



Fisheries Research and Development in India

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The fisheries sector of India is immensely contributing to the economy of the country. It provides valuable foreign exchange and employment to millions of people. At the same time it is an instrument of livelihood for a large section of economically backward population of the country. More than 7 million fishers in the country depend on capture fisheries and aquaculture for their livelihood. Indian fisheries are an important component of the global fisheries, with India being the fourth largest producer of fish in the world and second in Inland fish production. India's share in the world's fish production has increased from 3.2% in 1981 to 4.5% at present. Fishery sector occupies an important place in the socio-economic development of the country. Fish production in the country has been showing an increasing trend and has reached a record level of 6.4 million tonnes.

RESEARCH AND DEVELOPMENT SUPPORT

Inland Fisheries

The inland capture fishery resources comprise rivers and canals, estuaries, floodplains wetlands, lagoons and reservoirs and this sector holds enormous production potential to meet the inland fish requirement of the country. The river system of the country comprises 14 major rivers (catchments >20,000 km²), 44 medium rivers (catchments 2,000 to 20,000 km²) and innumerable small rivers and desert streams. Different river systems of the country, having a combined length of 29,000 km, provide one of the richest fish genetic resources in the world. The floodplain lakes are primarily continuum of rivers Ganga and Brahmaputra. These are in the form of oxbow-lakes (*Mauns, Chauras, Jheels, Beels* as they are called locally), especially in the States of Assam, Manipur, West Bengal,

Bihar and eastern Uttar Pradesh. Reservoirs constitute the single largest inland fishery resource, both in terms of resource size and productive potential. A detailed study made by FAO in 1995 has estimated a total of 19,370 reservoirs in the country with a total area of 3.15 million ha.

Indian floodplain lakes (0.24 million ha) are primarily a continuum of rivers Ganga and Brahmaputra. These are mainly located in the States of Assam, West Bengal, Bihar and Uttar Pradesh. They occupy an important position in inland fisheries of India, because of their magnitude, their production potential and as they serve as breeding and nursing ground for riverine fish stock. These water bodies are extremely rich in nutrients. The floodplain wetlands are lying uncared for and are in the process of swampification. These are capable of yielding one tonne of fish per ha on an average, if subjected to scientific management. Therefore, a vast untapped production potential is yet to be harnessed in floodplain wetlands.

The estuarine systems (2.7 million ha) are identified as an important source of fish and shrimp seed. These are vital for fisheries of both riverine and marine sectors. The exploited fisheries of estuaries in India are above subsistence level with average yield swaying between 45 to 75 kg/ha/year.

The post-independence period has witnessed commissioning of a number of small, medium and large river valley projects leading to creation of a chain of impoundments in the form of reservoirs. With present day magnitude of 3.15 million ha, reservoirs form the most important inland open water fishery resource of our country. The area under reservoirs is expected to reach 6.0 million ha in another

two decades. The present fish production from reservoirs is estimated at 0.94 lakh tonnes, with over 79% contributed of small reservoirs, followed by large (14%) and medium (7%) reservoirs. At the present level of management and utilization, reservoirs yield an average of 20 kg/ha/year, which is far below the potential. Though much higher per ha fish production is possible, even a moderate increase of 100 kg/ha for small and 50 kg/ha for medium and large reservoirs can provide an additional increment of 1.65 lakh tonnes of fish (Valued at Rs. 49.50 lakh @ Rs. 30/- per kg). Therefore, reservoirs are one of the most potential fisheries resource for future fisheries development of India. Scientific management of these waters through selection of right species and stocking, stock manipulation, fishery regulations, harvesting schedules, adoption of pen and cage culture technologies, and development of package of practices for different categories of reservoirs would help in increasing the fish production from these water bodies.

Indian upland fishery waters include rivers (8,253 km), natural lakes (21,900 ha) and reservoirs (29,700 ha). The capture fisheries of these waters are poorly developed. These are characterized by low primary productivity of resources, slow growth rate of fish, inefficient fishing practices and inaccessibility of fishing sites.

Marine Fisheries

The marine fisheries resources of the country are in terms of 8,129 km long coastline, 0.5 million sq. km of continental shelf and 2.02 million sq. km of exclusive economic zone. Contributed by major fish species like oil sardine, mackerel, Bombay duck, pomfrets, shrimp, the catches have gone up from 0.53 million tonnes in 1951 to





2.99 million tonnes in 2004. The fish production from the open seas has been stagnating since the last decade and marine fisheries are still restricted to the near shore areas. Against the estimated potential of 3.9 million tonnes, the sector has already reached the 2.99 million tonnes mark, thus leaving a balance resource of around one million tonnes, in deeper waters and oceanic zone.

Marine capture fisheries play a vital role in India's economy. The sector provides employment and income to nearly two million people. The growth in marine fish production during 1950s and 1970s has been faster as compared to the inland fisheries. However, in 1980s and 1990s, the trend has been reversed, as the marine fish production has been slow as compared to the inland fisheries. During the last decade (1990s) the marine fish production has reached a plateau. The present scenario suggests that the current level of marine fish production from the exploited zone has to be sustained by closely monitoring the landings and the fishing effort and by strictly implementing the scientific management measures.

To fish those resources for increasing fish production from the marine sector, the industry needs ocean-going vessels and sophisticated on-board facilities which are capital-intensive. The strategies proposed for marine fisheries management are: regulated and diversified fishing, targeting the under-exploited and non-conventional resources of the EEZ, identification of potential fishing zones, stock enhancement through sea ranching, installation of fish aggregating devices and artificial reefs, community based resource management, responsible fishing including closed seasons and mesh regulations, assessment and exploitation of resources available around islands and infrastructural support in terms of deep sea vessels, on-board and on-shore facilities.

The marine environment provides an immense biodiversity that is being catalogued for

commercial uses. These include several microorganisms, algal forms, and invertebrates, that could serve as potential sources of bioactive substances including antimicrobials, anaesthetics, anticarcinogens, etc. as well a wealth of valuable genetic material for transgenics and thus it presents a huge opportunity for both Food and Drugs from the seas. Identification of suitable sites along the Indian coastline of over 8000 km, hatcheries and grow-out systems for finfish, shellfish and other organisms, possibilities of cage culture in island eco-systems are the strategies for realizing these potentials.

Research thrusts in the next five years pertain to studies in the shelf, slope and oceanic realms of the EEZ to assess and map the resource potential, upgradation of mariculture technologies, socio-techno-economic aspects of marine fisheries and brackishwater aquaculture, design and fabrication of modern fuel-efficient fishing vessels, development of cost-effective and responsible fish harvesting systems, diversification and value addition for utilization of low value fish, quality assurance and management systems.

Culture Fisheries

Freshwater Aquaculture: The share of inland fishery sector, which was 29% in 1951, has gone up to more than 50% in 2003-04, indicating increasing contribution of inland sector to the total fish production. Further, it is significant that aquaculture production has increased tremendously during the last decade. Consequently, the percentage share of aquaculture in total inland fish production is estimated to be about 75-80%. Two specific aqua-produces, carps and prawns in freshwater aquaculture and shrimps in brackishwater aquaculture, have contributed to the bulk as well as value of the inland aquaculture sector.

Freshwater Aquaculture resources of the country have been estimated to be of the order of 6.23 million ha, of which 2.25 million ha are in the form of ponds/tanks,

0.827 million ha *beels/jheels/* derelict water bodies and 3.15 million ha of reservoirs. The present contribution of 3.5 million tonnes from these resources are hardly commensurate with their vastness and offer the scope for realising more production with the available technologies in the country.

There is a wide scope for increasing fish production through aquaculture and by utilizing the available reservoir areas. With only 40% of available cultivable water area under aquaculture, the average productivity of tanks and ponds is 2.2 tonnes/ha/year in FFDA ponds. By increasing the coverage of water area and the productivity of existing waters by 50%, the total production from the aquaculture sector could be doubled. Thus, the thrust has to be on bringing more and more water bodies under aquaculture practices and also to increase the productivity of water bodies through scientific management and inputs. Indian aquaculture is mainly dominated by major carps that account for around 80% of the total inland fish production. There are a number of potential finfish and shellfish species, catfishes, prawns, ornamental fishes, etc. suitable for different agro-climatic conditions and can be brought under the aquaculture practices. There is scope for achieving production levels of 6 to 8 tonnes/ha/year in several parts of the country. Such potentials need to be harnessed in order to increase the overall production from the aquaculture sector through intensification of cultural practices.

Coldwater fishery resources encompass high and mid altitude lakes, rivers, streams and man-made reservoirs. According to conservative estimates, the riverine stream length holding coldwater fisheries in the two mountainous zones trained by the Indus and its tributaries, Jhelum, Chenab, Ravi, Beas, Satluj, Bhagirathi and Alaknanda are about 7,000 km. The approximate fishable streams length of hill streams on North West and eastern Himalayas has been estimated as 3,200 km. Further, there are a large number





of natural lakes located in the uplands of Jammu & Kashmir, Himachal Pradesh, Uttaranchal, Arunachal Pradesh and Sikkim. These natural eco-tops are virtually dotted all over the hilly terrain of these States and they hold rich ichthyofauna of both commercial and sport fishes.

While there exists a vast scope for development of coldwater fisheries both on grounds of logistics and economics, these resources have largely remained untapped mainly due to lack of development and scientific efforts. The current fishing activities in the hills are limited to fishing/angling by individual fishermen in the rivers and streams, and are hardly of any commercial importance.

The successful evolvement of technology of commercial Rainbow Trout Farming in Jammu & Kashmir and Himachal Pradesh has opened tremendous potential in exploiting various hilly rivers and streams flowing in foothills of Himalayas. Similarly, successful Running water Fish Culture Programme being carried out by monoculture of mirror carp in the hill States has given a new impetus to the aquaculture promotion programme in the uplands. The expansion of both these programme could go a long way not only in boosting fish production in the Himalayan States but also in the generation of large scale employment for hill inhabitants.

Coastal Aquaculture: Coastal Aquaculture production in the country is largely on account of shrimp farming. It is estimated that, out of about 1.23 million ha identified as potential areas for brackishwater fish farming in the country, about 10% area is being farmed at present. Of this area, about 80% is under traditional farming systems and the remaining is under extensive and semi-extensive shrimp farming. At present, about 300 shrimp hatcheries are operational with a total production capacity of 12 billion post-larvae (PL 20)/year, mostly in the private sector. The farmed shrimp production has increased from 40,000 tonnes in

1991 to 1,15,000 tonnes in 2003. This contributes to the bulk of the Indian shrimp exports. The major constraints in the development of coastal aquaculture are diversification of candidate species suitable for different saline conditions, development of disease free broodstock of finfish and shellfish, development of hatcheries for seed production, health and hygiene in the hatcheries and culture system and development of quality feed which need to be addressed by undertaking research and development activities.

The country has around eight million hectares of inland saline soils which are not very suitable for other enterprises and can be a potential resource for aquaculture activities. The technologies for utilizing such sub-soil ground waters for culture practices have already been demonstrated. Utilisation of these water bodies for fish culture would help the country in moving forward to achieve the fish production targets in the next decade.

Mariculture: Mariculture is expected to be a major activity in the coastal areas in the years to come. Given the wide spectrum of cultivable species and technologies available, the long coastline and the favourable climate, mariculture is likely to generate considerable interest amongst the coastal population. At a time when we speak of over-exploitation in the near-shore waters, limited access to capture fisheries and the need for diversification, mariculture can be one of the most appropriate alternatives. Technologies for a couple of species are presently available in the country and there is an urgent need for developing a package of practices for many more commercially important species.

Growth of the Fisheries Sector

The Fisheries Sector contributes around 1.1% to the total GDP, around 4.7% to the GDP from the agriculture sector and over Rs. 6,000/- crores to the export earnings. India ranks fourth in the total fish production in the world

and second to China in the inland fish production with a total fish production of 6.4 million tonnes. Around ten million people are engaged in fisheries and ancillary activities. The per capita consumption of fish is around 9 kg. The projections by the end of X Plan for total fish production are based on the assumption of 8% growth rate in the inland sector and 2.5% growth rate in the marine sector with an average growth rate of 5.5% and with a total production potential of 8.4 million metric tonnes.

To manage the available vast resources and achieve the envisaged targets of bridging the gap between production and the potential, Fisheries Division of the ICAR has undertaken a number of R & D programmes. The aquaculture in our country is mainly dominated by the Indian major carps which account for 80% of the total inland fish production. There are a number of potential high value finfish and shellfish species, catfishes, prawns, ornamental fishes, etc. which are suitable for different agro-climatic conditions and can be brought under aquaculture practices. The technology for seed production and culture of such high value species have been developed by the fisheries research institutes and efforts are being made to propagate these technologies among the farming community so that the average income of the farmer will be enhanced. In marine sector, for augmenting fish production from seas, a series of programmes such as managing the exploited stock to realize sustainable yield through regulation, responsible fishing and fisheries management, exploiting and monitoring the deep sea fishery resources, diversification of fishing activities, installation of Artificial Reefs (AR) and Fish Aggregating Devices (FAD), stock enhancement through sea-ranching, increasing production through sea farming and coastal mariculture have been taken up. To achieve targeted growth of 5.5% and increasing the returns with fish farming and fisher community, the following issues are being addressed through various R & D programmes.





- Increase in the coverage of areas of ponds and tanks for aquaculture practices.
- Increasing productivity of existing water bodies.
- Diversification and intensification of culture practices.
- Popularisation of mariculture/sea ranching activities.
- Extending area of fishing operations.
- Developing technologies for utilization of unconventional fish species and by-catch discard.

Seafood Exports

Fishery sector has been one of the major contributors of foreign exchange earnings through seafood export. There has been phenomenal increase in the export of marine products both in quantity and in value terms during the last decade. The share of marine products in the total export earnings of India is around 3.4%. The quantity of marine products from the level of 1,39,419 tonnes in 1990-91 has increased to over four lakhs tonnes in 2003-04. While the value of the export quantity has increased from Rs. 893.37 crores to Rs. 6,400 crores during this period, in the 1990s, the export has increased with an annual growth rate of 10.41% and 20.23% in quantity and value respectively.

Among the exports of marine products, cultured shrimps contributed 52% in terms of quantity and 75% in terms of value of the total export earning from shrimps.

In recent years, there has been a diversification in export of items like frozen squid, cuttlefish and a variety of other fishes. Japan continued to be our major market, importing around 45% of the seafood from India followed by European Union in the recent past. Other major markets are USA, Belgium, Italy, Thailand, Republic of Korea, China, Taiwan, Hong Kong, Singapore, and Malaysia. Exports to the Middle-East countries have shown an increasing trend in the recent past. A notable

feature currently seen is the entry of low-value finfish as a major export commodity.

Prospects of export lie in diversified fishing, products and markets. Tuna and Cephalopods have been identified as potential export items. The trade in frozen fish, fish fillets and Surimi is promising and the industry is to be adequately geared and equipped to handle and export them in value added packages. Freshwater species, such as major carps too have a potential market, especially in West Asia. Modernization of the processing facilities to meet international standards is of primary importance for the industry in the coming years.

Supply and Demand

Estimating India's future demand for food fish is inherently difficult in view of the need for exactly predicting growth in population, GDP and change in pattern of food consumption. Based on current level of landings conventional marine resources are unlikely to meet the demand of the present century if they are not managed properly. In order to maintain the present per capita availability of fish consumption of 4 kg/person (9 kg assuming 56 percent of Indians are fish eaters), the country has to produce at least 0.2 million tonnes of fish additionally per annum.

Filling up the Gap in Supply-Demand: One near possibility of filling the supply-demand gap is aquaculture. As freshwater fish has little scope for export, its prices are not going to increase substantially in the near future and will remain accessible to an average Indian consumer. Further, aquaculture has several problems. Production is mainly carp-oriented, over ninety percent. One hundred percent farmed shrimp, *P. monodon* and *P. indicus*, is exported. Carp is not a delicacy in many fish-eating population of India except West Bengal, Orissa and Bihar. Hence, it is not profitable to an average farmer in view of the poor market price at production centers. This needs selection of the species for culture practices which are

acceptable to the local population. Although aquaculture appears a frontier technology in fish production, it is haunted by several constraints like seed, feed and disease. These issues have to be addressed on a war footing.

Other possibilities include utilization of trawl by-catch discards and reduction of post-harvest losses. This can give at least half a million additional fish annually for consumption. There are now many technologies available for better utilization of these low-value fishes. One of the best methods is to convert them to value-added products like fish fingers, balls, burgers, etc.. There are also many processing methods available for the utilization of these fishes but their consumer acceptability and economical potential need to be assessed.

Fisheries Potential/ Production

The country has a long coastline of 8,129 km and a vast area under estuaries, backwaters, lagoons etc., highly amenable for developing capture as well as culture fisheries. After declaration of the Exclusive Economic Zone (EEZ) in 1977, the marine area available to India is estimated to 2.02 million sq. km. comprising 0.86 million sq. km on the west coast, 0.56 million sq. km on the east coast and 0.60 million sq. km around the Andaman and Nicobar islands. With the absolute right on the EEZ, India has also acquired the responsibility to conserve, develop and optimally exploit the marine living resources within this area.

The harvestable potential of marine fishery resources in the EEZ has been revalidated by a Group of Experts constituted by the Government of India, Ministry of Agriculture at about 3.93 million tonnes (October, 2000) consisting of 2.02 million tonnes of demersal, 1.67 million tonnes of pelagic and 0.24 million tonnes of oceanic resources. In the Inland Sector, the resources potential has been estimated at 4.5 million tonnes which takes into account the production from both capture and culture fisheries.





While the inshore waters have been almost exploited to the MSY levels, the contribution from the deep sea has been insignificant. The thrust of the deep sea fishing industry has hitherto been directed at shrimps only, notwithstanding the other resources. As of today, the deep sea fishing industry is almost a 100% shrimp oriented enterprise, faced with over-exploitation of the available shrimp resources as well as the fierce competition from the smaller class of vessels.

The development of deep sea fishery industry is of concern to the entire marine fishery sector because it would have considerable impact on the management of near-shore fisheries, shore-based infrastructure utilization and post-harvest activities, both for domestic marketing and export. Similarly, the upgradation of the small mechanized sector to support the entrepreneurial interest in the sector will be given high priority.

Future Thrust Areas of Research and Development

Considering the vast potential of fisheries resources and to achieve the targeted production and productivity, following thrust areas of research and development have been identified which need attention on priority basis.

➤ Stock assessment and monitoring of commercially important marine fish species.

➤ Development of fuel efficient crafts and gears for deep sea fishing.

➤ Prevention of post-harvest losses, development of improved transport, storage and processing of fish.

➤ Development of value added fishery products for export.

➤ Extraction, production and evaluation of biomolecules from marine organisms and plants for industrial and pharmaceutical applications.

➤ Mariculture of fish/shellfish and culture of ornamental fish.

➤ Introduction of HACCP in seafood processing.

➤ Marine biodiversity conservation and management

➤ Rural aquaculture and integrated fish farming, increasing availability of fish seed and feed.

➤ Application of molecular biology in aquaculture.

➤ Genetic mapping of important fish species through DNA fingerprinting.

➤ Fishery informatics and databases.

➤ Fish nutrition and feed development.

➤ Diversified aquaculture.

➤ Breeding and culture of new fish and shellfish species in fresh and brackishwater environments.

➤ Environment monitoring of aquatic ecosystems.

➤ Development of ecofriendly and sustainable fish/shellfish farming.

➤ Development of hill fishery resources and management.

➤ Human Resource Development in emerging areas.

➤ Bioactive substances from aquatic biota.

➤ Coastal Zone Management and environment impact assessment.

Conclusions

The fisheries and aquaculture sector in the country is poised to play a major role in the lives of people in the coming decades, with increasing population pressure on land and alternate food production system being increasingly projected from the aquatic resources. The research and development activities as indicated above in the frontier areas of fisheries sector are urgently required on priority basis to meet the new challenges in fisheries sector and to make the whole system sustainable and eco-friendly. Such research and development support through various organizations will not only boost fish production and productivity but also ensure nutritional and food security, employment opportunities and socio-economic upliftment of the poorest of the poor.

