

# Cross-learning for Addressing Emergent Challenges of Aquaculture and Fisheries in India

**Prathibha Rohit, Pratap Chandra Das and Shinoj Parappurathu**

Indian Council of Agricultural Research, Department of Agricultural Research and Education,  
Ministry of Agriculture and Farmers Welfare, Government of India

## Abstract

Fisheries and aquaculture play a pivotal role in India's economy and contributes significantly to the food and nutrition security of the fish-eating population in the country. The sector has recorded an average annual growth rate of 8-10% over the past two decades. The continued vibrancy observed in the fisheries and aquaculture sectors in the country is largely due to the elaborate network of institutions and governance mechanisms that have been developed over years since independence (1947). Both formal and informal networks adorn the fisheries administrative, governance and management regime in India, with their formats diverse in terms of affiliation, ownerships, organizational framework, activity spheres, mode of operation, and so on. This country status paper summarizes the broad architecture of the above network and demonstrates how cross learning among the SAARC member countries could address the regional and sub-regional challenges therein.

**Keywords:** India, formal and informal networks, aquaculture and fisheries, institutions, governance

## 1. Introduction

Fisheries and aquaculture play a pivotal role in India's economy through their livelihood-supporting and income-enhancing prospects, netting together close to 28 million fishers, fish farmers and other intermediaries along the fish value chain (DoF, 2020). The sector contributes to the food and nutrition security of the fish-eating population in the country. India's blue economy which aims at the sustainable use of oceanic resources for the promotion of climate-smart and inclusive growth through a host of wide-ranging economic activities considers fisheries and aquaculture to be its key components. Presently, India holds the distinction of having the 4<sup>th</sup> largest capture (marine and inland) fishery and 2<sup>nd</sup> largest aquaculture, with an overall fish production that contributes to 7.6% of total global fish production (FAO, 2020). In 2019-20, India's total fish production stood at 14.2 million metric tonnes (MMT) which is the third largest in the world. In economic terms, this translates to 7.3% of the gross value added (GVA) of

agricultural and allied sectors and 1.2% of the total GVA in triennium ending (TE) 2018-19. Estimates show that the sector grew at an average annual rate of 8-10% over the past two decades, surpassing most other sub-sectors of agriculture. Foreign exchange earnings through exports of fish and fishery products is another major contribution of the sector to the country's economy, which was valued at about USD 6.73 billion in 2018-19. Seafood exports which has been the second largest exported product after rice, accounted for about 2.5% of total exports and close to 20% of agricultural exports from India (GoI, 2019). Of this, shrimp exports alone contributed to about two-thirds. (DAHD&F, 2018).

India's total fish production has shown a phenomenal increase from 0.75 MMT in 1950-51 to 14.2 MMT in 2019-20. After the inception of planned development (1950), the first few decades of growth in the sector were mainly focused around the capture fisheries and allied activities wherein, mechanization of fishing fleet, innovations in navigation and fish scouting techniques and intensification in fishing efforts through multi-day trips paid rich dividends. However, the last two decades witnessed a gradual plateauing of fish production from the capture sector at an average level of 3.2 MMT, but the slowdown more than offset by incremental growth coming from the culture sector. Aquaculture, has exhibited a staggering growth momentum, with production soaring from less than half a million tonne in 1980 to close to 10 MMT at present. While the country's 2.41 million hectare (M ha) of freshwater resources form the basis of freshwater aquaculture, the vast coastal brackishwater area and the inland saline area (1.16 M ha) have been put to use for the land-based aquaculture activity, mostly the shrimp farming that produces more than 0.8 MMT of cultured shrimp per year. The breakthrough in aquaculture came mainly in the form of advances in carp breeding and grow-out technologies in 1980s which were successfully adopted by the farmers and entrepreneurs resulting in substantial public and private investments. Success in large scale farming of brackish water shrimps also contributed considerably to the spectacle, despite constraints in the form of disease incidence and widespread crop loss in the late 1990s and early 2000s. Consequently, nearly three-fourths (73.7 %) of the total fish production presently comes from the inland production systems which are mature with sound technological and infrastructural establishments as well as management support (ICAR, 2011).

The vibrancy of growth associated with the sector rests to a great extent on the elaborate network of institutions and governance mechanisms developed over years in the country since independence (1947). Both formal and informal networks adorn the fisheries administrative, governance and management regime in India, with their formats diverse in terms of affiliation, ownerships, organizational framework, activity spheres, mode of operation, and so on. The

following section summarizes the broad architecture of the network along with the major players involved, stakeholders and their domains of activity.

## **2. Existing thematic networks for addressing regional and sub-regional challenges in aquaculture and fisheries**

The development in the fish production sector has been the result of the holistic participation of the farmers, entrepreneurs and others associated with the production chain. Fisheries Departments of the Union Government and the States, research institutes, government and non-governmental organisations, co-operative societies and federations, financial institutions and private entrepreneurs, with their strong support from various centrally and state supported schemes have catalysed the process.

### **2.1 Public sector networks**

#### **2.1.1 Departments and Organizations under the Union Government**

At the national level, the overall management and development of India's fisheries sector is spearheaded by the Department of Fisheries (DoF) under the Ministry of Fisheries, Animal Husbandry and Dairying (MoFAD), Government of India (GoI). Till 2019, the DoF (part of the erstwhile Department of Animal Husbandry and Fisheries, DAHD&F) was with the Ministry of Agriculture and Farmers' Welfare (MoA), when a new ministry was carved out to look after the special needs of the sub-sectors of fisheries, animal husbandry and dairying. A whopping Rs. 200.5 billion has been allocated to this Ministry in the Union Budget in 2020. The DoF is directly responsible for matters relating to formulation of policy and schemes relating to development of inland, marine and coastal fisheries. The range of activities and responsibilities that come under the purview of the Department include (i) promotion and development of fishing and fisheries and its associated activities, including infrastructure development, marketing, exports, and institutional arrangements (ii) development of fish feed and fish products industry (iii) welfare of fishermen and fisher-folk (iv) liaison and cooperation with international organizations (v) fisheries statistics, (vi) mitigation of the effects of natural calamities, (vii) regulation of fish stock import, quarantine and certification (viii) legislation and other related matters (ix) supervision of fisheries institutes and (x) financial assistance through State agencies/Co-operatives. On these matters, the Department functions according to the cardinal principles of the constitution of India and subject to relevant national legislations and policies in effect from time to time. The important organization/Institutes presently working under the DoF towards this cause are the Fishery Survey of India (FSI), Mumbai, the Central Institute of Fisheries Nautical and Engineering Training (CIFNET), Kochi, National Institute of Fisheries Post Harvest Technology Training (NIFPHATT), Kochi and the Central

Institute of Coastal Engineering for Fishery (CICEF), Bangalore. The FSI has got a fleet of research and exploratory vessels under its wing that helps in undertaking fish stock assessment and other related exercises on a regular basis.

The National Fisheries Development Board (NFDB) was established in 2006 at Hyderabad with an aim to enhance fish production and productivity in the country. At present, it is working under the DoF/MoFAD supports the aquaculture sector through development projects. It has also set up a centralised Freshwater Fish Brood Bank (NFFBB) facility at Bhubaneswar and also supporting State Governments in establishing Brood Banks to ensure availability of quality seed to the farmers.

The Department of Agricultural Research and Education (DARE), MoA through its network of research institutes under the Indian Council of Agricultural Research (ICAR) has been spearheading research, capacity building and human resource development in agricultural and allied sectors in the country. There are eight fishery research institutes in the Fisheries Division of ICAR which include (i) ICAR-Central Marine Fisheries Research Institute (CMFRI), Kochi; (ii) ICAR-Central Institute of Fisheries Technology (CIFT), Kochi (iii) ICAR-Central Institute of Brackish water Aquaculture (CIBA), Chennai, (iv) ICAR-Central Institute of Freshwater Aquaculture (CIFA), Bhubaneswar, (v) ICAR-Central Institute of Fisheries Education (CIFE), Mumbai, (vi) ICAR-Central Inland Fisheries Research Institute (CIFRI), Barrackpore, (vii) ICAR-National Bureau of Fish Genetic Resources (NBFGR), Lucknow and (viii) ICAR-Directorate of Coldwater Fisheries Research (DCFR), Bhimtal. These institutes work on key areas of fisheries and aquaculture and have contributed to the development of a strong foundation towards basic, strategic and applied research in the sector. Technologies generated through these networks have been providing strong support for the development of both capture fisheries and aquaculture sector, and contributed enormously towards increasing fish yield in the country. Over the years, technologies have been generated for induced breeding, seed production and grow-out culture of more than 40 freshwater species cultured in pond, cage and pen environment, including their husbandry, nutrition and pathological aspects. Similarly, seed production and grow-out technologies of more than 12 species including five species of shrimp have been developed to undertake brackish water pond and marine cage farming. The marine capture sector has also witnessed phenomenal development during the post independent era. Mechanisation of fishing fleets, improvement in crafts and gears through innovative designs, by-catch reduction devices, ecosystem-based fisheries management, policies and guidelines for responsible fisheries governance, technologies for bioprospecting of marine flora and fauna and efficient post-harvest value addition and storage are some of the key interventions of the fisheries research institutes of ICAR. Other research

organizations under the ICAR engaged in interdisciplinary research and extension activities such as the Central Inland Agricultural Research Institute (ICAR CIARI), Port Blair; Central Coastal Agricultural Research Institute (ICAR CCARI), Goa; ICAR Research Complex for Eastern Hill Region (ICAR RCEHR), Barapani; ICAR Research Complex for Eastern Region (RCER), Patna and Indian Institute of Water Management (ICAR IIWM), Bhubaneswar have also been contributing to fisheries and aquaculture development in multiple ways. The Central Research Institute for Dryland Agriculture (ICAR CRIDA) is the national nodal point for the National Innovations in Climate Resilient Agriculture (NICRA) which is being implemented at large number of Research Institutes of ICAR, State Agricultural Universities and Krishi Vigyan Kendras (KVKs) since 2011. The project aims to enhance resilience of Indian agriculture to climate change and climate vulnerability through strategic research and technology.

Apart from DARE, the Department of Animal Husbandry and Dairying (DAHD) and the Department of Agriculture, Co-operation & Farmers Welfare (DAC&FW) under the same Ministry have also contributed significantly for the fisheries and aquaculture development through their cross-cutting activities and networks. The Ministry of Commerce is another key player with a significant role in development of the fish production and trade in the country. The Marine Products Export Development Authority (MPEDA) under the Ministry of Commerce is instrumental in promoting the export of fish and fishery products in fresh and value-added forms. The major focus areas of MPEDA include market promotion, capture fisheries, aquaculture, processing infrastructure & value addition, quality control, research and development. This statutory body has its own research wing, seagoing facilities and also funds for research programmes in aquaculture and postharvest technologies. The Rajiv Gandhi Centre for Aquaculture (RGCA) is the R&D arm of MPEDA registered as a society, and is dedicated to augment the Indian seafood exports through sustainable culture technologies, seed production and distribution. Network for Fish Quality Management and Sustainable Fishing (NETFISH), the extension arm of MPEDA stands for improving the quality of fishery products exported from the country and the sustainability of fishery resources as well. It also contributes by imparting knowledge to fisher folk, processing workers, technicians, other fishery stakeholders etc. on fish quality management, conservation of fish resources and sustainable fishing. National Centre for Sustainable Aquaculture (NaCSA) is another outreach organization established by MPEDA in the year 2007 for uplifting the livelihood of small-scale shrimp farmers and promotes them for adoption of better management practices to enhance their production potential and profit.

The Department of Biotechnology (DBT) under the Ministry of Science and Technology as well as the Ministry of Earth Science plays a crucial role by

nurturing and supporting a number of research and development projects and networks that helped in bringing about technological breakthroughs and innovations in the aquaculture and fisheries sectors.

The Coastal Aquaculture Authority (CAA), Chennai established through an Act of the Parliament in 2005 provides for regulating the activities connected with coastal aquaculture and related activities. The Authority takes measures for regulation of coastal aquaculture by prescribing guidelines, and ensures that coastal aquaculture does not cause any detriment to the coastal environment and that various coastal aquaculture activities leads to the sustenance of the livelihoods of various sections of people living in the coastal areas.

The National Institute of Oceanography (NIO) headquartered at Goa is another public funded research organization working under the umbrella of the Council for Scientific and Industrial Research (CSIR) that co-ordinates a number of research programmes closely related to the oceans and marine resources. Other relevant research / development organizations that have direct or indirect bearing on India's fisheries and aquaculture through integrated research and outreach programmes include – Indian Meteorological Department (IMD), Pune; Institutes and Centres under the Earth System Science Organization (ESSO) such as Centre for Marine Living Resources and Ecology (CMLRE), Kochi; National Centre for Ocean Information Services (INCOIS), Hyderabad; Indian Institute of Tropical Meteorology (IITM), Pune; National Institute of Ocean Technology (NIOT), Chennai; National Centre for Polar and Ocean Research (NCPOR), Goa; National Centre for Earth Science Studies (NCESS), Thiruvananthapuram; National Centre for Coastal Research (NCCR), Chennai and the research institutes under the Indian Space Research Organization (ISRO), Bengaluru.

### 2.1.2 State Fisheries Departments

As per the seventh schedule of the constitution of India, fisheries are designated as a state subject. In matters related to fisheries development and governance, the principle of co-operative federalism enshrined in the constitution envisages a complementary role for the union government over the responsibilities of the state governments. Every State and Union Territories of the country has a Fishery Department for development and co-ordination of aquaculture and fisheries sector. While these Departments work directly under the State Ministry, they form the important linkage between the Centre and States for implementation of the central schemes. Almost every Fishery Department has their research and development wing and a network of extension mechanism in all the districts. The State Fishery Departments are basically responsible for addressing the sub-regional and regional issues pertaining to the fish production sector in the States. Towards this objective, many state governments have established public sector undertakings, welfare boards and other similar quasi-government

agencies/entities to supplement the activities of the Fishery Departments. For instance, the Tamil Nadu State Government has established the Tamil Nadu Fisheries Development Corporation Ltd. (TNFDC) and the Tamil Nadu Fishermen Welfare Board (TNFWB) that facilitates production-enhancing, processing and marketing of fish and fish products and other fisher folk welfare activities in the state. Similarly, the Kerala government has created agencies such as the Kerala State Coastal Area Development Corporation (KSCADC), Agency for Development of Aquaculture, Kerala (ADAK), Fish Farmers Development Agency (FFDA), Brackishwater Fish Farmers Development Agency (BFFDA), Kerala Fishermen's Welfare Fund (KFWEB), and societies such as State Fisheries Resource Management Society (FIRMA) and Society for Assistance to fisherwomen (SAF) to discharge various functions related to fisheries and aquaculture development. Besides planning and implementation of the State and centrally funded schemes, the Fishery Department and its affiliated agencies also establish linkage between the research organisations, universities, developmental agencies and the end users to ensure effective implementation of the schemes and programmes.

### **2.1.3 Agricultural/Fisheries University Network**

There are three Central Agricultural Universities and 63 State Agricultural Universities functioning as part of the National Agricultural Research System (NARS) which are dedicated to the service of agricultural and allied sectors including fisheries and aquaculture. These Universities with their technically qualified man power, elaborate professional networks, laboratories and other infrastructural facilities as well as field stations have their share of contribution to the sector. This includes services such as research, education, extension, business incubation, training and consultancy, and is being taken up by the regional research stations and colleges under the state university network. Traditionally, such activities in fisheries and aquaculture form a part of the State Agricultural Universities (SAUs) which in turn form an integral component of the NARS. However, in recent years, several autonomous universities with exclusive and specialized focus on fisheries and aquaculture have come up in many states. Apart from these, a number of traditional public sector universities and newly formed private universities have dedicated Departments that offer courses and curriculum programmes on fisheries, aquaculture and other related subjects thereby strengthening fisheries and aquaculture education in India.

## **2.2 Financial Institutions**

Fishing and aquaculture activities have become increasingly capital intensive over time. Apart from the investments made using own funds of individuals and private entrepreneurs, institutional financing has a crucial role to play in the

sector to enable efficient production and marketing activities. A considerable part of this capital requirement is being met by the elaborate network of banking institutions which consists of 12 public sector banks, 22 private sector banks, 46 foreign banks, 56 regional rural banks, 1485 urban cooperative banks and 96,000 rural cooperative banks in addition to co-operative credit institutions (IBEF, 2020). Apart from this, a number of non-banking financial institutions, informal money lending agencies and individuals also contribute to the credit requirements of the sector on a regular basis (Parappurathu et al., 2019).

The National Bank for Agricultural and Rural Development (NABARD) is the apex public finance institution vested with the responsibility of regulating and licensing the regional rural banks (RRBs) and apex co-operative banks as well as extending credit and refinance for the development of agricultural, allied sectors since its establishment in 1982. NABARD has an extensive network of 31 regional offices and 336 district development offices across the country besides 6 training establishments. The self-help group (SHG)-bank linkage programme and the Kisan credit card scheme (KCC) initiated and implemented by the bank had considerable impact for the small and micro enterprises in India's rural agricultural sector including fisheries and aquaculture.

### 2.3 Fishery Co-operatives

Co-operative movement has strong roots in India, having spread across a number of diverse sectors, and time-tested for its efficacy to bring about changes in the livelihoods of a substantial section of resource poor farmers and entrepreneurs. The first fishery co-operative in India was established in 1913, when a fisherman society was organized in the name of 'Karla Machhimar Co-operative Society' in the state of Maharashtra. Soon, followed suit by the fishermen of West Bengal and Tamil Nadu, the structure continued to grow over years into multifunctional units at various levels (ICAR, 2011). Presently, the fishery co-operative network in India has over 3.35 million members hailing from all over the country. The network has a federated structure with an apex national level federation, a number of state/regional federations, district-level societies and primary co-operative societies (Annexure 1).

The National Federation of Fishers Cooperatives Ltd. (FISHCOPFED), presently the apex national-level federation of the co-operative network in India was registered in the year 1980 under the Maharashtra State Cooperative Societies Act. Given its apex role, presently it is governed under the Multi State Cooperative Societies Act 2002. The administrative control of the Federation is under the MoFAD, Government of India. FISHCOPFED is having 110 member institutions including the Government of India and the National Co-operative Development Corporation (NCDC), and a nominal membership of 18,407 all over the country. Its main objectives are to promote and develop the fishery



cooperative movement of India, to educate, guide and assist fishers in their efforts to build up and expand the fishery cooperative sector and serve as an exponent of cooperative opinion in accordance with cooperative principles. It is one of the best service delivery systems in the country empowering the poor fisher members.

At the state level, there are 21 fishery co-operative federations which function mostly in independent and autonomous mode. Under them, there are 139 regional/district level co-operatives, and 21,741 primary societies. The state-level fishery co-operative federations with active support from their extended network have been playing a prominent role in undertaking and co-ordinating a variety of developmental functions for developing fisheries and aquaculture over decades. Their key interventions include ensuring the right of first sale of harvested fish to fishermen, providing technical and logistical support at the fish landing centres, extending credit and insurance coverage, provision of safety gears for fishers at subsidized rates, promoting innovative and scientific fish production practices, facilitating input and service delivery, microfinance and microinsurance, operation of retail fish marketing networks and cold chains, extending technical and financial assistance for fish marketing and primary processing activities, value added product development and sale, skill development and business incubation programmes for entrepreneurs and fisherwomen. Some of these federations have also ventured into eco-tourism and sport-fishing activities in recent times. Some widely popular and successful state-level fishery co-operative federations in India include: The Karnataka State Co-operative Fisheries Federation Ltd. (KSCFF) established in 1954, Kerala State Co-operative Federation for Fisheries Development Ltd. (MATSYAFED) established in 1984; West Bengal State Fishermen's Co-operative Federation Ltd. (BENFISH); A.P. State Fishermen Co-operative Societies Federation Ltd. (AFCOF); Tamil Nadu State Apex Fisheries Co-operative Federation Ltd. (TAFCOFED) and Gujarat Fisheries Central Co-operative Association Ltd. (GFCCA).

#### **2.4 Farmers Producer Organizations (FPOs)**

Farmer Producer Organizations (FPOs) are non-political legal entities formed by primary producers with a view to enhance their business opportunities through organized service delivery systems. An FPO can have various legal forms including co-operatives and societies but the recent thrust is to encourage incorporation of farmer producer companies (FPCs) which is a hybrid between co-operative society and private limited company. The main aim of FPOs is to ensure better incomes for their member farmers through integration of input delivery services as well as produce marketing services under the larger umbrella of a legally tenable organization so as to benefit from associated

economies of scale. FPCs with fishers and fish farmers as members are only limited in number. This is mainly due to the disproportionate emphasis given by the government to the crop sector so far in the FPO-related policies and programmes. However, this lacuna was recognized lately and an announcement was made to set up 500 Fish Farmer Producer Organizations (FFPOs)/ Fish Farmer Producer Companies (FFPCs) under the on-going flagship scheme, *Pradhan Mantri Matsya Samapada Yojana* (PMMSY) with an objective of economically empowering the fishers and fish farmers. To harness this opportunity, a number of small holder fish farmers, fishermen and entrepreneurs in various parts of the country are gearing up for forming new FPCs.

## 2.5 Non-Government Organisations (NGOs)

There are a number of domestic and international non-governmental organisations (NGOs) that are actively engaged in developmental and conservation activities related to India's fisheries and aquaculture sector. Their range of activities and sphere of influence vary considerably depending on the source of funding, basic objectives and linkages. Some of the notable areas of NGO interventions include protection and conservation of marine ecosystems, habitats and vulnerable organisms, climate change adaptation and mitigation, protection of the rights and livelihoods of the fisher folk communities, input and service delivery, fish marketing, value addition and allied activities as well as provision of social safety nets. Some of the prominent NGOs that have been maintaining longstanding stakes in India's fisheries/aquaculture include: the South Indian Federation of Fishermen Societies (SIFFS) based in Trivandrum; Dakshin Foundation, Bangalore; Action for Protection of Wild Animals (APOWA) and Alacrity in Odisha; Wildlife Trust of India, Noida, the Ashoka Trust for Research in Ecology and the Environment (ATREE), Bangalore and Centre for Aquatic Livelihood-Jaljeevika, Pune. The organizations such as the Society for Indian Fisheries and Aquaculture (SIFA) and Aquaculture Foundation of India (AFI) promote sustainable fisheries and aquaculture through provision of latest technologies, products, services, equipment and machineries to benefit the fish farmers and act as a common platform for various stakeholders in the sector. Some of the international NGOs such as Greenpeace and WWF that have cross cutting objectives have their presence in fisheries sector too. However, some of them such as the Sustainable Fisheries Partnership (SFP), The World Forum of Fish Harvesters and Fish Workers (WFF), Wildlife Conservation Society-India (WCS-India), Asian Fisheries Society (AFS), and the International Collective in Support of Fish-workers (ICSF) take exclusive interest in the fisheries sector and have an active presence in India. Similarly, a number of digital networks also operate in various spheres related to fisheries and aquaculture. Some such prominent networks operating in India include the

Marine Mammal Research and Conservation Network of India (<http://www.marinemammals.in>); Wildlife Conservation Network (<https://wildnet.org>); Students' Sea Turtle Conservation Network ([www.sstcn.org](http://www.sstcn.org)); IUCN Freshwater Fish Specialist Group (IUCN-FFSG) & Freshwater Fish Conservation Network of South Asia (FFCNSA) (<http://www.iucnffsg.org>) and TRAFFIC (TRAFFIC | Wildlife trade specialists).

## 2.6 Private/ Corporate Establishments

Sectorial growth of aquaculture largely depends on availability of quality seed, feed, fertilizers, therapeutics, etc. While technology generation for production of quality seed and feed have been the responsibility of the research organisations both in government and private sector, the effective adoption of these technologies can be possible only when these inputs are made available for larger commercial use. Therefore, the allied industries involved in producing these inputs are also important for aquaculture development. The last two decades have witnessed participation of many corporate entities in the aquaculture development process both in research and production-oriented activities. Similarly, several enterprises have established feed mills and units for production of other aquaculture inputs. Supply of balanced fish feed has enabled the aquaculture industry in achieving higher fish production. Similarly, timely availability of many drugs and therapeutics had significantly reduced the risk of crop loss and thereby, promoting the aquaculture activity. The fishing vessel and gear industry, seafood processing industry and small and medium enterprises engaged in post-harvest handling and value addition, cold storage, and other logistical support also have their share in development of fisheries and aquaculture in India.

## 2.7 Fishermen/ Fish Farmers' /Traders' Associations

Associations of fishermen, fish farmers and traders have played a significant role in shaping the development narrative of India's fisheries and aquaculture sectors. During the past half a century, many of these associations and unions have remained an integral part of mass agrarian movements that helped the grassroots level workers and the small-scale producer community in securing their basic rights and gaining certain level of bargaining power in a sector that was then heavily polarized by the disparities in resource endowments and access to technology. In the marine fisheries sector, these associations represented the interests of different factions of the fishermen community that are segregated by the 'technological divide' and having competing interests (Kurien, 1978; Sinha, 2012). For instance, in southern India, there are separate associations for owners of trawlers, purse seiners, ring seiners and non-motorized units, with differing points of view on fisheries management. Some of these associations maintain political leanings and remain affiliated to the dominant political parties of the

region. The Boat Owners' Associations that have active presence in most of the major fishing harbors across coastal India play multiple roles in organizing the vessel-owning community and taking care of their routine requirements such as assured supply of fuel, logistic support, market assistance, insurance cover and so on. Majority of these associations have their activity limited in a particular state or region though there are a few national-level associations with a pan-India presence. The National Fish Workers Forum (NFF) registered under the Trade Union Act of India, is a national federation of state level small and traditional fish workers' unions of India. The NFF has affiliated organizations in all the coastal states and union territories of the Indian mainland and focuses on protecting the life and livelihood of the fishing communities, fisheries resources, biodiversity and natural environment. It also is a major partner of the international movement of the fishing communities led by World Forum of Fisher Peoples (WFFP) (Nayak and Vijayan, 2006). Fish farmers in some states have formed associations and unions and take active part in the aquaculture activities through planning and working in a more organized manner. They remain in constant touch with the range of business entities in the sector and strive to ensure adequate supply of seed, feed, equipment and machinery, bank credit, insurance coverage and other inputs and services for their member farmers. The Seafood Exporters Association of India (SEAI) is an association of the exporters with a motto to protect and promote the interests of the marine product export industry and find solutions for larger global issues that could adversely affect India's seafood export prospects. In nutshell, such associations and unions often form an important linkage between the fishers, farmers, the government machinery and the larger civil society in understanding emerging issues and constraints and responding to them in a collective manner.

## **2.8 Other International/ Inter-governmental Organizations**

A number of international development agencies have been taking active interest in development of fisheries and aquaculture sectors of India. The Food and Agricultural Organization of the United Nations (FAO) maintains constant engagement with Indian fisheries through the Committee on Fisheries (COFI) and its sub-committees. The Bay of Bengal Large Marine Ecosystem (BOBLME), which is an eight-country regional forum, is being hosted by India at Chennai. Similarly, the Bay of Bengal Programme - Inter-governmental Organization (BOBP-IGO), another four-member regional forum hosted by India is mandated to enhance regional cooperation and provide technical and management advisory services for sustainable coastal fisheries development and management in the Bay of Bengal region. The World Fish Centre, Penang in recent years has been associated with aquaculture and livelihood improvement projects in India. The fisheries and aquaculture related matters that require regional co-operation in South Asia is addressed through South Asian Association for Regional Co-

operation (SAARC) and its arm, the SAARC Agricultural Centre (SAC), Dhaka. The International Fund for Agricultural Development (IFAD) is an international financial institution and a specialized agency of the United Nations that undertakes wide-ranging developmental activities in India's fisheries and aquaculture sectors. India is also associated with various other global and regional bodies dealing with fisheries such as the Indian Ocean Tuna Commission (IOTC), Asia-Pacific Fishery Commission (APFIC); Network of Aquaculture Centres in Asia and the Pacific (NACA); Intergovernmental Organization for Marketing Information and Technical Advisory Services for Fishery Products in the Asia and Pacific Region (INFOFISH); Convention for Conservation of Antarctic Marine Living Resources (CCMLR); Commission for International Trade on Endangered Species (CITES); International Whaling Commission (IWC) and Indo-Pacific Fisheries Commission (IPFC).

### **3. Role of Governance instruments and private sector in supporting fish farmers and fishers through cross learning**

#### **3.1 Fisheries governance structure and regulatory instruments**

The Seventh Schedule of the Constitution of India at Entry 57 of List 1 specifies Fishing and Fisheries beyond Territorial Waters as Union Subject, whereas Entry 21 of List II speaks of Fisheries as a State Subject. Reading both the Entries together, it follows that control and regulation of fishing and fisheries within territorial waters is the exclusive province of the State, whereas beyond the territorial waters, it is the exclusive domain of the Union. The Union Government acts as a facilitator and coordinator responsible for policy formulation, carrying out fishery research and channelizing funding support to the states in line with the national priorities and the commitments made to the State/UT Governments. As noted before, the MoFAD within the purview of its allocated business is mandated to assist the coastal States and the UTs in development of fisheries within the territorial waters, besides attending to the requirements of the sector in the exclusive economic zones (EEZ). DoF under the ministry acts as the focal point for fisheries development and management in the country. Therefore, management of fishery in the EEZ requires close coordination between the Union and the States (ICAR, 2011; GoI, 2018).

Fishery in general is open access in India and is governed by different acts introduced by the government over the years. Majority of these deals with the regulation of marine fisheries. The most relevant ones which have either direct or indirect bearing on the governance of fisheries and aquaculture are the following:

- The Wild Life (Protection) Act, 1972,
- Marine Products Export Development Authority Act, 1972

- The Territorial Waters, Continental Shelf, Exclusive Economic Zone and other Maritime Zones Act, 1976
- MFR (regulation) Bill, 1978 formulated after the EEZ declaration,
- Indian Coast Guard Act, 1978
- Maritime Zones of India (Regulation of Fishing by Foreign Vessels) Rules, 1982
- Environment (Protection) Act, 1986.
- Trade Unions (Amendment) Act 2001
- The Biological Diversity Act 2002
- Coastal Aquaculture Authority Act 2005,
- Coastal Regulation Zone, Notification, 1991 (re-notified in 2011 and 2019)
- Wetlands (Conservation and Management) Rules, 2010
- National Policy on Marine Fisheries, 2017

The challenges encountered in the fisheries sector, have been addressed through several interventions with the aim of sustainably exploiting the resources available in coastal and inland waters with due consideration for their conservation and protection. In 2004, the Government of India brought out the first Comprehensive Marine Fishing Policy, which set a framework for sustainable development of the fisheries sector in the millennium. To keep pace with the unfolding new requirements from harvest and sustainability point of view, the Government subsequently brought out the National Policy on Marine Fisheries, 2017 after elaborate stakeholder consultations. The government is presently in the process of bringing out a comprehensive 'National Fisheries Policy' that addresses the development priorities of all sub-sectors of fisheries and aquaculture including inland fisheries, mariculture, post-harvest processing and value addition.

However, there is still no law in effect to regulate the operation of Indian-owned fishing vessels operating in the EEZ, beyond and adjacent to the territorial waters. The Indian Marine Fisheries Bill, 2021 which is scheduled to be introduced in the parliament is expected to fill this legislative vacuum. The provisions under the Wildlife (Protection) Act, 1972 have been used to set up marine parks/ sanctuaries along the coastline in India with the larger objective of protection/ conservation of fauna and flora without infringing on the livelihoods of traditional fishers.

### **3.2 Marine Fishing Regulation Acts of the coastal States/ Union Territories**

The marine fishing activities within the territorial waters of maritime states are governed by the respective Marine Fisheries Regulatory Acts (MFRAs). These were first conceived in response to the growing conflicts in the coastal waters

during the late seventies. To reduce the conflicts and allow for regulation of fisheries in the territorial waters, the then Ministry of Agriculture formulated a Model Bill, which was circulated to the coastal States/UTs in 1979. The states of Kerala and Goa were the pioneering states to pass their own MFRAs in the year 1980 and other maritime states followed suit in subsequent years (List of MFRAs is provided in Annexure 2). The MFRAs contain several provisions to regulate, restrict or prohibit unsustainable / destructive fishing practices, to define access rights, to impose spatial and temporal fishing restrictions and to make licensing and registration of fishing vessels compulsory. Clauses to penalize non-compliance and appellate provisions are also inbuilt in them so as to ensure fair governance of fishing and related activities. The notable management measure that has been strictly enforced in all the maritime states and coastal Union territories is the 'closed fishing season' presently observed for a period of 61 days that coincide the peak fish breeding period in order to avoid catching of spawning and juvenile fish. Presently, the Union Government exercises closure of fishing and is enforced by the coastal State/UTs through 'Executive Orders'. Other major instruments include regulation of mesh size to avoid catching of juvenile fish, legal sizes for commercially exploited fish species, regulation of gear to avoid over-exploitation of certain species and reservation of zones for various fishing sectors to provide exclusive rights to traditional fishermen to fish unhindered in near shore areas. In 2017, the state of Kerala introduced minimum legal size (MLS) for 58 commercially exploited fish species for the first time in India to control juvenile fishing. The encouraging results from this experience have prompted several other coastal states to bring about changes in their MFRAs to accommodate MLS regulations. Other important aspects of regulation include vessel movement control, vessel inspection, and colour coding of vessels. Measures such as issue of biometric cards to fishermen and centralized online database on registration status of fishing boats are the latest steps being implemented with the help of states to facilitate better sea safety arrangements as well as monitoring of vessel movements (Parappurathu et al., 2017).

### 3.3 Major developmental schemes and programs

Developmental efforts in fisheries and aquaculture in India from time to time are mainly co-ordinated and implemented through schemes administered by the union government and the respective governments of the states and the UTs. During 2015-2019, the Centrally Sponsored Scheme titled "Blue Revolution: Integrated Development and Management of Fisheries" (both marine and inland) with a total outlay of Rs. 30.0 billion has been the main vehicle for such centre-state co-ordination on fisheries development. From 2020 onwards, the scheme was re-organized under the umbrella flagship scheme, PMMSY – mandated with sustainable and responsible development of fisheries sector in India at an allocation of Rs. 200.5 billion for holistic development including

welfare of fishers. PMMSY is being implemented in all the States and Union Territories for a period of 5 years from FY 2020-21 to FY 2024-25. The scheme is designed to address critical gaps in the fisheries value chain from fish production, productivity and quality to technology, post-harvest infrastructure and marketing. It aims to modernize and strengthen the value chain, enhance traceability and establish a robust fisheries management framework while simultaneously ensuring the socio-economic welfare of fishers and fish farmers. It is targeted to attain an additional fish production of 7.0 MMT, to double fisheries exports to Rs. 1000.0 billion and to generate 5.5 million employment opportunities for socio-economic development through PMMSY. The scheme, like other previous schemes has separate components for streamlining the funding: (i) Central Sector Schemes (CS) and (ii) Centrally Sponsored Schemes (CSS) wherein part of the project cost is shared by the State governments based on certain set of guidelines. Apart from the above umbrella scheme, the state governments design and implement a number of state-specific schemes and programmes to meet the developmental needs of the sector from time to time.

### **3.4 Extension, business incubation, skill development and training**

Effective participation of private entrepreneurs in fisheries and aquaculture activities is ensured through a slew of mechanisms for technology demonstration and piloting, business incubation, skill upgradation, training and capacity development programmes, with active support from research and development institutions as well as local self-government organizations. India has an elaborate network for frontline extension and technology transfer of agricultural and allied technologies that include Agriculture Technology Information Centres (ATIC)-single window for technology dissemination at ICAR research institutes and SAUs; Agricultural Technology Management Agency (ATMA), Krishi Vigyan Kendra (KVK)-extension wings of the ICAR at district level; and Agribusiness incubators (ABI) in selected research centres and universities to promote potential technologies into commercial ventures by involving promising entrepreneurs. Apart from this, there are a number of successful private extension models spearheaded by corporate companies and strengthened by input dealers, Agribusiness Centres and Agri Clinics at local levels. These have proved to be effective in providing information and support services, inputs, credit and marketing assistance, organizational and capacity development as well as entrepreneurship development (Sajesh et al, 2018). The training needs of fish farmers and fishers are met to a great extent by KVKs, Research Institutes and public entities such as Agricultural Skill Council of India (ASCI), MPEDA, RGCA, SAUs, and training establishments run by State Departments.



## 4. Case studies on cross-learning applications that improved fisheries and aquaculture in the country

Notwithstanding the tremendous achievements in terms of production and productivity enhancements, the capture and culture fisheries in India have however witnessed several challenges. Fortunately, most of the disruptions in production were overcome through suitable interventions by a synergy of individuals, research departments, fisheries societies, Federations, State fisheries and Central Fisheries Departments. The consumer demand for fish has been ever increasing and an equilibrium in supply-demand gap can be achieved through a combination of aquaculture and improved capture techniques. The section below provides accounts of some notable cases where networking across entities has helped the sector tide over crises and maintain a steady growth momentum.

### 4.1 Control of the Epizootic ulcerative syndrome (EUS) in carps

The Epizootic ulcerative syndrome (EUS) in fish is considered the most dreaded disease ever in the aquaculture sector of the country. It is primarily caused by the invasive water mould *Aphanomyces invadans* that grows on a body lesion and invades the body cavity and produces mycotic granulomas in all the visceral organs (Viswanath et al., 1998). This water mould was first recorded in the natural waters of India in 1988, and since then, has plagued almost all fishes inhabiting in it and has had a catastrophic impact on the fishery. With its entry into the culture system, EUS had played havoc in all the geographic regions of the country, seriously impeding the aquaculture activity. Almost every stakeholder from farmers to researchers have played a role in trying different formulations, starting from plant materials, chemical application or combination of both to contain the disease outbreak. Various formulations had been used by farmers but with limited success of disease control. However, ICAR-CIFA has developed CIFAX, a chemical formulation which by far has been the most effective one to control the EUS in grow-out pond. Subsequent extension efforts with active support from line departments and local-level development agencies made it possible to broad-base the impact of this technological intervention, thus resulting in effective control of the disease all over the country.

### 4.2 Interventions to overcome impact of White Spot Syndrome Virus (WSSV) in shrimp farming

Largescale intensive and organized shrimp farming, mostly of *Penaeus monodon*, began in the 1990s and the sector achieved remarkable success during the following five-year period (Vijayan, 2018). Organizations such as the MPEDA, DBT and through initiatives such as Andhra Pradesh Shrimp Seed Production Supply and Research Centre (TASPARC) and Orissa Shrimp Seed Production Supply and Research Centre (OSPARC) were instrumental for this noteworthy

evolution of shrimp farming in the country. However, aquaculture of *P. monodon* was severely affected by White Spot Syndrome Virus (WSSV) leading to a total collapse of multi-million shrimp farming activity since 1995. A therapeutic solution to control and prevent the spread of the virus leading to mass mortality of the farmed shrimps was to adopt suitable preventive strategies. Specific Pathogen Free (SPF) and Specific Pathogen Resistant (SPR) brood stock of *L. vannamei* were introduced in 2009 with encouragement in the form of subsidy for pond development, construction of new ponds, first year inputs, etc. under centrally sponsored (DoF, GoI, NFDB, MPEDA) subsidy schemes implemented by majority of the State Governments through FFDA/ BFFDAs for different categories of farmers (Koteswari et al., 2014; Aquaculture Authority News, 2019; Salunke et al., 2020). The combined involvement of the government, research organisations, CAA, and shrimp farmers societies have helped bringing shrimp farming activities back on track.

### 4.3 Disease surveillance to reduce crop loss

In fish farming, the animals are stocked in more density than that in the natural ecosystem and in that way, exposed to pathogen attack. However, apart from a few parasitic and bacterial infections with external identifying feature on the body, many of the disease and infection often go unnoticed. This happens mostly in stressed condition resulting in poor growth and yield. However, with increased level of farming, research thrust on health management has been stressed in the recent years. At present, disease surveillance programme is in place at a national level and being implemented in 17 states to track and report the occurrences of the disease (Jena and Das, 2020). The programme under the name 'National Surveillance Programme for Aquatic Animal Diseases (NSPAAD)' was first initiated by the MoFAD in 2013 with the support of NFDB at an estimated cost of about US\$ 6 million. The program involves active partnerships between State Fisheries Departments, Fisheries Colleges and ICAR Fishery Institutes. Similarly, a number of disease diagnostic kits have been developed over the years which aids in early detection of disease in fishes. A number of chemicals and drugs are also available to prevent and treat diseases which have helped in reducing the loss.

### 4.4 Increasing seed production for aquafarming

The entire aquaculture system till the middle of last century was relying entirely on wild fish seed collected from riverine and brackishwater sources. Besides uncertainty in timely availability, such seed sources were marred with mixing of unwanted seeds along with the desired one which often led to low survival and growth. Various universities and Research Institutes in the country worked towards finding a solution. Development of the induced breeding technology

through hypophysiation by the erstwhile Pond Culture Division of CIFRI (Presently ICAR-CIFA) and strongly supported by the Government with implementation of several schemes including the AICRP on Spawn Prospecting (later merged with Composite Fish Culture to one AICRP) in 1970s was a breakthrough in this regard. Since the successful demonstration of composite fish culture technique through AICRP, there was a huge demand for carp seed and it led to scarcity of the pituitary gland (PG). This prompted the intervention of the pharmaceutical companies to produce a synthetic analogue substitute for the PG extract. As a result, inducing agents like Ovaprim, Ovotide, Wova FH, etc. are available to seed producers which has not only increased the seed production efficiency, but also helped in breeding a wide range of cultivable fishes in addition to carps. Simultaneously, the technology for induced breeding and standardization of seed production protocol was achieved through interventions by the farmers and researchers over the years. Today, India is self-sufficient in supply of freshwater fish fry supply to the aquaculture sector and the seed production of more than 40 important freshwater cultured species have been standardised (Raizada et al., 2019).

Similarly, in brackishwater sector, seed production technologies have been developed for five indigenous and one exotic marine shrimp, ensuring a continuous seed supply for shrimp farming despite substantial increase in demand. Technology for induced breeding and seed production has also been established for more than ten species of brackishwater and marine finfishes during the last decade through the concerted efforts of ICAR-CMFRI, ICAR-CIBA, RGCA and other fisheries research organisations of the country. Assured availability of seed of these commercially important food fishes has widened the scope of finfish farming in brackishwater pond and cage culture in open sea. Further, development of an array of seed production technologies of more than twenty high-valued ornamental fish has strengthened the ornamental trade and the country is moving towards a healthy public-private partnership enterprise in this realm (GoI, 2020).

The need-based seed production technology developed and popularised mainly by research institutions has now reached commercial scale. Such development in fish breeding and seed production technologies over the years is a typical example of cross-learning among stakeholders by integrating and empowering the entrepreneurs, fisheries development agencies, State/UT Fisheries Departments and Fisheries Research Institutes with regard to financial, technical and marketing aspects.

#### **4.5 Development of mechanisms to ensure quality of fish seed**

Quality seed is the key to success of grow-out farming. However, due to lack of certification and hatchery accreditation in the freshwater sector, the fish seed

production sector has largely remained disorganized. As a result, hatchery owners in several States were not following the basic norms in hatchery operations. While there was high demand for seed, availability of space to raise broodstock and maintain them in the farm was constrained. As a result, many hatcheries were producing seed based on the availability of broodstock. Since hybridization is possible among three species of Indian major carps (catla, rohu and mrigal) and kalbasu, the unscrupulous use of these species based on availability had led to widespread production of hybrid seed, particularly in the eastern and north-eastern states, resulting in the poor grow-out performance and low yield. However, many State Fishery Departments have implemented special drive for increased awareness among the farmers and hatchery owners about the benefit of using good quality seed. Support in terms of various schemes had been ensured. Some States have already formulated their 'State Fishery Policy' and have increased vigilance to restrict the hybridization process. Hatchery certification for quality seed has been initiated at several places. Use of cryopreserved sperms of fishes has been used in some hatcheries to improve the seed quality. Selective breeding programmes were implemented in the research Institutes to improve the quality of the seed as in case of rohu, catla, freshwater prawn and Amur carp. Farms in different areas across the major producing States have been identified to propagate the use of improved seeds. The NFDB has established a National Freshwater Fish Brood Bank facility at Bhubaneswar to ensure supply of improved breeder seeds of important cultivable species to different States. At the same time, NFDB has supported establishment of State Level Brood Bank facility to further widen the supply of quality seed to the farmers. Such efforts over the years have transformed the seed production sector to an organized one with production of quality seed to ensure better fish yield.

#### 4.6 Ensuring adequate fingerlings supply

Fingerling of fishes are the appropriate stocking size considered for the success of grow-out farming due to their higher post-stocking survival. However, there has always been a dearth in the supply of fingerling partly because of the reluctance of the farmers to spare the three months of culture period for seed rearing. Non-availability of fingerlings leads to fry stocking in grow-out ponds which often resulted in poor survival and low production. Over the years, efforts were made by the State Fisheries Department and other extension machineries to create awareness on the benefit of stocking larger seeds (fingerlings) for better survival and production. Several schemes have been implemented from time to time towards achieving this goal - a notable one was the launching of 'Mission fingerling' by Govt. of India in 2017 (DAHD&F, 2017) that aimed to produce 426 crores fish fingerlings and 25.50 crores post larvae of shrimps and crabs in the country. Besides, the NFDB is also promoting *in situ* rearing of fish fingerling for release in the open waters to strengthen the culture-based capture fishery.

Early breeding protocol, off season breeding, use of specialized brood stock diet for early maturation (CIFABROOD™ by ICAR-CIFA), high density seed rearing for stunted juvenile production are some of the tools developed and used in the aquaculture sector for ensuring round-the-year availability of juveniles for grow-out stocking. These developments have opened up avenues for the farmers to practice varied cropping pattern such as single stock multiple harvests, multiple stock multiple harvest and multiple cropping, all realizing higher productivity.

#### 4.7 Promotion of bi-species, poly culture and Integrated Multi Trophic Aquaculture

Development of carp farming in the country has been mostly based on the composite farming of the Indian major carps (catla, rohu and mrigal) or along with the exotic carps (silver carp, grass carp and common carp) that ensures optimum utilization of the total pond niches. Over the years, while silver carp has lost its popularity, bottom dwellers such as common carp and mrigal have been gradually discarded due to harvest problem and slow growth. As a result, rohu has come up as the major species constituting almost 80-90% of the stock and the rest is of catla. Although this bi-species culture is against the principle of composite fish farming, farmers have promoted such practice due to the market driven demand for the two species and has been adopted in almost all parts of the country.

The bi-species and poly culture have been adopted in mariculture too with several compatible food fishes being cultured simultaneously. This concept has been popularised and encouraged by departments and is well accepted by fish farmers. The Integrated Multi Trophic Aquaculture (IMTA), where organisms of different trophic levels are farmed to improve production efficiency, reduce waste, and provide ecosystem services, such as bio-remediation is being encouraged by different departments. Integrated farming involving finfishes, shrimps, bivalves and seaweed is being practiced in estuarine and open sea cage farming with very good yield (CMFRI, 2015,2016,2019; Johnson et al., 2019a).

#### 4.8 Cage farming in open waters

The country is having approximately 0.195 million km of rivers and canals, 3.15 million ha reservoirs and 0.5 million ha flood plain wetlands. Fish production potential of these open waters have largely remained underutilised until the last decade. Fish yield from reservoirs have been reported to be 82 kg ha<sup>-1</sup>, despite having the production potential of 500, 250 and 100 kg ha<sup>-1</sup> from small, medium and large reservoirs, respectively (Jha, *et al.*, 2013). Efforts have been made over the years to promote fish production in these inland waters. Several States have framed their Reservoir Fishery Policies for overall management and sustainable increase in fish production. Cage farming in the reservoirs has been

overwhelmingly supported by the Ministry of Agriculture and the NFDB. A National Level Committee to Develop Guidelines for Cage Culture in Inland Open Waters' (NCGCC) was constituted in 2016 and entrusted with the mandate to assess the potential of cage farming to increase production, income and employment generation; to assess environmental and socio-economic impact of cage farming; and suggesting the mode of upscaling of cage farming on a sustainable basis (NFDB, 2016). Many State Fishery Departments with support from NFDB have promoted large scale cage farming in reservoirs. States like Chhattisgarh and Jharkhand have been undertaking large scale cage culture of exotic *P. hypophthalmus* in reservoirs and rivers. Similar attempt of cage farming has also been undertaken by the Fishery Department of Odisha in the Rushikulya and Mahanadi River system and in the Hirakud reservoir.

Cage farming of finfishes in the estuarine and open sea has been an important intervention made during the recent past spearheaded by ICAR-CMFRI with great success in the country. In the face of limited suitable land area and with the responsibility of enhancing production to meet the increasing demand for fish, farming food fishes in open waters using cages was initiated by CMFRI in mid-2000s. (Rao, 2012; Rao et al., 2013; Philipose et al., 2017; Johnson et al., 2019b; Megarajan et al., 2018) The transition from capture-based mariculture to availability of hatchery produced seeds, faster growth rate of marine fishes with production as compared to land-based aquaculture was quick. The synergistic association of the research institutes in developing the open sea cage farming technology followed by success in seed production of marine finshes, encouragement provided by the line departments to the farmers, the marketing agencies and the enthusiasm of the farmers has contributed to faster expansion of cage farming a major intervention in the PMMSY programme to increase the fish production in all suitable open waters.

#### 4.9 Seaweed farming

Seaweed farming in the country was initiated more than three decades ago through trials of *Gracilaria edulis* farming along the southeastern coast of Tamil Nadu. Interventions from research organizations such as the Central Salt and Marine Chemicals Research Institute (CSMCRI) and CMFRI, further contributed to the advancement of the seaweed farming. However, seaweed farming largely remained unorganized and impetus for large scale farming of seaweed came with the involvement of local fishers, especially women. This was coupled with interventions such as arrangements for marketing the harvested seaweeds and with the permission granted by the Government to cultivate the exotic red algae *Kappaphycus alvarezii*. Large scale farming of seaweeds was subsequently made possible through collaborative efforts involving National research institutes, State fisheries Departments, SHGs, FFPO and IFFCO and by ensuring funding

support for training, demonstration, financial assistance programmes and establishment of seaweed processing units. (CSMCRI, 2002; Immanuel and Sathiadhas, 2004, Krishnan and Narayanakumar, 2010). The success of these efforts was apparent for the first time when the cultivation technology was transferred to PepsiCo India Holdings Ltd. in 2001 and eventually to M/s. Aquagri Processing Pvt. Ltd (Anon, 2003). The implementation of seaweed farming schemes through the SHG *Kutumbam* (family) model yielded better coordination among the seaweed farmers and also resulted in higher productivity (Kaladharan et al., 2019). National financial institutions like the State Bank of India (SBI) and NABARD provided financial support through loans for commercial seaweed farming. In recent times, there is a renewed focus on seaweed farming with the announcement of a slew of research and development programmes by various Departments of the government, success achieved by the research institutes in development of a number of commercial products from seaweeds and the newfound enthusiasm observed in the industry and entrepreneurs to capitalize the emerging opportunities.

#### 4.10 Mussel farming

The green mussel (*Perna viridis*) is an important and popular marine edible bivalve especially in Kerala. The scientific farming technology developed by ICAR CMFRI in the 1980s enabled quick adoption, which in turn ensured a steady supply of green mussel in the region. The ease of culture and the high demand subsequently resulted in rapid horizontal expansion and establishment of large mussel farms by the aquafarmers and women's Self-Help Groups (SHGs). Financial assistance for these early efforts was made available through Swarnajayanthi Gramaswa Rosgar Yojana (SGSY), a scheme that takes care of economic empowerment of weaker sections and focuses attention on poverty alleviation through organized Self-Help Groups. The mussel farming activities flourished in Kerala mainly because of the cohesive actions and collaboration of different networking institutions and mussel farmers in the region. The green mussel seeds for farming were mainly sourced from the wild and year-round availability of seeds gradually became a limiting factor. The technology for mass scale seed production of green mussels by ICAR-CMFRI over the last few years has addressed this gap and is now able to supply good quality green mussel seeds to the farmers. However, of late, the green mussel farming has been witnessing setbacks mainly due to prevalence of disease. The issue is being closely monitored by research institutions. These transient problems however can be solved with the right interventions from research organizations, aquafarmers, line departments and with handholding by government and non-government organisations so that mussel farming gets back to its past glory.

#### 4.11 Organized marketing of fish and fishery products

Fish and fishery products are highly perishable commodities and unless the fishes are well preserved and transported to the destination (consumers) in the shortest time, the quality as well as the value of the commodity get affected. Most of the fish produced in the inland sector are consumed in the domestic market. Though part of the marine catch is exported, a big share is taken by the domestic consumers. Value addition increases the shelf life to a certain extent but domestic preference is mostly for fresh fish. Good marketing channels with excellent cold chain networks therefore are crucial in this sector. The MPEDA and Export Inspection Council (EIC) through awareness and support schemes have emphasised the need for maintaining the quality of fishes especially fishes that are to be exported. Establishment of modern processing plants including fish meal plants, hygienic drying methods also have gone a long way opening better avenues for marketing and procuring a fair price for these valuable but highly perishable commodity even during glut landings. However, except in few states, the domestic fish marketing system until recent years has remained mostly disorganized. Perishability of the fish in disorganized marketing system has been a major constraint to realize fair market price of the commodity. While absence of suitable transportation facility restricts longer distance movement, the glut production often severely affects sale price as well as keeping quality of the product at the end user level. The NFDB along with the State Fishery Departments have implemented several schemes to strengthen the cold chain facility and establish state-of-the-art fish markets in different places. Schemes supporting the retailers and vendors through supply of vehicles and insulated fish vending machines were also put in place. Organization of the fish producers on sub-regional basis has helped in organized harvesting and transport of fish. Further, promotion of the cold chain facility in the system has not only increased the reach to interior areas, but also ensured price stability of the commodity. Improvements in marketing channels also figures as an important aspect in the blue revolution and PMMSY schemes being implemented by the Department of Fisheries, Government of India.

#### 4.12 Dealing with dwindling natural population and depleting capture fishery

Over the years, while research Institutes have increased the knowledge base and capacity building of the line departments to address the challenges such as overfishing, climate change impacts and marine pollution, the planning and implementing agencies have intensified efforts to increase awareness among the local communities about the importance of participatory management of open water resources for improved and sustainable productivity, ecosystem health and better livelihood support. Habitat fingerprinting, stock assessment, spatial



planning, benchmarking for sustenance of aquatic ecosystem health, pollution abatement, fish disease surveillance, etc. have been some of the major aspects stressed for improving the ecosystem. Similarly, community participation in the observation of fishing holiday, mesh size regulation, seed ranching, etc. have strengthened the natural stock population.

#### 4.13 Invasion/incursion of alien and unconventional fishes

Illegal entry of the alien species into the culture system has been a continuous problem in the freshwater sector. These fishes are brought illegally through the porous border to raise in culture system due to their higher growth potential and wide adaptability. Some of the cultured alien fishes in the country include striped catfish (*Pangasianodon hypophthalmus*), African Catfish (*Clarias gariepinus*), red-tilapia (*Oreochromis niloticus*), red-bellied-pacu (*Piaractus brachypomus*) and bighead (*Aristichthys nobilis*) all of which had illegal entry. Although some of these species have proven their culture potential, escape of others like tilapia and African catfish to open water courses and subsequent establishment has brought potential invasive effect on the original fish population in open water system. Efforts have been made over the years to raise awareness among the farmers about the potential consequence of promoting such illegal alien species to our ecosystem. While Government of India have banned culture of species like African catfish, cautious approach has been adopted for scrutinizing these alien species before regularizing them in the country.

Poor fishery management, impact of changing climate and improved harvesting interventions often have resulted in changed species composition, and resultant landing of unconventional resources. However, this challenge has been addressed in a novel way so that these resources have been managed well and are fully utilized. One such instance during the last decade and a half is the huge landing of blowfish (*Lagocephalus* spp.). This blowfish was not considered as a tablefish and used to be accounted only as trash. Moreover, when fished and caught in the cod end of the net, it caused a lot of damage to the other commercially important fishes trapped in the cod-end as well as damaged the net with its sharp teeth. The boat owners, the marketing agencies, the processing plant units and the fishermen jointly decided to find a way out to use this fish in a more gainful manner. Initially, the fishmeal plants agreed to include this fish as a raw material for the preparation of fish meal and agreed to pay the similar price as for other low valued fishes. Later, scientific investigations revealed that the fish is safe for human consumption and that there is good scope for getting higher value for the catch through suitable handling and value addition. Accordingly, the blowfish was well iced, brought ashore, pre-processed (beheaded, degutted and de skinned) at the landing centre itself and marketed

for domestic consumption. Further, the gonads of the species supposedly have a curative value in south east Asian countries, and was preserved and sold separately to agents engaged in this business. Thus, a resource that was thoroughly disliked by the fishers and fetched very little value even among the low valued catch is now considered a tablefish fetching a good market price. The networking of the boat owners, crew, marketing agents, processing plants and department officials have equally contributed to this change over.

The red tooth triggerfish (*Odonus niger*) is another classic example of how a low value fish can be gainfully used thus enhancing its market value. The unprecedented landings of the red tooth triggerfish during recent past, and attaining the top position in the marine fish landing in most of the coastal states was of great concern to all stakeholders of the marine fisheries sector. The fish valued only as much as the low value trash fish, is now utilized and used for the preparation of surimi a fully exported product, thus enhancing its market value. The waste generated during surimi production is taken by the fishmeal plants for production of fish meal. This was achieved once again due to the strong networking between different groups engaged in fishing, marketing processing and exporting activities.

## **5. Gaps due to lack of capacity building initiatives to achieve a proper cross learning**

Major constraints impacting the growth of marine capture fisheries include limited scope for expansion due to overcapacities in territorial waters, weak enforcement of regulations, inefficient management and prevalence of less efficient fishing practices. Inadequate infrastructure especially, in fishing harbours, landing centers, cold chain and distribution systems, deficiencies in processing and value addition, high wastage, lack of proper systems in place to ensure traceability and certification, non-availability of skilled manpower, etc. are some of the other factors constraining the growth of the capture fisheries. In inland capture fisheries, seasonal nature of fishing operations, depleted stocks in natural waters, issues related with tenure and lease rights, use of obsolete technology for harvesting coupled with low capital infusion are some of the significant limiting factors.

Specific problems affecting the growth of aquaculture include poor physical condition of resources (specially the water quality) in many culture systems, lack of species diversity and diversity in their culture practices, lower productivity, inadequate regulatory mechanism and increased incidents of disease. Infrastructure-related, logistical and institutional deficiencies such as gaps in input and service delivery system, low levels of investment, inadequate access to institutional credit and high cost of credit, inadequate infrastructure for pre-

production, production, post-harvest and processing facilities, low adoption of technologies and shortage of skilled manpower for extension services, etc. dampen the vibrancy associated with aquaculture activities in a number of culture systems in the country (GoI, 2017, 2019a,b,c, Gopalakrishnan et al., 2019).

The above weaknesses can be addressed to a considerable extent by strengthening the knowledge and service networks in the sector and by capitalizing on the elaborate institutional mechanisms presently available in the country. Emulating successful experiences and cross-learning from one another not only from actors and networks within the country but from across regional and global platforms can facilitate this process in no less terms.

## **6. Conclusions and Recommendations**

The role of the networking systems, be it informal or formal, its crucial role in addressing the challenges in any sector is undeniable and it's not an exception in the case of aquaculture and fisheries. The paper provides an insight of the role of existing networking systems in India in adoption, popularisation and acceptance of solutions in the form of technologies for production enhancements, policy interventions for crisis management, conservation and protection of resources as well as conflict management among different stakeholders in the aquaculture and fisheries sectors in India. This can be catalyzed cross learning between government and semi-government organisations, private entrepreneurs, line departments and stakeholders and emulating success achieved in addressing similar challenges in other countries. Regular interactions and sharing of ideas, challenges and solutions in the fisheries and aquaculture sector with other SAARC member countries would definitely help to identify the existing gaps, enhance the capacity to address the similar challenges and develop suitable informed tangible solutions which would ultimately benefit the farmers, fishers and scientists among the SAARC member countries.

### **Recommendations:**

1. Necessary legislative, policy, scientific, infrastructural and logistic support may be ensured to maintain the growth in fisheries sector to meet the growing demand for fish and to secure income and employment security of fisher folk and fish farmers.
2. Research innovations and technological breakthrough are crucial to sustain productivity and efficiency of future fishery production systems. This may be ensured by prioritizing and implementing appropriate research and developmental programs in the sector and by strengthening the network involving scientific establishments, development departments, civil society

organizations, as well as the fishermen and fish farming community at the grassroots level.

3. In the marine fisheries sector, there should be considerable focus on sustainable management, habitat conservation and responsible fisheries governance.
4. Stock assessments and data collection systems needs to be given priority to facilitate informed decision making on key areas.
5. Freshwater and brackishwater culture systems need research focus on promising culture practices such as Recirculating Aquaculture System (RAS), biofloc, polyculture and IMTA.
6. Applications in frontier areas of research and technology such as, genomics and biotechnology, artificial intelligence, bio-informatics, etc. need to be harnessed through greater investments and other appropriate interventions.
7. Mariculture sector (cage culture, seaweed culture, bivalve culture) needs comprehensive development especially in the areas of leasing policies, seed and feed development, hatchery development, etc.
8. Post-harvest 'value addition' and 'value creation' need further boost to strengthen domestic as well as export value chains of fish and fish products.

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## Annexure 1.

### Fishery Co-operative Network in India

Name of the State / UT	Number of Societies (level)				No. of members
	State Level	Regional Level	District Level	Primary Level	
Andhra Pradesh	1		13	2,347	260579
Arunachal Pradesh				11	230
Assam	1		2	520	90000
Bihar	1			510	410007
Chhattisgarh	1		5	765	26154
Goa				20	1503
Gujarat	1		3	263	26045
Haryana				116	1276
Himachal Pradesh				45	5837
Jammu Kashmir				1	18
Jharkhand	1		1	384	22853
Karnataka	1		2	566	204689
Kerala	1			651	460486
M.P.	1		1	2,290	85731
Maharashtra	1	2	36	3,315	332636
Manipur	1		3	485	14,258
Meghalaya				18	611
Mizoram	1			47	1656
Nagaland				267	9234
Odisha	1	5		657	138143
Punjab			1	1	18
Rajasthan	1		1	34	4130
Sikkim				8	230
Tamil Nadu	1		11	1,355	679117
Telangana	1		10	4,348	302002
Tripura	1			142	22967
UP	1		22	1,011	54521
Uttarakhand				13	634
West Bengal	1		20	1,433	131578
Andaman & Nicobar Islands	1			41	1361
Daman and Diu				7	3176
Lakshadweep				6	2910
Puducherry	1		1	64	58525
<b>Total</b>	<b>21</b>	<b>7</b>	<b>132</b>	<b>21,741</b>	<b>3353115</b>

Source: FISHCOPFED, 2021



## Annexure 2.

### List of MFRAs of State/UT governments in India

- i. The Kerala Marine Fishing Regulation Act and Rules 1980 (Act 10 of 1981)
- ii. The Goa Marine Fishing Regulation Act, 1980
- iii. The Maharashtra Marine Fishing Regulation Act 1981, Government of Maharashtra
- iv. The Orissa Marine Fishing Regulation Act 981 (Orissa Act 10 of 1982) and the Orissa Marine Fishing Regulation Rules 1983
- v. The Tamil Nadu Marine Fishing Regulation Rules 1983
- vi. The Karnataka Marine Fishing Regulation Act, 1986
- vii. The Andhra Pradesh Marine Fishing Regulation Act, 1994 xxi. Lakshadweep Marine Fishing Regulation Act, 2000
- viii. The Gujarat Fisheries Act, 2003
- ix. Andaman and Nicobar Marine Fishing Regulation Act, 2003