources in the inshore waters; (2) increasing the exploitation of the deepsea and oceanic resources in the EEZ and the international waters; (3) effective prevention of third country fishing in the Indian EEZ; (4) mechanisation of artisanal craft to reduce their idling and to improve their capabilities; (5) establishment of artificial reefs for increasing productivity and production in the inshore waters; (6) improvements in the system of data generation pertaining to the exploited stocks; (7) protection and conservation of biodiversity; (8) improvement of domestic and export marketing through value- addition; (9) manpower development in R & D, fishing and processing; (10) development of obligatory linkages between different commodity organisations, community and trade; (11) development of marine fisheries information system; (12) development of infrastructure with particular emphasis on fishing harbours and berthing facilities; (13) popularisation of seafarming technologies; (14) establishment of Sea Farmers' Development Agencies; and (15) improvement of wild stocks through government- sponsored searanching programmes.

Introduction

In the context of rapidly growing human population and increasing protein malnutrition, food security assumes greater significance in the developing countries. Protein energy malnutrition is responsible for 56% of child deaths in 53 developing countries (Garcia, 1994). Increasing urbanisation and related activities are fast leading to significant declines in the arable land areas, resulting in increased attention on the aquatic sources of food. Increased production and improved availability of fish food, which is a cheaper source of protein, will help combat protein malnutrition to a very large extent. Among the aquatic resources, marine fisheries play an important role in supplementing the protein food requirements and employment generation. Marine fisheries in India underwent a phenomenal change during the past half a century, from a predominantly sustenance avocation to that of an industry due to the advancements made in the exploitation of the wild stocks and post-harvest technologies, the availability of lucrative export markets and trained manpower. The growth, however, resulted in the optimum exploitation of the inshore stocks, and hence the need to sustain their yields, minimise intersectoral conflicts and increase production through coastal aquaculture, seafarming, searanching, deepsea fishing and installation of artificial reefs and other fish aggregating devices.

The average annual landings in the recent years have been in the order of 2.4 million tonnes (mt) besides about 80,000 t obtained from coastal shrimp aquaculture. The projected requirement of marine fish production by 2020 AD is about 5.6 mt (CMFRI, 1997). The coastal aquaculture sector (particularly of penaeid prawns) received a boom since the beginning of the nineties, but went into a near calamity due to disease problems, ill-founded apprehensions of its adverse impact on the environment and a number of ill-conceived litigations. Though technologies for large scale culture of bivalves and seaweeds have been developed and are being transferred, they have not yet been adopted on a commercial scale. This situation warrants a close scrutiny of marine fisheries and mariculture research, the infrastructure, the human resource development and the social and economic conditions of the fisherfolk to meet the challenges of increasing the production to the estimated 5.6 mt level effectively. This is by no means a small task to accomplish, but requires concerted and cooperative R & D efforts to increase and sustain yields from the wild, to develop, improve and effectively transfer low-cost, ecofriendly technologies of mariculture and also to develop strong domestic and export markets. Human resources development in the different sectors of marine fisheries and mariculture is another vital aspect of this effort. It also requires political patronage, public and private funding and the cooperation of the fisherfolk.

The New Economic Policy and Marine Fisheries

In 1991, the Government of India launched the New Economic Policy (NEP), with competition, privatisation, liberalisation and globalisation as its main components. The NEP is aimed at promoting competition to eliminate monopoly profit and make private investments highly attractive through low tax rates, removal of controls and licensing system and, globalisation by reducing customs tariffs, and thereby opening the economy. The broad objective of the NEP has been to accelerate the country's transition to an internationally oriented economy with a view to deriving maximum benefits from the global market opportunities (Bhattacharya, 1995). According to Manmohan Singh (1992), the structural

reforms in the area of industrial and trade policies were designed to improve the productivity of resources and enhance export capabilities. The NEP has its implications in the marine fisheries and mariculture sectors also (James *et al*., 1993) in the context of increasing production by deepsea fishing, sustaining production from the presently exploited stocks, modernising the processing sector, generating additional employment, commercialising mariculture practices and further promotion of trade and exports. This policy also enables improving capabilities in the marine fisheries R&D and human resources development by encouraging the scientists and technocrats to visit foreign institutions and laboratories to make them familiar with the new developments taking place in the world.

Major Marine Fisheries Resources

Production factors : Among the four conventional factors of production (land, labour, capital and organisation), the geographical (land) base of India's marine fisheries economy consists of a long coastline of 8129 km, with an EEZ of 2.02 million sq km including the continental shelf of 0.5 million sq km (with an annual yield potential of about 4 mt fish), and 3638 marine fishing villages. A total of about 1.2 million hectares of brackishwater areas is available for commercial mariculture. The economic capital of the marine fisheries sector includes 2251 traditional landing centres, 109 modernized landing centres, 27 minor fishing harbours and 6 major fishing harbours which serve as the bases for the fleet capital of about 160,000 non-mechanised fishing craft, 32,000 motorised fishing craft, 47,000 small mechanised fishing craft and 180 medium to large trawlers operating in the Indian seas (Anon.,1996a). The capital also includes 372 freezing plants (6600 t capacity per day), 14 canning plants (52.5 t per day), 148 ice making plants (1800 t per day), 15 fish meal plants (330 t per day), 450 cold storages (80000 t per day) and 900 peeling sheds (2684 t per day) (CMFRI,1997). The sector has an impressive labour force of about one million active fishermen engaged in marine fishing operations and an equal number in the post-harvest and allied industries.

The fourth factor of production, i.e., the management in modern economics, promoting the growth of the sector, is basically the responsibility of the fisheries departments and the fisheries corporations of the maritime states, jointly discharged with assistance from and through the fisheries cooperatives, fishermen's associations and various other service organisations. The manpower required for the development and managerial services is met largely by the fisheries colleges, universities and various central and state training organisations.

The state of the exploited resource base: The Indian marine fisheries enterprises exploit a large number of species using different craft and gears in different localities in the depth range of 0 to 50 m (in recent years, this has been extended to about 100 m in some regions). The annual landing in 1995 was 2.3 mt (2.42 mt in 1996), principally constituted by the carangids (8.7%), penaeid prawns (8.2%), Indian mackerel (7.8%), croakers (7.4%), lesser sardines (5.6%), cephalopods (5.2%) Bombay duck (4.1%) nonpenaeid prawns (3.3%), ribbonfishes (3.2%) threadfin breams (3.1%), whitebaits (3.1%), perches (3.0%), elasmobranchs (3.0%), silverbellies (2.9%), stomatopods (2.9%), oil sardine (2.5%), pomfrets (2.0%) and others. The northwest coast comprising Maharashtra and Gujarat is the richest region contributing 36.2% to the total marine fish production, followed by the southwest (Kerala, Karnataka & Goa) coast (31.4%), the southeast (Andhrapradesh, Tamilnadu and Pondicherry) coast (25.8%), the northeast (West Bengal and Orissa) coast (5.1%) and the Lakshadweep and Andamans (1.5%) (Anon., 1996 b).

The pattern of marine fish landings in India during the past fifty years clearly reveals that the contribution by the artisanal sector to the total production was significant upto the sixties. As a result of the popularisation and consequent expansion of mechanised fishing during the subsequent periods along with the motorisation of artisanal craft, the contribution by the artisanal sector declined considerably. The contribution by the mechanised and motorised sectors accounts for 87% of the total catch while the artisanal sector accounts for only 13% (Anon., 1996b).

The growth of the fleets shows that the artisanal fleet (including the motorised) increased by about 110% from the sixties to the nineties and the mechanised fleet by about 570% during the same period (CMFRI, 1997). Thus, it is not just the physical growth in the fleet size, but principally the increase in the efficiency of fishing on account of mechanisation of the craft coupled with the induction of modern fishing gears, that has contributed to the increase in the total production . The growth certainly has led to significant increases in the production, employment generation and domestic and export earnings, and in the process, resulted in the optimum exploitation of the stocks in the currently fished grounds (Murty and Rao, 1996; CMFRI, 1997), warranting thereby, the need for effective regulations and management to sustain the economic gains. The estimated landing site value of 2.42 mt of fish caught in 1996 was Rs 74,100 million. The current production gap of about 1.5 mt from the EEZ is worth about Rs 45,000 million at current prices of which the tuna potential (*vide infra*) alone is worth Rs.3,000 million at international prices. The NEP should address these gap areas to bring about economic prosperity in the sector.

Potential Yield : The "Working Group on the Revalidation of the Potential Fish Yield from the Exclusive Economic Zone " of the country estimated the potential yield to be 3.9 mt comprising 2.2 mt from the 0 to 50 m depth zone and 1.7 mt from beyond the 50 m depth in the EEZ (Anon., 1991). In the rocky grounds that are not trawlable in the 75 to 360 m depth zone along Gujarat and Kerala, over Wadge Bank and in Gulf of Mannar, the perches (groupers, snappers and breams) are quite abundant (Silas,1969 ; Menon and Joseph, 1969; Menon *et al*., 1977; Bapat *et al*., 1982; Oomen, 1989).

The resources that are currently exploited in the inshore waters have already been listed above. Among the resources that offer scope for exploitation in the depths beyond the 50 m, the tunas (both coastal and oceanic) are the most important with an estimated potential of about 450,000t followed by the carangids (300,500 t), ribbonfishes (216,000t) threadfin breams (110,000t), elasmobranchs (71,000t), catfishes (63,000t), Indian mackerel (62,000t), bull's eye (55,000t), croakers (22,000t), lizardfishes (21,000t) cephalopods (21,000t), perches (15,000t) and others.

It is important to note the estimated landings of cephalopods during 1996-97 are of the order of over 1 lakh tonnes (CMFRI, 1997) while the estimated potential yield (Anon 1991, Sudarsan *et al*., 1990) of this resource is of the order of only 71,000t. The potential yield estimate from beyond 50 m depth zone in the Indian EEZ is principally based on the exploratory surveys, in the absence of directed commercial operations for this resource. In the light of the rather

heavy landings in recent years it appears necessary to obtain an updated estimate of potential yield of cephalopods taking to account the changes that have taken place since 1990. Besides, in the light of changes taking place in the fishing practices, area of operation and the landings over the past one decade, it is also necessary to obtain an updated, resource-wise potential yield estimates from the country's EEZ.

Most of the resources offering good potential for exploitation in the region beyond 50m depth are partly exploited from the inshore region also. Nevertheless, there is good scope for exploiting the oceanic and coastal tunas, carangids, ribbonfishes, threadfin breams, catfishes, Bull's eye and perches by extending the fishing operations to still deeper seas.

Ancillary Marine Living Resources of Potential Economic Use

Ornamental fish: Marine aquarium fish trade is gaining increasing popularity the world over with an estimated value of 4.5 billion US$ (Srivastava, 1994). The Gulf of Mannar, Palk bay, Gulf of Kutch, southwest coast and the Lakshadweep and Andaman group of islands are known to be rich in ornamental fishes (Murty, 1969; 1986; Murty *et al.*, 1989). The wrasses, damsel fish, surgeons, butterfly fish, moorish idol, squirrel fish, trigger fish, rabbit fish, parrot fish, angels, goat fish and puffer fish are the major aquarium fishes represented by nearly 180 species. Most of these fishes are numerically abundant and offer scope for live fish export and for the development of home aquariculture in the country. The results of the survey and assessment of marine ornamental fishes of Lakshadweep (nine islands) implemented by the Central Marine Fisheries Research Institute(CMFRI) indicate an annual potential yield (rough estimate), of 25 lakhs of fish consisting of 38.0% of wrasses, 32.7% of damsel fishes, 8.4% of goat fish, 7.4% parrot fish, 4.9% squirrel fish, 4.8% of surgeon fish , 2.1% of butterfly fish, 0.8% of trigger fish and others. The government and the industry are evincing keen interest in developing an export trade for this group of fishes. As majority of these fishes are associated with coral reefs and those in great demand are not very abundant, their exploitation may disturb the habitats and result in depletion of stocks, if suitable mechanism for sustainable exploitation using, for example, simple traps and monitoring the exploitation and export is not developed. The seahorses or pipefishes (*Syngnathidae*) are known to live in seagrass beds, mangroves and reefs in most shallow coastal waters of the temperate and tropical regions; about 300 species of about 30 genera are known (Vincent, 1996). While these fishes are suitable for aquaria, in recent years, their exploitation is carried out particularly by divers from the southeast coast of India because the dried seahorse is in great demand in Singapore and China for making soup and for medicinal purposes. Marichamy *et al.*, (1993) described the exploitation and export of this resource from the Palk Bay.

There is considerable scope to put up commercial marine aquaria, oceanaria and dolphinaria in the coastal cities and towns to provide tourist attraction and to create general awareness and knowledge of marine life and biodiversity among the general public and students. Besides the small marine aquaria at Mumbai, Vizhinjam (Thiruvananthapuram) and Mandapam (Rameswaram), the first oceanarium is coming up at Goa.

Sponges: About 519 species of sponges (*Phylum Porifera*) are known to occur in the Indian seas. Sponges are the major components of the benthic fauna and are distributed from the intertidal to the hadal depths and are a potential source of many new bioactive compounds (Thomas, 1996). Increasing interest is being shown on their biochemistry in the light of the isolation of unusual nucleosides from them and their possible use in treating certain diseases. Thomas (1996) listed a large number of chemical compounds isolated from sponges and stated that studies were needed to be conducted to understand their pharmaceutical applications. In India, our knowledge of the identity, biology, availability, population structure and possibilities of commercial exploitation of sponges is meagre and requires priority attention.

Corals : India is blessed with vast stretches of coral reefs in the Gulf of Mannar and Palk Bay, Gulf of Kutch, southwest coast and along the Andaman and Lakshadweep islands. Corals have many uses: recreation, tourism and shoreline protection. Besides, they are raw materials for industries such as cement, lime and calcium carbide (Pillai, 1996). A large number of organisms live on corals. About 225 species of corals are known from the Indian seas (Pillai, 1996). Indiscriminate exploitation of the corals, dredging the reef areas and the exploitation of the reef flora and fauna have resulted in the destruction of the coral reefs of India. Besides, pollution and sea erosion are also among the major causes of destruction of corals. There is an urgent need for a national policy on reef conservation (Pillai, 1996).

Gorgonids: Popularly known as the seafans or seawhips, the gorgonids (*Phylum Coelenterata*; class, *Anthozoa*), are available in fishable magnitudes in the Gulf of Mannar, although distributed almost all along the Indian coasts including the Andaman sea. These organisms support a minor export market providing raw materials for the extraction of prostaglandins which are claimed to be wonder drugs. Thomas and Rani Mary (1987) gave a detailed account of the distribution and exploitation of these resources and suggested that India should step up the production of chemical compounds that have pharmaceutical properties from gorgonids. During 1983-84, India exported 1008 kg of gorgonids valued at over Rs one lakh.

Seaweeds: A large number of seaweed species known from the Indian seas are edible and serve various industrial purposes. They are most abundant along the Gujarat, Kerala and Tamilnadu coasts and around the Andaman and Lakshadweep islands. Considering the standing crop of about 100,000t, the present landing of about 11,000t forming only 11% of the standing stock is very minimal. The edible seaweeds form 70% of the standing stock, followed by algin (16%), carrageenan (8%) and agar (6%) yielding seaweeds. There are about 60 small scale industries using seaweed as raw material in Gujarat, Tamilnadu and Kerala, but their capacity utilisation round the year is very poor primarily due to the nonavailability of raw material, lack of adequate demand for the products in the domestic markets and the products not meeting (because of their very crude nature) the standards for export. The edible seaweeds are known to be rich in protein (20 to 25%), carbohydrates (16 to 24%), lipids (6 to 11%), vitamins and aminoacids. Farming technologies have been developed, but commercial farming is yet to be initiated in the country. There is an urgent need for utilising the edible seaweeds for food, for effective utilisation of the existing capacity of industrial units and for taking up of

seaweeds aquaculture on a commercial scale.

Utilisation and Discards

Out of the total annual marine fish landings of about 2.7mt (1995-96), about 15% is exported and naturally adequate care is taken for the preservation and processing of this component from the time of capture till export. About 44% of the catch is used in fresh or iced condition for domestic consumption, 31% by curing and drying and 15% by reducing to fish meal and by canning and freezing (Sathiadhas *et al.*, 1994). Leaving certain fishes like the Bombay duck, whitebaits, ribbonfishes and a few others which are cured in fresh condition, bulk of the landings (25% to 30%) is processed only after it becomes unsuitable for fresh consumption. This results in the nonavailability of fresh fish in the potential demand centres in the country and poor returns to the producer.

Discarding the bycatch is an evil in the marine fisheries sector, the world over. A recent study (Alverson *et al.*, 1994) of global discards shows that an estimated 27 mt of bycatch is discarded annually, of which shrimp trawl fisheries in the tropical seas contribute to one third of total discards. The discards in the Indian Ocean region account for 2.27 mt forming 8.4% of global discards. This estimate suggests that discards by shrimp trawlers in India could be of the order of 0.3 mt, though precise estimates of discards are not available. While the country cannot afford such large scale discards in the context of protein malnutrition and increasing population, absence of data on the quality and quantity of discards poses problems in stock assessment. There is also an urgent need to utilise the discards of finfish for human consumption. Suitable methods of onboard collection of discards and their value addition (into ready-to-eat or ready-to-cook food items) need to be developed and implemented. Such an initiative will go a long way in providing food security and prevent economic waste.

Economic Potential of Mariculture

During the past three decades, considerable progress has been achieved in the mariculture of various candidate species. The hatchery technology for the penaeid prawns has been developed and standardised, so also the package of practices for cultured pearls, clams, mussels, edible oysters and seaweeds. Areas suitable for the culture of different organisms have been identified for the entire Indian coastline including the inshore seas, estuaries, backwaters and coastal land areas. India's estimated annual mariculture production potential of 2mt includes 5% of finfish, 50% of crustaceans, 15% of bivalves and 30% seaweeds, and it is expected to be achieved progressively through the next 5 successive 5-year plans starting from the 9th plan.

Socio-economic Status of Marine Fisherfolk

Of the current (1997) one million active fishermen engaged in marine fishing in India, about 0.2 million are engaged in the mechanised sector, 0.17 million in the motorized sector and the rest in the artisanal sector. Among those engaged in the mechanised sector, 75% work in trawl fisheries and 25% in the fisheries operating gillnets, dolnets, purseseines and deepsea vessels. In the case of the motorized sector, 60% are engaged in the ringseine fishery alone, which is operating predominantly in the states of Kerala and Karnataka and the rest in various other forms of motorised fishing. In the artisanal sector, of the total of 0.63 million active fishermen, 41% are engaged in the operation of catamarans, 31% in plank built boats and the rest in the dugout canoes and others. Among the fisherfolk engaged in marine fisheries activities, about 0.7 million work as labourers of whom 65% are engaged in artisanal fishing. The annual income of labourers working in a mechanised boat was estimated to be Rs 34,200, motorised boat Rs 15,200 and artisanal unit Rs 8,000 during 1995-96. It is thus clear that only 30% of the fisherfolk possess some sort of ownership of fishing implements, while a large number of them (70%) work as labour force. There is a very wide disparity in income between those engaged in the different subsectors, and hence the clashes and conflicts (Sathiadhas, 1996).

Issues Requiring Policy Support

The issues pertaining to marine fisheries in India are not unique to the country, but common to most tropical developing countries and need to be addressed through proper policy supports. Some of them are of very serious nature involving food security, environment, economy and the livelihood of the marginal fisherfolk. The fisheries sector in India, as is well known, is governed by the state governments as well as the central government through different ministries which play varied roles. While the marine living resources cannot be partitioned on the basis of terrestrial boundaries and managed through convenience- based governance, the need for an integrated national policy on marine fisheries becomes immediately obvious, particularly in the present context of overexploitation in inshore zone, underutlilisation in the offshore/oceanic zone, sectoral conflicts, economic waste, underemployment and protein food insecurity. In the light of the NEP, policy supports need to be extended to the following sectors.

1. Artisanal fisheries: Owing to the steady growth of the mechanised fleet, the artisanal sector contributes only 13% to the annual production currently. This situation is a cause for major concern in view of the large number of people involved in the traditional fishing sector, warranting priority attention through appropriate policy interventions leading to their ameleoration, reduction in the wide disparity between the different income groups of fishery labour (*vide supra*), elimination of conflicts and clashes between different interest groups and reduction in indiscriminate exploitation of young fish.

The inshore sea areas are known to be the nursery grounds for a great majority of fishes. In most of the tropical seas, fish production originates in the littoral areas, where the fingerlings become benthic before migrating towards the deeper waters, growing in size and decreasing in numerical abundance (Garcia, 1986). The juveniles of majority of finfish and shellfish inhabit shallower inshore waters while the larger fish inhabit the relatively deeper regions (Nagabhushanam, 1971; James and Adolph 1971; Weber and Jothy, 1977; Pauly and Mortosubroto, 1980; Murty, 1988). Certain gears like the ringseines catch appreciable quantities of youngfish (James, 1992). Therefore, fishing pressure needs to be restricted in the inshore waters. In the light of the above, the following measures need to be implemented through policy support.

i. *Mechanisation of large artisanal craft:* There is a strong possibility of successfully fitting the artisanal craft of about 30' OAL from among the existing fleet, with energy efficient 26hp inboard engines for offshore pelagic fishing for the larger pelagics like the sharks (following the Bay of Bengal Programme - Srilanka: BOBP-

SRL model of boats). This programme would, however, have to take care of the berthing facilities in as many fishing villages as possible. The best option in this regard is the establishment of floating type marina berths in all prospective villages, where such mechanized artisanal vessels requiring not more than 3m depth could be berthed. Fuel berths could be easily integrated with the marina type floating quays. Such artisanal mechanised vessels could carry enough salt for curing the catches taken over a cruise duration of 12 to 15 days each, in the same way as the SRL (BOBP) vessels fishing from Mangalore and Malpe ports for the offshore larger pelagics like the sharks. Unlike the medium OAL mechanised boats (42'to 57') fitted with 110 hp Ashok Leyland engines, SRL type boats or larger artisanal boats fitted with 23hp Yanmar engines have a potential annual income of Rs 6 lakhs and net profit of Rs 2.5 lakhs as the fuel consumption is only 3 l diesel/hr as against 10 l/hr for the 42'to 57' vessels with 110hp engines. By introducing this programme, the production gap for the midshelf grounds (50 to 200m depth) could be bridged and most of the idling fleet put to active use. Besides, the problems of unemployment, underemployment and economic waste could be reduced.

ii. *Integration of seafarming with seafishing* : The failure to integrate small scale coastal mariculture and seafarming within the small scale marine fishing sector, although the mariculture packages have been developed and made available nearly two decades ago, has led to the aggravation of famine and deprivation during seasons of low catches from capture fisheries. Besides appropriate floating rafts and other devices used in seafarming, the floating marina type berths proposed above may also provide good platforms for integrating seafishing with seafarming.

iii. *Establishment of artificial reefs* : Inshore artificial reefs have been established so far only along the coasts of Trivandrum and Kanyakumari districts (31 reefs) and Chengalput district near Chennai (only 2 reefs). They need to be established throughout the country as in South Korea as an industry by itself, and duly integrated with inshore seafarming to promote productivity and production in the artisanal sector.

2. *Infrastructure:* At present there are only 6 major and 27 minor fishing harbours in the country, all built by the government, but they are not adequate for the landing and berthing of 47,000 small and 180 large trawlers. There is urgent need for the construction of more harbours to cater to the needs of the present fleets and the proposed offshore / oceanic fleets of tuna longliners and purseseiners. Harbours are capital-intensive and therefore setting them up should be decided based on realistic assessments of the potential stocks and fishing grounds and the locations of the new harbours. Since they belong to the core infrastructure, they could be constructed under the " Build, Own, Operate and Transfer "(BOOT) concept of the NEP, by Indian and/or foreign builders, and the cost recovered over a long term through a tax or cess on the users. Privatisation of the fishing harbours, therefore, assumes considerable significance. There are already instances of privatisation of such ventures on "Build, Own, Operate and Maintain" (BOOM) basis in the country and the marine fisheries sector needs to adopt this approach. The 9th plan proposals for new fixed (permanent) harbours could be implemented through this approach. Similarly, the floating berths or quays for the proposed artisanal boat mechanisation could also be established under this concept.

Cold chains, linking all major, medium and small cities and towns in the country could also be planned under the BOOT/ BOOM programme exclusively for fish marketing to facilitate: (a) remunerative prices to the producer of both marine and freshwater fish , (b) elimination of marine fish discards, and (c) availability of fish to the consumer at fair prices.

3. *Deepsea fishing*: Realising the potential for increasing the production from the outer continental shelf, the government of India took several initiatives such as: 1) providing soft loans to the deepsea fishing sector through the Shipping Development Fund Committee (SDFC) (subsequently abolished to establish the Shipping Credit and Investment Corporation of India Ltd, SCICI, which has recently been merged with the Industrial Credit and Investment Corporation of India- ICICI), to acquire deepsea fishing vessels; 2) charter policy to enable the Indian companies to charter vessels from abroad and conduct fishing in the Indian EEZ; this policy was aimed at exposing the Indian entrepreneurs to the developments in the technology of harvesting the deepsea resources and to build up a deepsea fishing fleet for the country, and 3) deepsea fishing policy to promote the exploitation of nonshrimp resources in the EEZ and to induct the latest technologies for resource-specific fishing and value addition. this policy had three components: joint ventures between Indian and foreign companies in deepsea fishing, test fishing by engaging foreign fishing vessels, and leasing of foreign fishing vessels for fishing in the Indian EEZ.

The government of India gave permission for the introduction of about 180 vessels of the 23m to 27m OAL class for operation in the Indian EEZ, but most of them concentrated along the northeast coast to exploit mainly the virgin Sandheads grounds for shrimps. Due to the continuous and excessive fishing pressure, only 120 vessels are operating currently along the northeast and southwest coasts. Sixteen of these vessels (16) have diversified into cuttlefish/squid fishing along the Karnataka and Goa coasts, while most others are either not operating throughout the year due to declining yields and lack of adequate working capital or planning to engage in multipurpose fishing by rigging the vessels with monofilament longlining system for tuna fishing.

The effective implementation of the deepsea fishing policy for nonshrimp resources could have resulted in the harvest of the deepsea and oceanic resources (which offer a total potential of about 1.7 mt), value addition and export, but this policy went into rough weather with all the fishermen associations protesting against the policy and objecting to the operation of foreign vessels in the Indian EEZ. Consequently the government of India constituted a Committee (Murari committee) to review this policy. This committee recommended, among others, the cancellation of all the licences issued under this policy (Anon., 1996c). The government considered this report and finally scrapped the deepsea fishing policy of 1991; however, 11 vessels which were granted licences earlier under the deepsea fishing policy are currently operating in the country's EEZ, but their licences will not be renewed after expiry. This policy has adversely affected the exploitation of the offshore resources, resulting in economic waste, besides poaching by third country vessels.

The Third United Nations Convention on the Law of the Sea (UNCLOS III) provides exclusive opportunities to the

coastal states to exploit the fisheries resources in their EEZs. Under Article 61 of the UNCLOS III, a coastal state must determine the allowable catch of the living resources of its EEZ, which, according to Article 62, the state is obliged to utilise at the optimum level, and if it does not have the capacity to harvest the allowable catch ,it shall, through agreement or arrangement give access to the other states to the surplus of the allowable catch. The absence of the Indian fleets in the outer shelf will entail other coastal states to gain access to the country's EEZ for the exploitation of the unexploited stocks. Therefore, it is essential that the country urgently formulate a policy for the optimum exploitation of its offshore resources.

The medium sized boats of 23m to 27m OAL, presently carrying out trawling for shrimps, are reported to be facing crisis in view of the declining yields resulting in losses and the consequent non-repayment of loans. To prevent these losses, high enough priority deserves to be accorded to diversify fishing by these boats. The Florida type longlining system with 4 mm diameter monofilament is suitable to these vessels as this requires less storing area on the deck in contrast to the polyfilament longlines. Such diversification promotes the exploitation and utilisation of deepsea and oceanic resources. Diversification of fishing by traps in the rocky and coralline grounds for larger perches of high export potential, also needs to be supported.

Tuna longliners of 20 m OAL with 80 t fish-holds and 30 m to 40 m OAL with 200t to 400 t fish-holds should be introduced either through import from countries like Indonesia or through construction in the domestic yards where there is capacity and knowhow. In order to diversify their operations, the Indian companies are interested in tuna longlining in the international waters contiguous to the Indian EEZ and also in the EEZ of island states like Maldives, Madagascar and Mauritius. The vessels could be imported under OGL for 100 % export of the tuna in fresh chilled condition from the Indian ports to the international markets (e.g., Japan) as air cargo.

The lack of harvesting infrastructure and expertise in onboard processing in respect of the offshore resources is the principal bottleneck in developing deepsea sector. Though the country encourages joint ventures in nearly all agricultural and industrial sectors under the NEP, such an encouragement is not available in the marine fisheries sector (*vide supra*). Under these circumstances, in order to build deepsea fishing capabilities and the required manpower over the longterm, an Indian Academy of Seafishing and Seafarming (similar to the Police Academy, Naval Academy) could be established to train the Indian youth in deepsea fishing, onboard processing and open sea mariculture. The candidates passing out from this Academy would provide the manpower required for this sector within the Indian EEZ, third country EEZs and international waters, independantly or jointly with the neighbouring and other developing nations or their groups, for example, the SAARC and the ASEAN groups. Such an initiative would help exploit the deepsea resources on a sustainable level and share the benefits proportionately.

The international community, through the UNO, has finalised an agreement for the conservation and management of straddling and highly migratory fish stocks, and the code of conduct for responsible fisheries of the FAO (Anon., 1995) provides the guiding principles and standards for the conservation, management and sustained development of all fisheries. The code stipulates that members and nonmembers of the FAO, governmental and private agencies concerned with fisheries resources and trade should collaborate in the fulfillment and implementation of the objectives and principles contained in the code. Effective Indian participation in these activities will not be possible if the country does not have a strong offshore fishing industry of its own, independently as well as jointly.

4. Fisheries management : This has to be participatory and based on regulatory measures.

i. Need for implementation of regulatroy measures: In the context of the near optimal or overexploitation of fisheries resources in the 0 to 50m depth zone, there is need for a national policy to effectively implement all the existing and emerging regulatory measures arising from a sound research base, through the willing and active involvement of the fishing community, the industry and the domestic and export trade. Though several suggestions have been made at the appropriate times by the R & D institutions on the adverse effects of indiscriminate exploitation of fish stocks, management in the marine fisheries sector has not been satisfactory. The shrimp-oriented capture fishery development has been primarily responsible for the present situation of indiscriminate exploitation in the inshore grounds. The emergence of the fleet of ringseiners and minitrawlers operated from the motorised traditional craft, the steady growth of the purseseiner fleet and the conspicuous reduction in the mesh size of the bunt of the purseseines and ringseines along the southwest coast and the trawl codend have further aggravated the problems of both growth overfishing and recruitment overfishing of the smaller pelagic and demersal stocks.

The demand for even small shrimps in the export market and the growing demand for the seed of cultivable shrimps for aquaculture have resulted in their indiscriminate exploitation in the bays, backwaters and creeks using small meshed gears, together with heavy landings of the young ones of various finfishes. Such practices have made fisheries management in the inshore waters extremely complex (Rao and Murty, 1993). Greater attention needs to be focussed on this important issue through appropriate extension activities involving the state governments and by motivating the fishing industry and the community towards speedier adoption of the prescribed measures of management. The media, extension literature in local languages and video shows in fishing villages should be used effectively to bring about the required changes in the attitude of the fisherfolk.

ii. Need for participatory management: Several organisations are engaged in marine fisheries R & D, but for various reasons, data exchange and use for a common national cause is not effective enough. The National Marine Living Resources Data Centre (NMLRDC) functioning in the CMFRI is consolidating data of the last 50 years on various aspects of marine fisheries from both primary and secondary data sources and inputs from various central and state agencies. The quality of this database needs to be constantly improved and the results of analyses brought out regularly. Working groups comprising representatives of fisheries departments, research institutions, fishermen organisations and trade could identify the outputs required from this database for specific purposes of, say, investments, optimisation, regulation etc.

A large number of species exploited by the Indian fleets in the Indian EEZ are also exploited by the fleets of the other countries bordering the Indian Ocean in their respective EEZs. To make data exchange feasible among these nations and to formulate measures for their rational exploitation, the establishment of an international agency (e.g., of SAARC countries) involving representatives from the scientists, development officials, industry and trade from all participating countries bordering the Indian Ocean could be considered. Such an initiative will be very timely in addressing marine fisheries research, development and management needs effectively in the South Asian region as a whole. Elsewhere in the world (e.g., ICES for the North Sea fisheries) such agencies are successfully functioning actively assisting in fisheries development and management.

5. Database: There is need for a strong database on marine capture fisheries and its continuous updating for information on regionwise, depthwise and specieswise (groupwise) catch and effort, discards at sea, cost and price of various fishery products, the population characteristics particularly the changing stock sizes and the optimum yields therefrom, the demographic profile of the fishing community, the structure of the fishing industry (artisanal and industrial), trade (domestic and export) and the infrastructure in the production and post-harvest sectors. There are several government organisations equipped with these data. The industry does not furnish the information on fishing effort and catch. Though the NMLRDC is located in the CMFRI, the data inflow is almost totally absent for various reasons, particularly due to lack of obligatory linkages.

In most of the developed countries, there is a regular system of collection, processing and utilisation of statistics of landings and economics for research leading to better estimates of stocks and effective implementation of regulatory measures including ban on fishing in particular areas and/or seasons, allocation of particular sea areas for different categories of resource users and for fixing catch quotas. The fishing industry should be persuaded to furnish fishing logs of commercial vessels to help build up the database in addition to the ongoing system of data acquisition based on the random sampling methods in vogue for the last 50 years. In order to improve the quality of the data, proper proforma for fishing logs should be framed in consultation with the fishermen, boat owners, traders and government organisations. Many developed countries have made it mandatory on the boat owners to furnish fish landing and effort data to the governments in the form of log sheets resulting in considerable saving on account of the otherwise laborious and expensive data collection tasks. Noncompliance of the fishing industry to maintain and make available the fishing data in log books is primarily due to the lack of appreciation of its value among the concerned, besides social and political reasons. There is also a general lack of appreciation of the importance of research and its dependence on sound database. The need for the adoption of a viable model of sound data-based fisheries management, requires to be impressed upon the various government agencies, industry and the fisherfolk.

The collection of landing and effort statistics from all along the country's coast following the CMFRI's Stratified Multistage Random Sampling Scheme should be continued effectively as it is very basic to the formulation and implementation of management measures. However, for various reasons and apparently due to the lack of recognition of its importance, proper funding support is not extended to this programme. Moreover, several state governments are collecting these statistics through their own sampling designs which may not be compatible with the CMFRI design. One national agency (e.g., CMFRI) could be entrusted with this responsibility, actively assisted by the state agencies like the departments of fisheries. Demographic and socioeconomic profiles of the marine fishing industry through quinquennial surveys of fisherfolk population, their households, landing centres, craft, gears and other capital infrastructure also constitute essential inputs to this database.

6. Coastal mariculture and seafarming: A recent report of the consultative group on international agricultural research states that within the next 15 years, fish farming and searanching could provide nearly 40 % of all fish for the human diet and more than half of the value of the global fish catch. According to a report of the FAO, the world aquaculture production is projected to increase by 2.69 times by 2025 AD, growing from 19.3 mt in 1992 to 26.9 mt in 2000 AD and to 51.8 mt in 2025 AD. Marine fish production by farming is expected to increase from 0.36 mt to 1.0 mt, crustaceans from 1.0 mt to 4.1 mt, molluscs from 3.5 mt to 8.9 mt and seaweeds from 5.4 mt to 9.8 mt. With these optimistic projections, India as a leading country in Asia in aquaculture production, should be able to achieve atleast a production of 2mt (0.1 mt finfish, 1.0 mt crustaceans, 0.3 mt molluscs and 0.6 mt seaweeds) through mariculture by the year 2025 AD, i.e., 3.9% of the projected global aquaculture production of 51.8 mt. With improvements in the domestic marketing, diversification of marine products exports, availability of a vast range of cultivable candidate species, several culture technologies and hydroclimatic (or agroclimatic) zones for coastal mariculture and seafarming, India is poised to become one of the world's leading producers of mariculture products.

Issues related to Coastal Regulation Zones (CRZ), Integrated Coastal Zone Management (ICZM) and the proposed Ocean Regulation Zone (ORZ) and the unfounded apprehensions that coastal mariculture would adversely affect the environment, are leading to unnecessary or avoidable litigations retarding the growth of the mariculture sector. This difficulty, however, would be got over after the likely passage of the Aquaculture Bill in the ensuing Parliament session (Winter session of 1998), or the next and after the recently constituted Aquaculture Authority gains strength to function and perform seriously and genuinely. The current totally shrimp-oriented, land-based coastal mariculture has resulted in the underutilisation of the technologies developed for the culture of bivalves, seaweeds and pearls, and hence requires to be diversified and broad-based to take maximum advantage from the high production potential of tropical aquaculture farms.

Out of the 1.2 million ha of brackishwater areas available for shrimp culture, only 10% is utilised. There is also urgent need to manufacture fish and shrimp feeds on a large scale with cooperation from countries having the expertise, utilising the provisions of the NEP. Recently foreign companies like the CP Aquaculture and Higashimaru feeds have set up

commercial feed mills at Chennai and Sherthalai (near Cochin) respectively. Simultaneously, indigenous feeds like the CMFRI's Mahima shrimp feed should also be promoted through intensive onfarm trials. In view of the shortage of products of animal proteins like fish meal, its replacement with vegetable protein products deserves consideration in the indigenous formulations. The outbreak of diseases in coastal shrimp culture systems has resulted in near total mortality of the crops and hatchery seed in some farms in recent years. The prevention, diagnosis and cure of diseases in different culture systems have not received the required attention due to the existence of only very few well-equipped laboratories and limited expertise. The desired expansion of research on physiology, nutrition, pathology, genetics and endocrinology of cultivable species, matching with the growing needs for technologies for maturation, breeding , strain development, feeds and integrated disease management has not yet taken place. These areas of research need to be supported through the NEP.

7. Marine biodiversity: India is blessed with vast regions of mangroves along the coast of West Bengal, Orissa, Andhrapradesh, Tamilnadu, Maharashtra, Gujarat and the Andaman islands with a total area of about 682,000 ha. Coral reefs are found in the Gulf of Kutch, along the Maharashtra coast, Kerala coast, in the Gulf of Mannar, Palk Bay and the Wadge Bank along the Tamilnadu coast and around the Andaman and Lakshadweep islands. These regions support very rich fauna and flora and constitute rich and varied floral and faunal assemblages. The coastal areas all along the country's coastline are rich in biodiversity. Most of these regions face grave threats due to increasing human intervention characterised by pollution, deforestation, indiscriminate exploitation, dredging, quarrying, and other activities leading to environmental degradation, which in turn affects biodiversity. After the 1992 Rio UN Conference on Environment and Development (UNCED), increasing attention is being paid to protect biodiversity all over the world.

The ability to address the needs of biodiversity conservation and protection depends largely on the knowledge of taxonomy of the flora and the fauna constituting the biodiversity, the species interactions and ecology. Devaraj (1996) dealt with this subject in considerable detail and suggested measures for the protection and conservation of marine biodiversity in India. Lack of encouragement to basic research in general and taxonomy in particular in recent years has resulted in the shortage of expertise even in the case of major marine organisms like finfish, leave alone other organisms like coelenterates, sponges, echinoderms and others.

Sponges, gorgonids, corals, pipefishes and others are being exploited for the extraction of drugs which are known to cure several diseases. While there are reports of overexploitation of certain of these resources, there are also reports of environmental degradation due to anthropogenic influences. Certain fragile and sensitive ecosystems, will not be available to the posterity if adequate care is not taken now. In order to achieve improved returns while protecting the environment, a suitable policy needs to be formulated to exploit the resources on sustainable levels, to extract the drugs indigenously, basically for domestic use and for limited export. There is a natural urge for intensive exploitation of exportable commodities, but the country cannot lose sight of the need to protect biodiversity and meet domestic requirements in its bid to increase foreign exchange earnings.

8. Manpower development: The complexities of tropical marine fish stocks and fisheries necessitate specially trained manpower to carry out the various R&D and commercial tasks of capture fisheries and mariculture. Some fisheries research institutes under the ICAR, fisheries colleges and many academic universities are conducting masters and doctoral programmes in various disciplines of fisheries science including mariculture since the late seventies. However, greater emphasis on applied research has led to the neglect of basic research in areas like taxonomy resulting in the acute shortage of taxonomists. We need to establish schools of taxonomy in fisheries research institutes to carry out biodiversity as well as to undertake the required HRD by expanding the present educational base by introducing additional programmes on biodiversity, taxonomy, capture fisheries management, fisheries oceanography, fishing technology, fish processing technology, aquaculture practices, aquaculture biotechnology, aquaculture genetics, aquaculture nutrition, aquaculture pathology, aquaculture physiology and aquaculture endocrinology in order to meet the growing demands for these cadres in all the R&D and commercial activities of fisheries and aquaculture activities. Training of Indian scientists in well- established laboratories in the U.S.A, Japan, U.K and other countries in these disciplines requires priority consideration in the light of the NEP. The current efforts of the Ministry of Environment & Forests, government of India at launching a long term national project on taxonomy and biodiversity are expected to lead to many fruitful results in the years to come.

9. Marketing: Postharvest fisheries activities including processing, product development, transport and marketing provide greater employment to labour than the harvesting sector. As the demand and price of fish keep continuously increasing in the domestic and export markets, the opportunities for the above activities also keep growing. Fresh fish, once inaccessible to distant locations till a few years ago, are now easily available due to the vast improvements in handling technologies coupled with fast transportation and consequent market penetration. Thus, fish marketing, to a large extent, has been made pragmatic enough to facilitate satisfaction of existing and potential demands. (Sathiadhas and Narayanakumar, 1994). However, the infrastructure for fish marketing in India is still principally oriented towards the export market.

The fishermen's share in the consumer's rupee is the best index to measure the efficiency of the fish marketing system. Marketing studies at the all-India level indicate that the fishermen's share in the consumer's rupee ranges from 30% to 68% for different species/groups of marine fish (Table 1 at P. 26). Marketing costs including transportation range from 6% to 13% of the consumer's rupee. The wholesalers receive 5% to 32% and the retailers from 14% to 47% of the consumer's rupee for different species/groups of marine fish. Statewise analysis indicates that the fishermen in Gujarat receive 37% (catfish) to 83% (ribbonfish) of the consumer's rupee while in Maharashtra, it ranges from 36% (sharks and barracudas) to 81% (seerfish). They receive the highest share for cephalopods (71%) in Karnataka and Kerala, for big jawed jumper (67%) in

Tamilnadu and for sardines (58%) in Andhrapradesh (Table 2 at P.27). In certain production-cum-consuming cities, the role of the middlemen traders has put both fishermen and the cities' consumers to the greatest disadvantage. A new beginning is now being made by the fishermen to group themselves into associations which will take up not only fishing, but also selling the catches directly to the consumer so as to benefit themselves and the consumer by eliminating the middleman traders. It is, however, feared that this step may have the potential danger of the middlemen revolting against the system and attempting to sabotage it by some means or the other.

In the internal marketing system, marine fish sales used to be mostly confined to the coastal and adjoining regions in the past. Currently, about 50% of fish is consumed fresh in and around the producing centres, 43% in the demand centres located upto a distance of 200 km from the coast and only 5% in the centres located beyond 200 km (Sathiadhas *et al.*, *1994*). There is enormous scope for improving the distribution process through enhanced private investments in the preservation, processing and transportation sectors of the internal marketing system under the liberalised economic policies. There is vast potential for marketing hygienically processed and packed dried fish in our domestic hinterlands and canned fish in cities and defence establishments (Devaraj, 1987). The quantity of about 30% of the total landings which are processed after they become unsuitable for fresh consumption, suggests good scope for market development of value-added products for domestic consumption.

Marine products exports from India yielded foreign exchange worth Rs. 4697 crores from the export of 380,000 mt during 1997-98. This is an incredible achievement with the fabric of the fishing industry undergoing rapid transformation over the last three decades, contributing substantially to the economic development of the country. However, the achievements in exports and forex earnings do not appear to be due to the country's competitive export marketing strategy, but mainly due to the ever increasing international demand for marine products. In the process there are apprehensions that India became a passive supplier of marine products to foreign traders, underutilising the potential export markets.

The seafood industries in the developed countries concentrate on mass production of processed ready-to-eat or ready-to-cook items. The demand for items for instant cooking, baking, grilling, frying and microwaving (convenience food items) is increasing in the developed countries. So far, India has been mostly supplying frozen seafoods which are reprocessed by the importing countries. As a result, the importing countries realise higher profits than India. Export of value-added products not only enhances the country's foreign exchange earnings, but also generates substantial employment. By adding value to about 10% of the seafood presently exported in bulk form, our export earnings can be increased by another Rs 400 crores. (Anon., 1997) The export of surimi-based products and pasteurised crab meat to Japan offers immense scope for further development. Three processing plants, two for surimi-based products at Ratanagari (Maharashtra), Veraval (Gujarat) and one at Visakhapatnam (Andharapradesh) and the other for pasteurised crab meat at Kottapatnam (Tamilnadu) have been started recently. Depending on their performance, such plants need to be further promoted. The export of live items is gaining momentum and it should be further encouraged. The NEP will provide sufficient boost to private investment for modernising the seafood industry. All the trade promotion delegations and international fairs should be combined with an overseas market survey and adequate care taken to include the scientists also in these delegations to enable adequate situation analysis and develop suitable strategies for increasing the export earnings. Production of value-added products is highly capital intensive and requires sophisticated machineries and improved processing and packaging technologies which are currently insufficient in India. Hence, there is good scope to establish such units in India in collaboration with foreign concerns which have expertise in this field for the promotion of both the external and internal fish marketing in the country. Owing to the failure of India to meet the quality standards stipulated by the

Table 1. Distribution (%) of consumer's rupee for different varieties of marine fish during 1996-97

Name of fish	Share of			
	Fishermen	Handling & transportation	Wholesalers	Retailers
1. Seerfish	68	6	12	14
2. Pomfret	60	7	9	24
3. Barracudas	40	9	30	21
4. Tunas	45	9	28	18
5. Sharks	43	10	32	15
6. Catfishes	56	10	10	24
7. Mackerel	50	9	11	30
8. Sardines	33	12	23	32
9. Ribbonfishes	48	10	12	30
10. Rays	47	13	22	28
11. Whitebaits	40	12	28	20
12. Lizardfishes	35	12	15	38
13. Goatfishes	57	13	16	14
14. Threadfins	42	9	20	29
15. Croakers	48	11	14	27
16. Silverbellies	30	15	8	47
17. Big-jawed jumper	55	10	9	26
18. Mullets	41	9	17	33
19. Half & full beaks	65	9	10	16
20. Cephalopods	65	10	5	20

Table 2. Fishermen's share in the consumer's rupee for selected varieties of fish in different maritime states during 1996-97.

Name of fish	Gujarat	Maharashtra	Karnataka	Kerala	Tamilnadu	Andhra Pradesh
		Percentage share to fishermen				
1. Seerfish	71	81	40	65	49	49
2. Pomfrets	64	68	46	43	51	53
3. Barracudas	-	36	55	53	54	24
4. Tunas	63	43	-	51	60	36
5. Sharks	45	36	40	63	60	17
6. Catfishes	37	76	35	58	63	33
7. Mackerel	50	50	33	50	55	26
8. Sardines	60	57	54	43	63	58
9. Ribbonfishes	83	60	41	37	55	36
10. Rays	-	-	-	30	57	40
11. Whitebaits	-	-	33	26	48	22
12. Lizardfishes	44	43	31	30	53	36
13. Goatfishes	-	-	-	60	60	42
14. Threadfins	43	-	-	-	53	23
15. Croakers	56	45	38	31	63	27
16. Silverbellies	-	-	-	35	32	21
17. Big-jawed-jumper	-	-	60	45	67	44
18. Mullets	-	45	42	59	46	38
19. Half&fullbeaks	-	-	-	61	65	-
20. Cephalopods	63	75	71	71	51	44

European Commission, the EC had (July 1997) threatened India with stopping its marine products imports into the EEC countries (but later relented), thereby forcing the country to sell about 20 % of its products for some time in other countries at noncompetetive prices. Therefore, India needs to step up its quality vigilance and compliance to reach the required international standards immediately.

MPEDA is the nodal agency in the country to develop markets for export and to facilitate approval of licensing of offshore fishing. A cautious marketing policy giving equal importance to domestic and export needs should be framed and launched. In the context of the liberalised economic policies, the domestic consumer should not be deprived of fishery commodities at affordable prices, due to the excessive emphasis on exports. Marine products which are capable of fetching the highest competitive price in the international markets alone should be diverted for export and the rest channelised into the domestic market including the vast hinterlands, together with the freshwater fish. Product diversification and domestic market development should be accorded high priority in our export and internal fish marketing. Export of more and more value-added products, competitive selling rather than passive supplying of our products and strategic market expansion would fetch maximum foreign exchange from marine products.

In view of the fact that only 25% of the capacity of Indian fish processing plants is being utilised, it is necessary to consider import of raw materials for processing and export. In order to circumvent the problems of shortage of power and water to the processing plants, centralised facilities to ensure sustained supplies of power and water to all the plants located in vulnerable areas have been proposed and one such centre each in West Bengal and Kerala is likely to come up soon with assistance from the Ministry of Food Processing Industries, Government of India.

10. Information technology and networks: In order to keep pace with the global developments in the R&D of capture fisheries and mariculture, greater use of computers and information networks should be facilitated. The provision of modern computer and communication facilities under MARSIS (by the NRSA-DOD) AND ARIS (by the ICAR) in the recent years is a step in the right direction, but these require to be expanded.

11. Linkages and working groups: Marine fisheries research, development and trade are administered through four different central ministries: (1) the Ministry of Agriculture in the Departments of Animal Husbandry and Dairying, Agricultural Research and Education and the ICAR institutes, (2) the Ministry of Food Processing Industries (3) the Ministry of Science and Technology in the Department of Ocean Development, Department of Biotechnology and Department of Science and Technology and the CSIR laboratories like the NIO, and (4) the Ministry of Commerce together with the Marine Products Export Development Authority (MPEDA). At the state level, the fisheries colleges of state agricultural universities, some academic universities, the fisheries departments, fisheries corporations and the Brackishwater Fish Farmers Development Agencies administer the R&D activities of the fisheries sector. There is

need to establish Sea Farmers' Development Agencies (SFDA) in each coastal district for the speedy adoption of mariculture technologies. The lack of mandatory linkages among these different organisations is preventing free flow of data and knowledge resulting in the underutilisation of information, and in some instances, duplication of effort. Therefore, working groups comprising representatives from the concerned ministries and organisations should be constituted, defining their respective roles and responsibilities to bring about coordinated functioning and progress in the sector.

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