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Resilience in Fisheries and Sustainability of Aquaculture

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Over the last four decades, the aquatic systems of the globe have undergone a rapid transition. Worldwide per capita fish consumption nearly doubled from about 8 kg in the early 1950s to 15.8 kg in 2006. Fish exports from the developing countries have surpassed export of traditional crops and meat. A study by the Food and Agriculture Organization (FAO) projects a global average per caput demand for all seafood to be about 18.4 kg by 2010 and 19.1 kg by 2015. The study also highlighted that developing countries already produce and consume more fish than developed countries and it predicts that the dominance of developing countries will grow further to 2020. In India, fishing activities in the pre-independent days used to be carried out at a subsistence level, almost exclusively by the traditional fishers. Today, the sector has been recognized as a powerful income and employment generator to over 14 million fishers and fish farmers, majority of whom live in over 3,600 coastal villages, besides hamlets along major river basins and reservoirs in the country. Stimulating the growth of a number of subsidiary industries, the sector offers cheap and quality animal protein to the people, ensuring nutritional security. Further, the forward and backward linkages of boat building, construction of fishing harbours, fish processing, *etc.*, have further contributed to diversification and strengthening of the economy.

India is a major maritime state and an important aquaculture country in the world. Being home for more than 10% of global fish biodiversity, the country ranks third in the world in total fish production. While marine sector is almost constituted by capture fisheries, aquaculture has been the principal contributor in inland fisheries sector, with a share of 77%. With an annual fish production of over 6.8 million tonnes, the sector accounts for a turnover of over Rs. 300 billion, contributing over a percent of total GDP and five per cent of the agricultural GDP. The sector has been one of the major foreign exchange earners, with revenue reaching Rs. 7,555 crore in 2007-08 accounting for about 14% of the agricultural export. Producing 4.7% of the world's fish, India trades to the extent of 2.5% in the global fish market. There are however, concerns regarding the stagnating marine fisheries yields, quality deterioration and unregulated access in open waters and continued returns from aquaculture practices. It is in this context that the aspects of resilience and sustainability are being discussed with regard to fisheries and aquaculture respectively.

Marine fisheries

With the estimated potential yield from the marine sector to be 3.9 million tonnes, comprising 2.2 million tonnes from the 0 to 50 m depth zone and 1.7 million tonnes beyond the 50 m depth in the EEZ, there is good scope for exploiting the oceanic and coastal tunas, carangids, ribbonfish, threadfin breams, catfish, bull's eyes and perches by extending fishing operations to deeper waters. Increase in the marine fish production in India has been largely due to: (i) introduction of mechanized fishing vessels and synthetic gear materials, and the development of infrastructure for preservation, processing and storage in the 1950s; (ii) expansion of trawl fleet and indigenous boat construction in the 1960s; (iii) introduction of purse-seining, diversification of fishing, development of fishing harbours and expansion of export trade in the 1970s; (iv) motorization of traditional fishing craft, introduction of ring seines and increase in the number and efficiency of craft and gear in the 1980s; and (v) substantial growth in the number and efficiency of trawlers and motorized craft, and change in the export trade from resource-based to food-engineering-based industry in the 1990s.

Challenges

The most important characteristic of marine capture fisheries is that resources are a common property, the access to which is free and open. The sustained increase in the demand for seafood and the commensurate rise in prices have increasingly encouraged the induction of more manpower and fishing vessels with improved catching efficiency into the traditional as well as the new fishing grounds over the years. Coastal fisheries in India remained in a pre-developed phase till 1962 (pre-mechanization period; with the annual average production during 1950-1962 being <0.8 million tonnes); a prolonged growth phase till 1988 (intensive mechanization phase; annual production during 1963-1988 being 0.8 to 1.8 million tonnes); followed by the fully exploited coastal areas, annual production being 1.8 to 2.8 million tonnes. Fishing effort has increased steadily throughout the three phases of development, more so in the fully exploited phase. Marine fishing activity, as in several parts of the world, has largely remained unregulated in India too.

Marine fisheries operations remained essentially an inshore activity till about the mid 1980s. Though fishing subsequently extended to offshore areas, only about 20 per cent of the total landings were from the offshore areas. This causes enormous pressure on the coastal fish stocks. Increasing competition among different fishing fleets as to who should have access to coastal fisheries resources and thereby, benefit directly from the use of these resources, is leading to conflicts and confrontations.

Increasing fishers' population has implied reduction in fishing area available per fisher. Trawlers have become the mainstay of the fishing sector, contributing to major non-selective fishing practices. As regards modifications in the trawl net for example, the mouth opening has been increased to enhance efficiency and the cod end mesh size reduced from about 35 mm in the 1960s to the present 20 mm or even 8 mm to retain the entire gamut of biota that is trapped. Operation of mini trawls from motorized traditional crafts since the late 1980s has added to the effective exploitation of inshore demersal stocks. Operation of purse-seines, ring-seines, trammel nets and gillnets of more than a kilometer length and an array of different mesh sizes (ranging from 10 to 300 mm) effectively exploits the entire water column.

Responsible fisheries

Given the fisheries situation that exists in India, temporal restrictions *i.e.* seasonal closure of fishing appear to be an option, which could be effectively implemented. At present, the maritime State Governments in the east and west coasts independently decide on the seasonal closure of fishing (also known as monsoon ban) on a year-to-year basis prior to or during the southwest monsoon for about 30 to 45 days in a year.

The obvious need for sustaining marine fisheries production is to regularize the fishing effort, particularly in the inshore, traditional fishing grounds. At present, there is no effective licensing system to limit the entry of new or existing fishing vessels into the coastal fisheries of India. Licensing and responsible fishing could be extended to cover the entire fishing industry including the artisanal sector to help monitor fishing efforts and optimize inputs. Implementation of these measures demands a stakeholder-endorsed policy as also complimentary rules and regulations. Installation of fish aggregating devices (FADs) and artificial reefs in the recent years has shown significant beneficial effects in terms of enhancing local fish yields.

Deep sea fishing

Despite the tremendous growth in India's marine fisheries during the past 50 years and the declaration of the EEZ in 1977, there has not been strong commercial deep sea fishing. It is estimated that 0.5 million tonnes or about 40 per cent of the unexploited stocks in the deep sea are the tunas, which undertake transoceanic migration. Island fisheries development with suitable fishing as well as

marketing with a value chain approach is to be accorded high priority. Realizing the nature of distribution of the resources in the EEZ as well the high costs of exploiting them and the technology capability that is required, regional cooperation and public-private partnerships appear to be the options.

Remote sensing

Satellite imageries provide continuous data on sea surface temperature and chlorophyll covering the entire EEZ. These have several applications, including mapping the potential fishing zones (PFZs) and fisheries forecast on a short and long-term basis. These forecasts on an experimental basis revealed that the catch rates of pelagic fish in the PFZs are higher by about 60 per cent compared to that in the non-PFZs. However, more information would be required to forecast demersal fisheries potentials.

Climate change

It has been recognized that climate change will have economic consequences, both benign and disadvantageous. Fisheries are expected to be impacted by climate change, with obvious difficulties in assessing the effects of global warming on fish stocks and their migrations. There are two uncertainties in the causal chain from global warming to the fisheries. First, the impact on ocean temperature and currents is uncertain, not just in magnitude but possibly also with respect to direction. Second, even if we knew the changes in temperature and ocean currents, we would not necessarily know the effect on abundance and migrations of fish stocks. Nevertheless, it is true that little research has been carried out on the possible consequences of climate change on fisheries.

Most fish species have a fairly narrow range of optimum temperatures related to both their basic metabolism and the availability of food organisms, that have their own optimum temperature ranges. Depending on the species, the area they occupy may expand, shrink, or be relocated with changes in ocean conditions. Marine ecosystems are in a constant state of change that varies on many spatial and temporal scales. Fish populations respond to this variability in different ways. For example, during short-term weather changes such as storms, fish may take refuge from rough conditions through minor changes in distribution. Annual changes in the ocean environment, on the other hand, may result in changes in the distribution patterns of migratory fishes and affect reproduction and recruitment in other species. Moreover, decadal and longer-scale variations may have other impacts, including cyclic changes in the production level of marine ecosystems in ways that may favour one species or group over others.

Information on the likely impacts of climate change for fisheries is very limited. Moreover, the inherent unpredictability of climate change and its mechanisms of impacts on fishery are complex. Efforts in this context should emphasize developing strategies by which fisheries and aquaculture, can play a part in our wider adaptation to the challenges of climate change. One reason why adjusting to climate change might be more difficult now than it was in the past is that the fisheries in many parts of the world have become more regulated. While the need for regulation is not in doubt it often comes at the cost of flexibility, making it more difficult to enter another fishery, if one collapses.

Mariculture

Mariculture is expected to be a major activity in coastal areas in the years to come. Given the wide spectrum of cultivable species and technologies available, the long coastline and the favorable climate, mariculture is likely to generate considerable interest amongst the coastal population. At a time when we speak of over-exploitation in the near-shore waters, limited access to capture fisheries and the need for diversification, mariculture can be an appropriate alternative. Technologies for a couple of species are presently available in the country and there is an urgent need for developing a package of practices for several more commercially important species (*e.g.* grouper, cobia, sea bass, sea bream).

The commercial culture of edible oyster (*Crassotrea madrasensis*), green mussel (*Perna viridis*), brown mussel (*P. indica*) clams (*Meritrix meritrix*) and *Anadara granosa* in captivity has met with success. Entrepreneurship in mussel culture with interested markets is growing in coastal areas. Technology for the culture of marine pearls and farming of the pearl oyster *Pinctada fucata* in open sea as well as shore-based systems has been developed, that could be put to a larger commercial use, with the added advantage of higher growth rates in warmer tropical waters of India as compared to others. Possibilities of cultivation of sea cucumber, *Holothuria scabra* must be explored, with its achieved success in breeding. Similarly, agar-yielding seaweed, *Gracilaria edulis* with commercially viable productivity in three months by vegetative fragment culture (net/ropeculture) is a successful enterprise at several locations in coastal areas. Seabass (*Lates calcarifer*), pearl spot (*Etroplus suratensis*) and marine ornamentals such as *Amphiprion percula* and *A. ocellaris* have been successfully bred and their seed production technology standardized. Entrepreneurship response would determine the commercial projects with assured necessary institutional finance. These species will form viable choices for shrimp farmers as well as alternative crop for ecological balance of the coastal aquaculture systems.

Brackishwater aquaculture

Brackishwater aquaculture presently is synonymous with coastal aquaculture, that too dependent on a single species, tiger prawn, *Penaeus monodon*. However, with increasing salinisation of inland soils, spreading to over eight million hectares, inland saline aquaculture could become an important economic activity in the years to come. The major problems of the sector, viz., lack of disease-free shrimp seed, slumping prices of shrimp in overseas markets and lack of diversification are impacting on the growth. While efforts are being made to produce specific pathogen-free shrimp seed both through selection programmes in the country and establishment of a multiplication centre for SPF seed with Hawaiian technology, domestic markets are being pursued and diversification protocols for *Penaeus vannamei*, seabass farming and crab fattening formulated.

Ensuring pathogen-free broodstock being the major challenge, it is necessary that appropriate quarantine and biosecurity measures are adopted in the hatcheries as an immediate measure. In order to overcome the problem of deficiency of broodstock, development of captive broodstock and domestication can be an alternative for supply of disease-free seed.

Development of environment-friendly and cost-effective culture technologies of both shrimp and finfish focusing on small-scale farmers is the need of the hour. Protocols for better management of soil and water resulting in reduction of pollution can substantially reduce the risk. The risks of diseases like loose shell syndrome in grow-out culture system and Mondon baculovirus in hatcheries need to be tackled. Further, development of diagnostic techniques for other exotic viruses like yellow head virus and taura syndrome virus are to be given utmost attention in view of their possible threat in the coming years. A comprehensive health management approach in shrimp farming including development of effective therapeutants, probiotics and vaccine is to be formulated.

Since brackishwater aquaculture is presently mainly dependent on exports, issues such as traceability and anti-dumping are expected to have a significant influence on growth of the sector. Development of a strong domestic market for the produce, establishing a well-knit system for market information and intelligence for aquaculture produce are other aspects needing thrust. Implementation of aspects HACCP, traceability, eco-labeling and quality assurance criteria for uniform and wider compliance is necessary for building the confidence of the importing nations and boosting the export of our produce.

Inland capture fisheries

The segment of inland fisheries has been growing at an annual rate of over 4 percent with freshwater aquaculture component showing much higher growth rates. With a composition of more than 50 percent in the fish basket presently, it is expected to further increase in the coming years. Some studies in the recent past have established that much of the growth is technology-driven, with specific solutions in different aspects of stock management in open water and 'pond-to-plate' approach in aquaculture.

The open-water resources have been under stress due to increased water management projects, efflux of large volumes of sewage and other waste waters, which in turn have been affecting the biotic communities and fisheries adversely. Developing suitable mitigation action plans with EIA studies would be of paramount importance for safeguarding the utility functions of these ecosystems. Lack of reliable database on open-water fisheries, both physical as well as biological, remains an impediment in formulating appropriate management norms. Remote sensing and GIS technologies may be employed for creation of appropriate data bases. Aspects of minimum and environmental flows for the riverine systems are important to be dealt through inter-departmental deliberations for sustenance of fisheries and also conservation of biodiversity.

Efforts on scientific management in several small reservoirs have shown enhanced yields of 102-316 kg/ha/yr in different reservoirs. Thus immediate thrust is sought to exploit the fisheries potential of at least the 1.5 million hectares of small reservoirs, and subsequently the medium and large reservoirs through proper species and stock enhancement. Floodplain wetlands offer tremendous scope for both culture and capture fisheries. Production levels of as much as 1,000-1,500 kg/ha/yr have been demonstrated in such waters, while the present level remains at one-tenth of the potential.

Substantial gaps between the potential and actual fish yields from culture-based fisheries resources such as reservoirs and wetlands provide ample opportunity for fisheries enhancement. Therefore, it is necessary to scale up the fish yield enhancement initiatives in small and medium reservoirs and wetlands, which can be managed effectively by working in a co-management mode with the stakeholders. Financial assistance for stocking of reservoirs with advanced fingerlings being provided in the recent past is expected to enhance the productivity of these water bodies as also livelihood opportunities for the fishers. Large-scale cage and pen culture in reservoirs for raising desired large size stocking materials can also be a profitable venture for the habitants around.

Coldwater fisheries

The capture fisheries in upland water-bodies of Kashmir, Himachal Pradesh, Uttarakhand, North West Bengal, Sikkim, Arunachal Pradesh, Nagaland, Meghalaya, Nilgiris and Kodai hills and Munnar high range of Peninsular India are poorly developed primarily due to low natural fish yield, difficult terrain and inaccessibility. The promotion of trout farming through scientific management offers a huge scope for enhancing production for both domestic and export markets. Besides, bringing natural Himalayan lakes located at different altitudes and newly created and existing upland reservoirs under farming can improve the fish production in hills to a great extent. There is a significant potential for developing sport fishery based on trouts and indigenous mahseer, which can generate economic avenues for people in remote hill areas through fish-based eco-tourism. The mid-altitude exotic carp farming which has shown good promise can be extended to other regions in the hill states.

Freshwater aquaculture

With production of over 3.3 million tonnes from the inland fisheries sector, the country has occupied the second position in the world. Such growth has been possible due to impressive developments in aquaculture, mainly through carp culture in freshwater ponds and tanks as also the integrated fish farming practices. During the past two decades, the inland aquaculture fish production

has increased to 2.9 million tonnes, with carps alone contributing over 85 per cent. A host of technologies developed over the years has contributed to such growth in the sector, with carps, catfishes and prawns being important components of culture practices. The three Indian major carps – catla, rohu and mrigal, together contribute a lion's share of over two million tonnes, with exotic silver carp, grass carp and common carp forming the next important group. Culture of giant freshwater prawn and the catfishes like magur and singhi has also received increased attention in recent years due to their high market price.

The technologies of breeding and seed production of potential fish and prawn species were the most important breakthrough, which have placed aquaculture on a faster track of development. Considering the increased popularity of ornamental fish at household level, captive seed production and rearing technology of both domesticated exotic species and indigenous species have been standardized. Multiple carp breeding, design of portable hatcheries, development of improved rohu through selection (CIFA IR 1), protocols for intensive carp culture have shown visible impacts on productivity levels in freshwater aquaculture. Further R&D efforts are needed in areas of genomics and transgenics, breed improvement, bioremediation, feed and health management.

Region-specific aquaculture models

Of over 640 species of freshwater fishes of India, several species are confined to south Indian (peninsular) waters. These include: (i) some of the endemic food/sport fishes, viz. *Labeo dussumieri*, *L. ariza*, *L. kontius*, *Tor khudree*, *T. mussullah*, *Gonoproktopterus (Hypselobarbus) curmuca*, *Cirrhinus cirrhosa*, *Puntius pulchellus* and *P. carnaticus*; and (ii) several brightly coloured attractive ornamental fishes such as loaches, *Nemacheilus* and *Travancoria* and species of very elegant barbs such as *Puntius arulius*, *P. denisonii*, *P. narayani*, *P. filamentosus*, *Danio malabaricus*, etc. Despite its vast water resources and a rich faunal biodiversity, the contribution of peninsular aquaculture with local species to total inland fish production in the country is negligible. It is highly desirable to conserve and propagate some of them, especially those which are in high demand in the peninsular region.

Recognizing the importance of local adaptation of native organisms, several international gatherings including the 'Earth Summit-1992' had recommended the use of native stocks including fish, wherever possible, for enhancement of culture operations. Efforts have been initiated to incorporate some of these local potential cultivable species in culture systems for diversification of aquaculture in peninsular states and simultaneously to generate more information on their biology, breeding pattern, recruitment and stock identification. Captive breeding and larval rearing techniques have been developed for *Labeo dussumieri*, *Gonoproktopterus (Hypselobarbus) curmuca*, *Osteobrama belangeri*, *Puntius pulchellus* and *P. carnaticus* and native ornamental species having export potential such as *Pristolepis marginata*, *Horabagrus brachysoma*, *Danio malabaricus*, *Puntius filamentosus* and *P. fasciatus*.

Approach

The mean national pond productivity has remained at about 2.4 tonnes ha yr⁻¹, despite production levels of 6-8 tonnes ha yr⁻¹ being realized by farmers in several parts of the country. This indicates the enormous scope for both horizontal and vertical expansion of freshwater farming. In this regard, it is necessary that district-wise developmental plans are made based on the soil fertility, water retentively and nutrient status, climatic conditions, available water resource structure, market structure of the area, investment capacity of farmers, etc. Considering the availability of technological strength and resource potentiality of the Indian farmers, it is feasible to enhance the mean pond productivity to 4 tonnes ha yr⁻¹ in the next ten years is feasible. In this context, it is necessary that the aquaculture resources of the country are mapped through remote sensing and potential aquaculture zones identified on GIS platform.

Seed being the most important critical input, establishment of adequate hatcheries in different regions in order to minimize long-distance transportation and subsequently providing required rearing space for ensuring supply of desired fingerlings in adequate quantities necessitate a strategic planning. Diversification of farming with high valued species being an important proposition for enhancing farm income, culture of high valued species like freshwater prawn, catfishes and other diversified species of regional importance holds great promise. It is expected that the sector would utilize at least 15-20 diversified species of finfish and shellfish for commercial production as against present level of 7-8 major species for meeting the domestic and international market, which would contribute 20-30% of the total freshwater aquaculture production. Therefore, it is necessary to ensure mass scale seed production of these species and their supply to the places of demand. Ornamental fish farming being an important economic enterprise with increasing demand in both domestic and export market, its promotion as a cottage industry and also large-scale enterprise holds great promise in the years to come.

Considering the projected horizontal and vertical expansion of freshwater aquaculture, the feed requirement in the next ten years has been estimated to be about 10 million tonnes, which would include at least 30% commercial pelleted feed. Establishment of feed mills through private participation is a viable approach. To combat the prevalent and emerging diseases in the wake of increased intensification of farming practices, it is necessary to ensure the availability of required diagnostics, vaccines and other therapeutics.

In view of the shrinking freshwater availability and increased wastewater generation, necessary amelioration measures and production technologies with minimal water requirement need greater emphasis. Further, in view of the emerging market for organic farmed fish, emphasis must also be given for its wider adoption and contributing at least 10% of the total aquaculture production for meeting the niche market. With increasing costs of labour in recent years and aquaculture becoming an entrepreneurial activity, use of more mechanical gadgets, machinery and tools for automation in farm management and harvesting would become important. Capacity building in this area is crucial.

Fish processing

While most of the fish in the country is consumed fresh or transported with ice, frozen fish and shellfish form bulk of the exports. With increasing diversification of markets, products such as filleted fish products, canned fish and shellfish, ready to serve curry in flexible pouches with long shelf life, cured fish, rack dried fish, IQF fish products, dehydrated jelly fish, *beche-de-mer* (sea cucumber), *masmin/masmin* flakes from tuna, fish wafers, soup powder, battered and breaded value added products, pickles, etc. are becoming available. A number of by-products with applications in medicine, surgery, industry and food processing are chitin and chitosan, surgical sutures from freshwater carp guts, collagen-chitin film as artificial skin, shark cartilage, squalene from shark liver oil, shark fin rays, isinglass for liquor industry, concentrated PUFA from fish oil with Omega 3 fatty acids, agar-agar and agarose from sea weeds, insulin, fish albumin, glucosamine hydrochloride, bile extracts, drugs/chemicals from sea weeds, and steroids and other compounds from marine animals.

Packaging plays a key role in the commercialization of food products and modified atmosphere packaging has become a trend in seafood industry. Most of the countries now prefer the packaging materials to be recyclable, though no legislation has been adopted in this regard. With most processing plants implementing principles of HACCP, eco-labeling and barcoding are being incorporated to enhance acceptability of products in overseas markets.

Epilogue

The issues in fisheries and aquaculture that need to be addressed pertain to biodiversity loss and depletion of fish stocks, excess coastal fishing, oceanic and deep sea fisheries, enhancing fish productivity in all cultivable waters, impact of climate change on fisheries, trans-boundary fisheries issues, inland and coastal pollution, large scale sedimentation of rivers, estuaries and lakes/wetlands, effective compliance of code of conduct of responsible fisheries, lack of diversification in aquaculture practices, water management in aquaculture, quality seed and relevant certification measures, planning for feed provision in farming, introduction of exotics with due quarantine procedures, emergence of new diseases, mechanization in fisheries and aquaculture, cold chain and hygienic fish handling, quality assurance issues in exports, overseas market fluctuations, disaster management, credit and insurance, inadequate database and poor linkage in domestic marketing. Suitable programmes must hence be formulated to build in resilience in fisheries and sustainability in aquaculture.

Demand projections for fish by 2012 is 9.74 million tonnes at an estimated annual consumption growth rate of 3.5%. The required annual growth rate for meeting the demand would be of the order of 5.4% and the supply projections are given in Table 1.

In order to realize full potentials of the sector, some of the action points suggested are : Value chain approach for fishing high value species with suitable consortia of private-public partnerships, where island ecosystems will be in focus; Capacity enhancement for deep sea fishing and maximising the benefits from the Indian EEZ; Major initiative to explore and harness non-conventional seafood resources; High value compounds from seas with proper linkages between biologists, chemists and process technologists to formulate potent biomolecules; Potential sites for mariculture, both open and enclosures, with due backward linkages in terms of quality seed of finfish/shellfish to harness the vast potential along the Indian coast; Diversification of species in coastal aquaculture and consortia approach for production of inputs such as quality seed, feed, diagnostics and health management measures; Open water fisheries management with due recognition of the potentials of inland aquatic resources; Habitat restoration and fish conservation in marine and inland ecosystems; Water management including pollution management, bioremediation and multiple use of waters; Fish genomics and breed improvement for enhanced aquaculture productivity; Assured provision of quality inputs such as seed, feed, fertilizers, drugs through Aqua-shops as a single window facility for freshwater aquaculture; Integrated farming, aquaculture as a tool for treatment of domestic sewage, aquaculture in degraded systems like inland saline waters; Ornamental fisheries and allied aspects like pearl culture, aqua-tourism, sport fisheries; Mechanisation of farming practices; Aquaculture at par with agriculture; Effective cold chains and market models suitable for different practices in inland fisheries and aquaculture; Customised fish product development to suit different preferences in the country; Wealth from waste with high value products; Promotion of fish as health food through commissioned studies and media interactions; Fish and shellfish seed certification and hatchery accreditation; Comprehensive fisheries policies and acts for both regulating open water fisheries and enabling productivity enhancement in culture systems; and necessary capacity building and skill development.

Table 1. Present and projected fish production from different segments.

Area	Production in 2008, million tonnes	Projected production in 2012, million tonnes	Approach
Marine capture fisheries	2.99	3.10	Regulated fishing and capacity reduction in mechanized sector, Conservation, sea ranching, FADs, Diversified fishing in Deep sea & Oceanic resources
Mariculture	0.007	0.05	Identification of suitable sites along the coastline, Hatcheries and grow-out systems for high value fish, crustaceans, molluscs, sea cucumber, ornamental fishes, Cage culture in open seas & island ecosystems
Coastal aquaculture	0.144	0.20	Increasing water area under aquaculture, Diversification of species, from existing shrimp to Seabass & pearl spot, Inland saline aquaculture as an added component
Inland capture fisheries	0.80	1.20	Culture-based fisheries in Reservoirs with stocking of advanced fish fingerlings, Pen & Cage culture in large water bodies and Canal fishery development, Resource-specific harvesting techniques, Implementing code of conduct of responsible fisheries
Coldwater fisheries	0.0003	0.001	Seed production of trout and mahseer, Hill aquaculture, Ranching of streams, Sport fisheries
Freshwater aquaculture	2.93	5.40	Increase in the coverage of areas of ponds and tanks for fish culture, Reclamation of weed choked waters, Diversification of species and Intensification of culture practices, Integrated fish farming and wastewater aquaculture to optimize water productivity
Total Export	6.87 0.54 (Rs. 7,555 crore)	9.95 0.80 (Rs. 10,000 crore)	Diversification of products and markets, Upgradation of infrastructure, Hygienic handling of fish, Quality assurance