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Introduction

The fisheries sector plays a vital role in the Indian economy. It addresses various issues like food and nutritional security, employment, livelihood support and socio-economic status of fishing communities. The sector provides employment and income to over 5 million fishers and fish farmers, majority of whom live in over 3600 coastal villages, besides fishers hamlets along major river basins and reservoirs in the country. The fish production in India registered an excellent growth during the past half century and reached 6 million t in the year 2002 from a meagre 0.75 million t in 1950. The fishers primarily depend on fisheries in these waters for their livelihoods. The fisheries sector in India contributes to nearly Rs. 220 billion which is 1.4% of the total national gross domestic product (GDP) and 4.6% of agricultural GDP. The sector is one of the major contributors to foreign exchange through export. In India, the seafood export industry is mainly with the private sector.

The inland fisheries of our country include both capture fisheries and aquaculture. Capture fisheries had been the major source of inland fish production till mid eighties. But, the fish production from natural waters like rivers, lakes, etc., followed a declining trend, primarily due to proliferation of water control structures, indiscriminate fishing and habitat degradation (Katiha, 2000). The depleting resources, energy crisis and resultant high cost of fishing have led to an increased realisation of the potential and versatility of aquaculture as a viable and cost effective alternative to capture fisheries. During the past one and half decades, the inland aquaculture fish production has increased from 0.51 million t in 1984-85 to 2.69 million t in 2003-04, while for inland capture fisheries the same has declined from over 0.59 million t in 1984-85 to 0.33 million t in 1994-95 and 0.5 million t in 2003-04. (Anon., 1996a,b; Anon., 2000; Gopakumar *et al.*, 1999, Dehadrai, 2003). The percentage share of aquaculture has increased sharply from 46.36 to 84.33. It is primarily because of 4.25 fold increase in freshwater aquaculture. Its share in total inland fish production has also increased from 27.95 to 65.83% (Anon., 1996a,b; Anon., 2000). Still, it has greater scope for enhancing fish production.

Among the countries bordering the Indian Ocean, India, endowed with

a coastline of 8129 km, 2.02 million km^2 of EEZ and 0.5 million km^2 of continental shelf has a catchable annual marine fishery potential of 3.93 million t and occupies a unique position. Besides, there are vast brackishwater spread areas all along the coastline, which offer ideal sites for seafarming and coastal mariculture. Among the Asian countries, India ranks second in culture and third in capture fisheries production, and is one of the leading nations in marine products export. Marine fisheries sector occupies a very important place in the socio-economic development of the country. The sector has been recognized as a powerful instrument to generate income and employment as it stimulates growth of a number of subsidiary industries and is the source of cheap and nutritious food besides being a foreign exchange earner. At the same time it is an instrument of livelihood for a large section of economically backward coastal population of the country. The development of Indian marine fisheries from a traditional subsistence oriented one to industrial fisheries through Five Year Plans was phenomenal. However, the present scenario is characterised by declining yields from the inshore waters and increasing conflicts between different resource users, whereas the increasing demand for fish in domestic and export markets indicate good prospects for oceanic and deep sea fishing, large scale seafarming and coastal mariculture.

Fisheries is considered as a sub-sector of agriculture. Hence policies influencing fisheries sub-sector are embedded in the agricultural policy documents. Nevertheless, the Five-Year Plans contain some broad growth and development oriented policies for fisheries. The main objectives of fisheries policy have been: (a) enhancing production of fish and productivity of fishermen and fishing industry; (b) generating employment and higher income in fisheries sector; (c) improving the socio-economic conditions of traditional fisherfolk and fish farmers; (d) augmenting export of marine, brackish and freshwater fin and shell-fishes and other aquatic species; (e) increasing per capita availability and consumption of fish (present target is 11 kg per annum); (f) adopting an integrated approach to fisheries and aquaculture and (g) conservation of aquatic resources and genetic diversity (Planning Commission, 2002).

The Tenth Plan has proposed a fish production target of 8.19 mt envisaging a growth rate of 5.44 percent per annum (marine 2.5 percent and inland 8.0 percent). During the X Five Year Plan, new initiatives for development of fisheries are planned to increase production and productivity from deep seas, inland capture fishery resources like rivers, canals, etc. and from culture based resources like reservoirs, beels, ox-bow lakes, aquaculture in ponds, for replenishment of fishery resources through mariculture etc. Besides, development of infrastructural facilities for better post-harvest management, technology for suitable aquaculture, setting up

of cold storage and marketing network through viable fishermen co-operatives etc. are to be taken up to ensure better livelihood for fishers and enhance export promotion for economic development of the country (Planning Commission, 2002).

Evolution of fisheries research and development

Efforts to study the fish and fisheries of India were initiated in the 19th century by the British administration who requested Dr. Francis Day to study the fish and fisheries of the whole of British India. It resulted in two reports (1) the Freshwater Fish and Fisheries of India and Burma, 1873 and (2) the Sea Fish and Fisheries of India, 1878. In the former, Day highlighted the widespread practice of killing brooder fish using dynamite and poisons and suggested remedial legislative measures, which resulted in the promulgation of Indian Fisheries Act of 1897. In the second report, Day recommended measures for proper exploitation and development of marine fishery resources of India.

The dawn of 20th century saw the conduct of a number of detailed studies on the fisheries of British India notably by Sir F.A. Nicholson, Dr. James Hornell and Rao Bahadur V. Govindan (Madras Presidency), Sir K.G. Gupta (Bengal Presidency), Dr. A.T. Sorky and Mr. W.H. Lucas (Bombay Presidency). These reports and studies resulted either in the constitution of a separate department of fisheries in many provinces or the provision of some assistance to the fish curing industry. Despite all this, the Royal Commission on Agriculture (1928) noted the failure of the Government in developing the fisheries as a source of food and revenue for the territory and reaching the full potential for growth. In 1941, a report entitled *Preliminary Guide to Indian Fish, Fisheries, Methods of Fishing and Curing* was published by the Directorate of Marketing and Inspection giving a broad outline of the Fishing Industry of India. In 1943, Dr. Baini Prasad, the then Director of Zoological Survey of India, submitted a 'Memorandum on the Post-war Development of Indian Fisheries' to the Policy Committee on Agriculture, Forestry and Fisheries giving valuable recommendations for development of Indian Fishing Industry. His chief suggestion was the establishment of a Central Institute for promotion of Fisheries Research in India. Thus, in 1947, two major research Institutions, the Central Marine Fisheries Research Station (later designated as Central Marine Fisheries Research Institute) with headquarters at Mandapam (shifted to Cochin in 1971) and the other for inland sector at Calcutta (later renamed Central Inland Fisheries Research Institute, Barrackpore) were established. Subsequently deep sea fishing station (later renamed as Exploratory Fisheries Project and now known as Fishery Survey of India) based at Mumbai was established. Later Central Institute of Fisheries Technology (CIFT), was

established at Cochin in 1957 based on the recommendation of the Fisheries Research Committee (1954) appointed by the Ministry of Food and Agriculture, Government of India.

CIFRI initially focussed its attention on aquaculture research and development in consonance with the plan priorities of Government of India and established Freshwater Aquaculture Research & Training Centre at Dhauli (Orissa) in 1977, which later on became Central Institute of Freshwater Aquaculture (CIFA), Kausalyaganga, Bhubaneswar in 1986. Simultaneously, Central Institute of Brackishwater Aquaculture (CIBA), Chennai and National Research Centre on Coldwater Fisheries (NRCCWF), Bhimtal were carved out from this Institute to further expand research activities on brackishwater aquaculture and coldwater fisheries, respectively. Thus, this Institute has given birth to three major Fisheries Research Institutions in the country. The original Institute was renamed as Central Inland Capture Fisheries Research Institute with its headquarters at Barrackpore. However, its acronym is retained as CIFRI. During 2003, the Institute was again renamed as Central Inland Fisheries Research Institute. Another fisheries research Institute, namely National Bureau of Fish Genetic Resources (NBFGR), Lucknow, established in 1983, is responsible for research on fish genetic resources of the country and conservation and preservation of fish germplasm.

Implementation of fisheries developmental schemes in India is in the purview of state governments. Therefore, the state governments are primarily responsible for the extension or transfer of technologies to the fishers and aquaculturists. Some of the central sector developmental schemes are implemented by Government of India through its Fishery Division under Department of Animal Husbandry and Dairying (DAHD). The organisational set up for fisheries sector is given below (Fig. 1).

Ministry of Agriculture is the apex body in the country, which has two departments namely Department of Agricultural Research and Education and Department of Animal Husbandry and Dairying to monitor and implement fisheries research and development, respectively. The former is responsible for agricultural research and education and has Indian Council of Agricultural Research (ICAR) as the nodal research organisation and fisheries colleges under agricultural universities as the educational institutions.

The activity brief of Institutions involved in Research and Development in fisheries sector of India is given below :

Fig. 1. Organisational structure of fisheries Research and Development in India

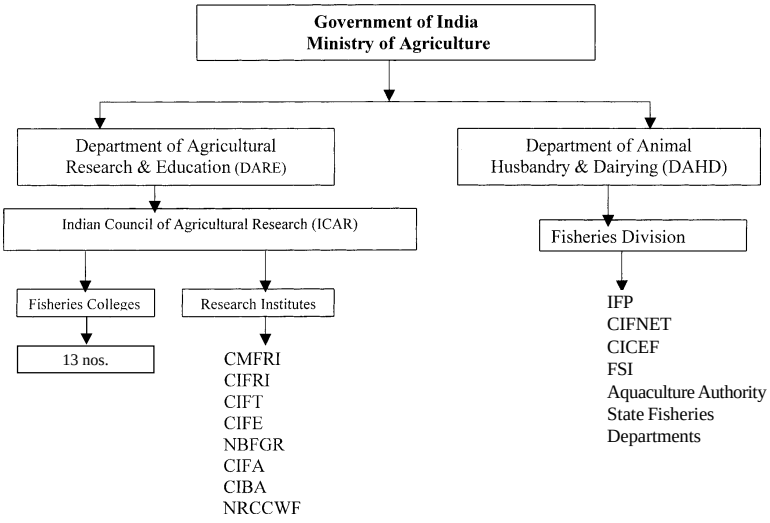

Table 1. Institutions involved in Fisheries Research and Development

Institutions	Activities
Government of India	
Fisheries Divison, DAHD (M o Agri.)	Formulation of policies/programmes and financial support
CIFNET	Central Institute of Fisheries Nautical and Engineering Training, Cochin is for generation of technical personnel statutorily required for manning medium and large fishing vessels and functionally required for shore establishments.
CICEF	Central Institute of Coastal Engineering for Fisheries, Bangalore is primarily concerned with engineering issues of marine fisheries and harbours.
FSI	Fishery Survey of India, Mumbai conducts exploratory resource surveys and imparts onboard training to the fishing-hands.
IFP	Integrated Fisheries Project, Cochin imparts onboard training in fishing vessels, fish processing and marketing, refrigeration and slipway works.

Aquaculture Authority	Authority has been set up under section 3(3) of the Environment (protection) Act 1986 to perform the functions indicated in the Supreme Court judgement dated 11th December 1996 regarding setting up of shrimp farms in coastal areas (Anon., 2001; 2002).

Indian Council of Agricultural Research

CIFE	Central Institute of Fisheries Education, Mumbai has been given the status of Deemed University on March 29, 1989. It is mandated for fisheries education at different levels (Post graduate, Doctoral) and R&D activities.
CIFT	Central Institute of Fisheries Technology, Cochin is conducting R & D on fishing crafts and gears, fish processing, quality control, value addition and packaging.
CMFRI	Central Marine Fisheries Research Institute, Cochin with its Regional/Research and Field Centers is dedicated towards R & D on capture fisheries and sea farming technologies, fisheries education, transfer of technology and consultancy services.
CIFRI	Central Inland Fisheries Research Institute, Barrackpore with its Regional and Survey Centres is to conduct research on fisheries and environment of inland open waters including rivers, reservoirs, floodplains, estuaries, etc.
NBFGR	National Bureau of Fish Genetic Resources, Lucknow is to collect, classify and evaluate information on fish genetic resources of the country; catalogue genotypes and conserve endangered fish species.
CIFA	Central Institute of Freshwater Aquaculture, Bhubaneswar is conducting basic and applied research on aquaculture and its environment for development of improved sustainable culture systems in freshwater.
CIBA	Central Institute of Brackishwater Aquaculture, Chennai is doing research for development of techno-economically viable and sustainable culture practices/system for finfish and shellfish in brackishwater.

NRCCWF	National Research Centre for Coldwater Fisheries, Bhimtal is to assess coldwater fishery resources in the upland areas and formulate strategies for their sustainable exploitation and suggest measures for their conservation and management.
KVKs	*Krishi Vigyan Kendras* conduct training in various avocations in Agriculture, Animal Husbandry and Fishery related activities.
TTCs	Trainers' Training Centres impart training on various aspects of capture and culture fisheries to trainers.

Council of Scientific & Industrial Research

NIO	National Institute of Oceanography, Goa with its three Regional Centres conducting researches on different aspects of coastal and open ocean environment
CFTRI	Central Food Technological Research Institute, Mysore established in 1950 is conducting research on food conservation, food protection and enhancement of the nutritious status of food products and setting national standard for food quality

Department of Ocean Development

DOD, created in 1981, functioning as a nodal department for organizing, coordinating and promoting ocean development activities including Antarctic research. Antarctic Study Centre (ASC), Goa, Centre for Marine Living Resources and Ecology (CMLRE), Cochin, National Institute of Ocean Technology (NIOT), Chennai are functioning under DOD.

Marine Products Export Development Authority

MPEDA, Cochin, an agency of Ministry of Commerce, set up in 1972, is responsible to develop and regulate marine products industry with special reference to export promotion.

MoE&F, ICAR, CSIR,UGC, DST, DBT, DOD	Providing funding support to R&D Institutions and Universities to undertake research in frontier areas.

NABARD, NCDC, NCUI	Promote development of fisheries through financial assistance for various activities/projects taken up by the R&D organizations, States & entrepreneurs

Union Territories/State Governments

State Fisheries Departments	Research and Development
Government Fishermen Training Centres	Training fishermen in operation and maintenance of small fishing boats and related activities.
Staff Training Centres	Orientation for departmental personnel.
Fisheries Colleges under State Agricultural Universities (SAUs)	Vocational training for various fishery related programmes, education at different levels (B.F.Sc., M.F.Sc., Ph.D.) and R & D activities.
Universities	B.Sc., M.Sc., Ph.D in fishery related subjects
Fisheries Schools	Educate the fishers' children mainly in coastal states.

Non-Governmental Organizations

M.S. Swaminathan Research Foundation (MSSRF) - A non-profit Trust at Chennai registered in 1988 mandated to impart a pro-nature, pro-poor and pro-women orientation to a job-led economic growth strategy in rural areas through harnessing science and technology for environmentally sustainable and socially equitable development.

Aquaculture Foundation of India (AFI) - A non-profit organisation at Chennai for facilitating and promoting ecofriendly aquaculture practices for addressing the needs of aquafarmers and for popularising aquaculture in the country.

South Indian Federation of Fishermen Societies (SIFFS) - SIFFS focuses its attention on technology for small-scale fishworkers, undertakes fish marketing and caters to the credit requirements and other welfare activities

Inter-Governmental Organization

Bay of Bengal Programme (BOBP) - A regional multi-agency fisheries programme funded by the FAO since 1979, covers seven countries around the Bay of Bengal. The Programme plays a catalytic and consultative role;

it develops, and promotes new methodologies, techniques and technologies to help improve the conditions of small-scale fisherfolk.

Development Programmes

The development programmes for Indian fisheries sector were aimed at increasing the fish production, improving the welfare of fishermen, promoting export and providing food security. The first step towards developing fishing was made in 1898 by strengthening fisheries to fight famine. After the independence, in 1948 it was decided to seek foreign co-operation to create necessary infrastructure for modernizing the fisheries sector. In 1952, a tripartite technical co-operation agreement was signed between India, Norway and the United Nations for fisheries development and a year later, the Indo-Norwegian Project (INP) was started in Kerala. From then onwards modernization of fisheries was initiated in the coastal states in India. Several programmes have been launched for both marine and inland fishery developments in the country, some of which are briefly described below:

Inland

In recognition of the increasing role of inland fisheries in overall fish production, the Government of India (GOI) has been implementing two important programmes in the inland freshwater sector since the Fifth/ Sixth Five Year Plans. These are the Fish Farmers' Development Agencies (FFDAs) and the National Programme for Fish Seed Development. A network of about 429 FFDAs cover all potential districts in the country. The FFDAs have covered about 5.67 lakh ha of the total water area under scientific fish culture and trained 6.51 lakh fish farmers. But the average productivity from waters covered under this programme remained almost static at about 2.2 t ha^{-1} $year^{-1}$ during the IX Plan period. This scheme was revised during the IX Five Year Plan by increasing the unit costs and adding new components such as freshwater prawn hatcheries, laboratories (at state level), soil and water testing kits to each FFDA, integrated units including hatcheries for ornamental fishes, etc.

In coastal areas, 39 Brackishwater Fish Farmers' Development Agencies (BFDAs) have also been established. These provide a compact package of technical, financial and extension support to shrimp farmers. About 6240 ha was brought under brackishwater aquaculture activities during the IX Plan through these BFDAs (Planning Commission, 2002). However, the performance of the programme was affected due to environmental concerns.

Under the national programme for fish seed production, more than 50

fish seed hatcheries have been commissioned. It has led to a marked improvement in the production of fish seed from 409 million fry in 1973-74 to about 17000 million fry in 2000-01.

Marine

The programmes for development of marine fisheries as envisaged in different Five Year Plans include: (i) intensive surveys particularly of the Exclusive Economic Zone (EEZ) for marine fishery resource assessment, (ii) optimum exploitation of marine resources through judicious mix of traditional country boats, mechanized boats and deep-sea fishing vessels, (iii) providing adequate landing and berthing facilities to fishing vessels by completing the ongoing construction of major and minor fishing harbours, (iv) intensifying efforts on processing, storage and transportation, (v) improving marketing particularly in the co-operative sector and (vi) tapping the vast potential for export of marine products. During the VII Five Year Plan some selected villages were grouped for setting up "Fisheries Industrial Estates". The major developments include construction of 30 minor fishing harbours and 130 fish landing centres apart from five major fishing harbours at Cochin, Chennai, Visakhapatnam, Roychowk and Paradip to provide landing and berthing facilities to fishing crafts. There were 181284 non-motorized traditional crafts, 44578 motorized traditional crafts and 53684 mechanized boats available in India in 2000-01. The Government also provides subsidy to poor fishermen for motorizing their traditional craft, which helped increase the fishing area and the frequency of operation with a consequent increase in catch and earnings of fishermen. Improved beach landing crafts are also being supplied to groups of fishermen. A scheme of reimbursing central excise duty on HSD oil used in fishing vessels below 20 m length is also in operation to help the small fishermen to reduce their operational cost. About 18000 such vessels are benefited every year under the programme for the last few years.

The welfare programmes presently being carried out can be broadly divided into two categories: protective and promotional. The former is concerned with the short-run task of preventing a decline in standards of living and the latter with enhancing the long-term general living standard by improving the basic capability of the people. There are three important programmes for the welfare of traditional fishermen: (i) Group Accident Insurance Scheme for active fishermen (ii) Development of Model Fishermen Village and (iii) Fishermen insurance for Rs 50000 in case of death or permanent disability and for Rs 25000 in case of partial disability. About 12.2 lakh fishermen were insured during 2000-01 under this scheme. Under the programme of Development of Model Fishermen Villages, basic amenities such as housing, drinking water and community hall were provided

to fishermen. Concomitantly, both the protective and promotional social security schemes are on the increase over the years.

Several international organizations, including the World Bank, UNDP, DANIDA, NORAD, Sida, ODA (UK and Japan) provide aid to India for the development of fisheries sector. Under the Bay of Bengal Programme (BOBP), started in 1979, assistance is provided for development of small-scale fisheries to enhance the socio-economic conditions of the fishing communities. ODA (UK) has provided technical aid for the prevention of post-harvest losses in marine fisheries. Recently, FAO launched a scheme for providing technical assistance to implement Hazard Analysis Critical Control Points (HACCP) in seafood processing industries. A Shrimp and Fish Culture Project was started with the assistance of the World Bank in May 1992 and it continued up to December 1999.

Manpower

The manpower in the fisheries sector includes scientific, technical and fishers. The scientific manpower is primarily under the ICAR institutes, State Agricultural Universities, Academic Universities and the organisations under Ministry of Agriculture, Commerce and Science and Technology. The strength of scientists is nearly 1500, and that of the technical staff is approximately 2000.

The total fisher population was over 6.7 million in 1991 (Anon., 2000). The number of families engaged in fishing was over 2.43 million. The number of persons engaged in activities other than fishing were marketing 0.47 million, repair of fishing nets and crafts 0.22 million, processing of fish 0.09 million and in other activities 0.25 million. According to a recent estimate, 7 million people are engaged in fisheries and ancillary activities.

Investments in R & D

The total plan outlay and outlay for fisheries have increased over 400 times (Anon., 2000) in the past five decades (Table 2). The fisheries outlay for R & D was Rs 5.13 crore in the I Five Year Plan, which increased to Rs 2100 crore in IX Five Year Plan. The percentage outlay for fisheries ranged between 0.24 - 0.52 in the total and 1.74 - 5.62 for agriculture allocation. The investment in IV Five Year Plan for agricultural research was Rs 85 crore which has increased to Rs 2100 crore in IX plan (Table 3). The share of fisheries has increased from 2.7% in IV Five Year Plan to 6% in IX Plan. The investments in fisheries research and development were one of the highest among the agricultural and allied activities.

Table 2. Investment on R & D during various Five Year Plans

(Rs in crores)

Plan period	Total Plan Outlay	Outlay Agri./Allied	Outlay fisheries	% for Fisheries Outlay Total outlay	Outlay Agri./Allied
I	1960	294	5.13	0.26	1.74
II	4600	529	12.26	0.27	2.32
III	7500	1068	28.27	0.38	2.65
IV	15902	2728	82.68	0.52	3.03
V	39322	4302	151.24	0.38	3.52
VI	97500	6609	371.14	0.38	5.62
VII	180000	10524	546.54	0.30	5.19
VIII	434100	22467	1232.82	0.28	5.49
IX	859200	42462	2070.00	0.24	4.88
X*	398890	20668	765.00	0.19	3.70

* Allocation of central funds only

Source: Anon., 2000 and X Five Year Plan 2002-07. Planning Commission, Government of India, New Delhi.

Table 3. Allocation for fisheries research

(Rs. in crores)

Plan Period	Agri. and Allied	Outlay for ICAR/ DARE	Outlay for Fisheries Research	(%)
IV	2728	85.00	2.25	2.7
V	4302	153.56	9.60	6.2
VI	6609	340.00	15.75	4.6
VII	10524	448.00	18.25	4.0
VIII	22467	1300.00	65.00	5.0
IX	42462	2100.00	125.00	6.0

Source: Anon., 2000

Fish Production

Fish production in India recorded tremendous growth during the post-independence era (Table 4). The total increment was 8.5 times and has reached 6.3 m t from 0.75 m t of the pre-plan period. The fish production increased for both the sectors, but the growth of the inland sector (0.22 to 3.4 m t) was much higher than that of the marine sector (0.53 to 2.9 m t). Growth potential still exists for the inland sector particularly for freshwater aquaculture both in terms of horizontal expansion and increase in productivity. The fish production in marine sector is almost saturated particularly from the inshore waters. But mariculture has immense potential to enhance fish production from this sector.

Table 4. Fish production from marine and inland sectors over Five Year Plans

Plan period	Marine (m t)	Inland (m t)	Total (m t)
Pre	0.53	0.22	0.75
I	0.60	0.24	0.84
II	0.88	0.28	1.16
III	0.82	0.51	1.33
IV	1.21	0.75	1.96
V	1.49	0.82	2.31
VI	1.70	1.10	2.80
VII	2.28	1.40	3.68
VIII	2.97	2.38	5.35
IX	2.76	2.93	5.69
X	2.90	3.40	6.30