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# **Sustainable Fisheries and Aquaculture for Nutritional Security**



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## **Introduction**

Feeding seven billion people on earth through agriculture in an environmentally sustainable manner has posed a major problem. Based on the current demographic trend, the world population is projected to reach 9.4 billion by 2050 and Indian population 1.5 billion. Though living resources are self-renewable, they have to be utilised rationally on a sustainable basis in harmony with the environment. Hence, scientists all over the world are exploring the possibility of using water as a major source of food production. Seawater is a rich and cheap medium for aquafarming. Moreover, the mechanism of production of organic matter in the ocean is more efficient than that on land. In terms of productivity, slow-growing angiospermous plants cannot match with rapidly multiplying planktonic algae.

Aquatic resources of India are vast and diversified. The marine jurisdiction alone spans 2.02 million km<sup>2</sup> (EEZ) and the coastline stretches to a length of 8,129 km. Among lagoons and backwaters, the Chilka, and Vembanad alone cover an area of 800 km<sup>2</sup>, and estuaries spread over 300,000 ha. The potential brackishwater area available for aquaculture is 1.4 m ha. Replenishment and creation of water bodies through Southwest and Northeast monsoon in India are nature's gifts. The river system of the country comprises 14 major rivers (catchments > 20,000 km<sup>2</sup>), 44 medium rivers (catchments 2,000 to 20,000 km<sup>2</sup>) and innumerable small rivers and desert streams that have a drainage of about 2,000 km<sup>2</sup>. Different river systems of the country, having a combined length of 20,000 km, provide one of the richest fish genetic resources in the world. India has 19,134 small reservoirs with a total water surface area of 1,485,557 ha; likewise, the medium (180) and large (56) reservoirs spread over 527,541 and 1,140,268 ha, respectively. Thus, the country has 19,370 reservoirs covering a total area of 3,153,366 ha. Hence, scientific utilisation of the vast and diverse aquatic resources should immensely benefit us, especially in the food production sector.

Fish production in our country has increased by more than five times, and the contribution of fisheries to the GDP of India has also increased three times, a growth, arguably, one of the highest among the food production sectors.

The success in induced breeding of carp in 1957 and subsequent technologies on induced breeding and larval rearing for a number of species of carps, paved the way for the current annual freshwater carp production of > 1 million metric tonnes.

The Central Marine Fisheries Research Institute (CMFRI, Kochi) developed the hatchery technology of penaeid shrimps during 1973-1978 followed by commercial scale production of PLs started by MPEDA in the late eighties helped the country to export farmed shrimps worth > \$ 1 billion in 1999-2000.

Hatchery and mariculture technologies for the pearl oyster, edible oyster, mussels and clams have also been developed in the country. Of these, pearl culture and mussel culture have made significant impacts among the entrepreneurs and fishermen.

Fisheries scientists have designed a high opening trawl net with the help of gear experts in India. The design has revolutionised the capture fisheries' sector. In two decades, all the trawlnets (150,000 in number, in 1998) in the country are of high opening type. They are responsible for an annual fish harvest of > 1.2 million mt. These developments have paved the way for what is hailed as the 'Blue Revolution' or 'Aquaplosion' in India.

Marine fisheries production increased from 0.5 million mt in 1950, to 2.7 million mt in 1999. However, the scope for its further increase is limited. During the corresponding period, the inland fisheries production also increased from 0.2 to 2.5 million mt, despite declining riverine fish production. A progressive increase in inland fisheries production has been possible owing to the development of eco-friendly, culture-based fisheries. There is scope for its further improvement.

Per capita fish availability to an average Indian is about 9 kg, less than the world average (12 kg), and the quantity (11 kg) recommended by the WHO for nutritional security. In India, aquaculture activity was ventured first by the farmers of West Bengal and later, in Andhra Pradesh. With 30 billion USD, investment on global aquaculture by 150 countries, which practice aquaculture, and with more than 10 per cent annual growth rate, contribution to fish production through aquaculture is in the range of 36 million mt, worth \$ 50.4 billion and Asia's share to this production is 91 per cent. In India, about 100,000 ha have been brought under aquaculture during the last decade to produce about 82,000 t shrimps by small and medium farmers, with the necessary hatcheries and processing plants at a total investment of about Rs. 70,000 million. Unfortunately, our coastal aquaculture has begun to suffer even at the very early stage due to its failure in diversifying candidate species and system and having no regulations for sustainable development of coastal fish farming. Following the directions of the Supreme Court, the Government of India has constituted the 'Aquaculture Authority', whose main function is to give approval to farmers to operate traditional and improved traditional systems of aquaculture with improved technology for increased fish production.

Asia has been the centre of fishing and aquacultural activity. Among the Asian countries, India ranks second in culture and third in capture fisheries. More than 6 million fishermen and fish farmers of India depend on fisheries for their livelihood. About 5.6 million mt of fish and edible invertebrates worth Rs. 2,22,000 million are now captured or cultured. Our annual fisheries export is 0.4 million mt worth 1.2 billion USD. Thus, the fisheries constitute a highly productive sector, a source of valuable food and employment, and a net contributor to the national income.

The export earnings substantially increased from Rs. 25 million in the 1950s to Rs. 52,000 million in 2000. There has been a shift in export from low value fish and fish products towards the high value products. For instance, export of finfishes decreased from 99 per cent of the value during 1940-1946 to 12 per cent during 1990-1994, but that of high value shrimps and cephalopods increased to 72 per cent and 12 per cent, respectively. Also, the export pattern shifted from dried, salt cured and canned products to frozen products/live organisms.

These issues were examined carefully at a national seminar organised by the National Academy of Agricultural Sciences. Recommendations, emerging out of the deliberations held at this seminar are summarised below.

## **Policy Recommendations**

### *1. Policy and Legal Issues*

- The instrument on fisheries' policy was first devised in 1898 and has undergone only peripheral modifications since then. It is, therefore, necessary that the Government of India formulates a new fisheries' policy taking into consideration the need for increasing sustainable fish production. Incidentally, the MPEDA Act, 1972 and a few other Acts of the central and state governments are obsolete in the present context of new developments; they all need revision with proper amendments.
- India is one of the wettest countries in the world. The average rainfall of the country is 117 cm per annum. The potential of the Indian river basin is 1,869 billion cubic metre, equivalent to 66,000 tmc but the utilised water flow, excluding that of groundwater is 24,367 tmc only. Hence, the unutilised water resource remains as high as 41,637 tmc. Even in penninsular India, which is relatively dry, the level of unutilised water is quite high, viz. 8,637 tmc. Water is the most precious commodity, essential to sustain domestic, agricultural (including aquaculture) and industrial activities, but its per capita availability will progressively decrease from 2,200 m<sup>3</sup> in 1998 to 1,500 m<sup>3</sup> by 2025. Hence, there is an urgent need that the National Water Research Council takes into consideration the requirement of fisheries sector to promote fisheries and aquaculture development and conservation of aquatic resources. All efforts should be made to utilise the sheltered bays for mariculture. This will require an enabling conducive policy and creation of basic facilities and essential inputs.
- In recent years, increasing attention is being paid to the environmental problems of the coastal areas. India too has exercised its powers under Section 3 (1) and 20 (v) of the Environment (Protection) Act, 1986, through a legal instrument called the Coastal Regulation Zone (CRZ) Notification, February, 1991. The CRZ Notification of up to 500 m from the high tide line with the landward boundary has inherent weakness. For a country like India, with diverse physiography, development needs and urban concentrations, a common regulation for the different maritime states is not realistic and desirable. Hence, there is need to evolve scientific policies and legal framework for supporting coastal and opensea aquaculture, particularly on the following critical aspects: carrying capacity of coastal and marine ecosystems of different areas, quantity and impact of groundwater abstraction for shrimp culture, extent of conversion of agricultural lands and impact of untreated wastewater from shrimp farms.

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\* *Seminar on Sustainable Fisheries and Aquaculture for Nutritional Security at Chennai from 29th November to 2nd December 2000.*

The present Environmental Protection Act, 1986 and Rules February 1991, may have to accommodate the coastal aquaculture in the CRZ and declare aquaculture as a permitted activity requiring water front facilities. Coastal aquaculture should be integrated with other activities of the coastal region.

## 2. *Financial Support*

- There is a justifiable claim for increasing financial support for further development of the fisheries sector. Firstly, the projected increase for the production targets for the next decade in India, is in the range of 22-28 per cent for cereals but 100 per cent for fish. Secondly, the contribution of the fisheries' sector to the GDP of India has increased from 0.7 per cent in 1980-81 to 1.4 per cent in 1999-2000, compared to stagnation of the agricultural sector to the total GDP at 28.7 per cent. Consequently, the contribution of fisheries to the GDP of the agricultural sector has increased substantially from 1.97 per cent to 5.35 per cent. Yet, the government investment in the fisheries sector is stagnating at a mere 0.35 per cent of the total plan outlay through the five year plans, compared to the substantial increase from 1.74 per cent to 5.49 per cent in the agricultural sector. Therefore, the fisheries sector deserves better recognition and greater investment for its growth and sustenance.

## 3. *Capture Fisheries*

- The scope for increasing capture fisheries' production from the coastal waters is limited. To sustain its present level, which contributes 50 per cent of the total fish production in India, we will have to concentrate on resource enhancement programmes such as sea-ranching and eco-friendly mariculture. Effective implementation of fishing regulations also will have to be given priority. A rational approach to match the fishing capacity with maximum sustainable yield has to be evolved. There is also a need for a scientific introspection on practicality and efficacy of the Marine Fishing Regulation Acts. It is necessary to create a Fishing Regulatory Authority with powers of implementing sustainable fishing. This authority should be bestowed with legal powers.
- Contributions from inland fisheries to India's total fish production increased from 25 per cent in 1950, to 46 per cent in the 1990s. Despite declining riverine fish production, there is substantial increase due to development of culture-based reservoir fisheries. But the Indian reservoirs produce much less than their potential; their productivity can be increased to three million mt. There is need for an action plan to develop appropriate model for determining management parameters, such as stocking density, stocking size, size at capture and species selection. Though they are highly productive, we know very little about our wetlands and beels; their development in the Northeast is strategically important. Management norms for the upland lakes are virtually non-existent. A master plan is required for the development of fisheries in wetlands, beels and upland lakes.
- Suitable strategies for exploiting oceanic tunas and Antarctic krill need to be developed soon.

#### 4. *Aquaculture*

- Aquaculture is the fastest growing enterprise within the agricultural sector. Global aquaculture production increased from 15.5 to 36.0 million tonnes during the years 1988-1997, indicating an annual increase of 11 per cent. The level of increase in aquaculture production is likely to remain high for quite sometime in the future, while other water- and land based food production systems are reaching their limits. However, aquaculture is more complex than agriculture/animal husbandry, owing to diversity of taxonomic groups and unfamiliarity of the environment/medium to the cultivator. China harvests 67 per cent of the world aquaculture production, while India's contribution is stagnating at 6.2 per cent. Unlike China, diversification of aquaculture in India is relatively poor. Even though production is less than half that of India, Japan (4.37 \$/kg) and Indonesia (2.75 \$/kg) fetch higher value for their products compared to 1.11 \$/kg of India. Hence, diversification of candidate species for aquaculture in India has to be judiciously manoeuvred. Of 297 species cultured, 53 per cent are fishes, 15 per cent crustaceans, 27 per cent molluscs and 5 per cent seaweeds. India claims to have mastered the technology of aquaculturing 15 species, whereas as many as 39 and 52 species are profitably cultured by China and Korea, respectively. The need for diversifying taxonomic species and aquaculture systems is obvious to increase cumulative aquaculture production, enhance value for produced fish. Sustainable aquaculture system can be developed in harmony with the physico-chemical and biological environment as well as the socio-economic environment involving other sub-sectors/sectors, namely fishing, agriculture, forestry, tourism, public health and housing among others, ensuring protection of all the stakeholders involved. Aquaculture thus, would be part of a total sphere development, as envisaged in integrated rural area development or coastal area management.
- Being basically a small scale enterprise, freshwater aquaculture provides for the domestic food security of rural India. This sector has undergone due intensification and diversification. Likewise, brackishwater aquaculture is a highly promising sector and about 1.4 m ha of potential brackishwater area is available for farming in the country, of which less than 10 per cent area is under cultivation to produce 82,000 tonnes. Its productivity is low (800 kg/ha), in comparison to that of Thailand (2,500 kg/ha). There are 226 shrimp hatcheries with a capacity of 10.5 billion seedlings. There is an urgent need to have a uniform leasing policy. To boost aquaculture of inland, brackishwater and marine organisms, a scientific policy of leasing water bodies will have to be formulated to utilise them rationally and legally. There is also need to provide the required infrastructural facilities such as seeds, finance by the NABARD and aquaculture insurance scheme. Since, recycling freshwater will become increasingly important in the years to come, policy guidelines must be framed for mandatory provision of depuration ponds in farms undertaking sewagefed fish culture.
- Total feed requirement for carp farms of Andhra Pradesh alone is 200,000 t but only 35,000 t is produced by our feed mills. Hence, there is a gigantic need to increase commercial production of inexpensive, balanced feeds for finfish and shellfish. To encourage establishment of larger fish-feed industries, the aquaculture feed industry must be granted a status of parity with poultry and cattle-feed industries, and given a

waiver and/or tax concessions, as enjoyed by other feed industries. Regulation devised for other feed industries may also be imposed on the fish-feed industries to ensure quality control of the products. When formulating standards for quality monitoring, the following must be considered: (i) particle and pellet size, (ii) fibre content, (iii) water stability, and (iv) the permitted levels of steroids, antibiotics, pigments. Specialised fish-feed plants have to be encouraged to provide sectoral development of aquaculture feeds.

- A major constraint to the development of aquaculture is the loss caused by microbial diseases which inflict heavy mortality. The loss due to such disease problems in Asia has been estimated to be several hundred million dollars. To contain microbial diseases, early detection of pathogens is very important. Molecular techniques for early and rapid detection of pathogens are being developed in India. Diagnostic laboratories with facilities for rapid detection of pathogens by molecular methods, such as PCR should be set up in all the fisheries colleges of India. Farmers should have easy access to these laboratories to get the desired diagnosis, medicine and suggestions at subsidised cost, as is being done for livestock animals.
- Intense anthropogenic activity and heavy load of pollutants have driven several aquatic organisms, especially commercially important fishes to the status of threatened/endangered species. There is a need to prioritise species and aquatic habitats for conservation. Financial support for research on cryopreservation of fish sperm and cell-lines has become of paramount importance. Training and capacity building for fish taxonomy and genetics merit support on priority basis. With regard to exotics and related issues, more research attention has to be given to mitigate their negative impacts.
- Greatest emphasis and financial support must be given to the post-harvest technology. On the global basis, around 27 per cent of the harvested fish are being discarded as bycatch. The proportions of discards are also high in India. Larger trawlers should be provided with additional storage facility for the bycatch of low value fish, or they should have an installed plant, that would process about one mt bycatch per day for fish meal and fish oil. This installation must be encouraged and subsidised.
- A survey conducted at different fish landing centres, clearly indicated that five per cent of the landed fish is of unacceptable quality. Hence, fishermen should be encouraged to carry ice on board to preserve the harvest. There is a need to create an awareness among fishermen and processors about the need for hygienic handling of the harvested fish. The traditional bamboo basket must be replaced by insulated container. The fish can be carried to the urban consuming centre in good condition within four hours after harvesting. Transport by air, where required, should be encouraged and subsidised.
- Fish is a highly perishable commodity; the processes responsible for its decomposition are autolysis, bacterial spoilage and oxidative rancidity. These processes can be retarded effectively by chilling with ice. Radurisation is an irradiation process for extension of shelf life of fresh fishery products in ice or under refrigeration by reducing the number of spoilage bacteria. The major benefit of the

application of radiation in fishery products is in the reduction of post-harvest losses and improving the hygienic quality. Recognising the technoeconomic advantages, 40 countries including India have permitted such radiation treatment. It is recommended that irradiation facility be established by the government at least in two strategically important landing centres in each maritime state, each installation at the minimum cost of Rs. 75 million.

- Long-chain polyunsaturated fatty acids present in fish and fish oils have several positive health benefits during different stages of human life—conception, growth and development, and prevention of diet-related chronic diseases. Iron deficiency is the most common micronutrient disorder. This problem is most severe in India, where 88 per cent of pregnant women are anaemic. Eating fish 1-2 times/week before conception, during pregnancy, lactation and breast feeding will significantly contribute to the growth and development of babies and ensure good health of both mothers and babies. The public should be made aware of the health benefits of fish-eating habits.

#### 5. *Fisheries Education and Research Publications*

- Qualified and trained manpower is a critical input for sustainable fisheries development. Fisheries education had a late start in India. Till the sixties 'fisheries' education was confined only to a special paper in postgraduate programmes, in disciplines like zoology in some universities. Under the State Agricultural University (SAU) system fisheries education the first College of Fisheries was established at Mangalore under the auspices of the University of Agricultural Sciences, Bangalore, in 1969.
- A four-year degree course in fishery science is offered in 11 colleges to train about 300 students. Two-year-postgraduate and doctoral degree courses are offered only at 8 and 6 institutions, respectively. About 150 and 50 candidates secure their M.F.Sc. and Ph.D. degrees from these respective institutions annually. Unfortunately, 28 per cent of the sanctioned faculty positions lie vacant in these colleges. The Education Division of the ICAR must devise a method to make the vacant positions filled by the respective colleges. As over 18 per cent of the sanctioned scientific and technical positions are vacant in the eight national fisheries institutions, many qualified fisheries graduates remain underemployed or unemployed; the government should give consideration to these nascent institutions to grow by filling the vacancies. There is a need for colleges of fisheries to establish linkages with other national laboratories and institutions of the conventional universities.
- Although, fisheries scientists have accomplished a commendable task of increasing fish production in the country, both the number and quality of their publications suffer at the international level due to poor visibility. An important reason for this is that our fisheries scientists publish mostly in non-indexed journals. An all-out effort must be undertaken to improve the image of the premier fisheries research journal of the ICAR, namely, *Indian Journal of Fisheries*.