Marine fisheries in India: The path ahead.....

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Fishery sector in India serves as potential source of nutritional and livelihood security for about 40 million people. The fish production in India is now about 7.85 million tonnes out of which, 3.32 is contributed by marine fisheries and the rest by inland fisheries. Marine fisheries in India has been showing a slow pace of growth during the last one decade. Though the production from the seas was stagnating, the annual total marine fish landings exceeded three million tonnes. However, meeting the requirements of the growing population in the years to come is a big challenge. To meet this challenge, we have to look into the seas again as it is the only available alternate food production system, which offers immense potential like sea farming systems. To harness the potential of sea farming/mariculture bio-secured facilities are to be developed on priority basis for broodstock management. Sea farming is an emerging field that requires massive investment to establish. On this line, CMFRI had initiated demonstration of open sea cage farming since 2007 and has nearly standardized the technology making it available to enthusiastic entrepreneurs.

Marine capture fisheries

The estimated landings from the marine capture fisheries from the peninsular region of the country (excepting Lakshadweep and Andaman and Nicobar isles) stands at 3.65 million tonnes (2009-10) with a quinquennial smoothed growth rate of 4.62%. In the past decade the inter-annual growth rate of landings have ranged from -10.7% to 12.8 %. The estimated harnessable marine resource potential of the Indian EEZ is 4.4 million tonnes at the present exploitation rates. The most liberal of the exploitation forecasts predicts that by 2030 the landings off Indian shores could reach upto 4.6 million tonnes. The trend based surveys have indicated that in the depth range upto 100 m, which contributes to about 86% of the total exploited resources, have practically no possibility of witnessing quantitative expansion of harvesting. However the depth ranges beyond 100 m have avenues of expansion, *albeit* more on qualitative terms. In this domain the possibility revolves around oceanic resources like tuna, billfishes and allied species whose combined potential is pegged at 0.2 million tonnes with the lucrative Yellow Fin Tuna contributing to the tune of 40% to it. Another feature of the decadal trends of landings is that among the various groups the contribution by pelagic and demersal fin-fish resources has shown marked increase while the crustaceans (shrimps) and molluscs are fluctuating around a flat trend. This adds relevance to the argument that quantum increase need not necessarily indicate increase in value of the products in the same vein.

The nine maritime states and two UTs in the peninsular region have retained their distinctive patterns when it comes to the dominance of sectors as well as resources primarily focused upon. Obviously resources with geographic loyalty like Bombay Duck, non-peneaid prawns, *Hilsa* etc. are being continued to be exploited in the North West and North East regions of the Indian coast as were in vogue. But at the same time certain other resources like Cat fishes which were quite dominant in the South West region have shown alarming downward slide in the past decade. One stand out factor in the recent past is the thick fast spreading of Oil Sardines in the South East coast which stands at 0.13 million tonnes in 2010. Among the states Maharashtra, Gujarat and Kerala have consistently recorded near total domination of fishing propelled by machines. In fact the out-board sector (motorized) which had galvanized the meandering fisheries of Kerala in late 80s has usurped place of prime with a strength of 1.3 units for each mechanized unit. The artisanal crafts, non-mechanised and out-board, dot the east coast more (73% and 60% of national count), whereas around 60% of mechanized crafts including trawlers are recorded against the west coast. Even in the North West region where the penetration of the core mechanized crafts was the least, the past couple of years have shown stark decline in the contribution by non-mechanised vessels. Another interesting feature of the fisheries is that the mechanized operations tend to be more multi-day in operation thereby further paling the demarcation between states' territorial boundaries. In the past couple of years, the focus is more on more per trip than more trips per month

as even the motorized crafts slugging out for more days. This has a firm indication towards the compulsions of operational constraints. The fishermen families which are around 8.63 lakhs in the main land have 9.26 lakh active core fishers as per latest figures (2010).

The way ahead in marine capture fisheries management needs to focus on the following issues

(i) Expansion of fishery is no more uni-focal, ie. simple increase in quantity

(ii) Fast shrinking space for virgin avenues. Oceanic resources and deep sea resources are sure fire possibilities in the coming quinquennium

(iii) The intra-coastal geographic divide has little bearing on most of the resources exploited and it is in fact the marketing avenues which influence patterns in a telling fashion

(iv) Significant, sustained spread of not so high valued resources onto unconventional areas is noticeable. The role of environmental upheavals like global warming and climate change need special flagging

(v) The trend has been of sustained increase over the past six decades and more interestingly there has been no let down in the last five years. This augurs well for the validity of harvestable potential forecasts

(vi) Crafts tend to be prepared for longer trips and hence the increasing numbers, either as conversions/upgradations or as new build-ups, have to be seen with national resource availability at the back drop or bifurcated thereafter to local territorialisations

(vii) Ventures onto relatively unexploited domains like open sea cage culture may come in handy from the sustainability perspective of fishermen

Capture based aquaculture (CBA)

The room for increasing production from marine capture fisheries sector in relation to the growing demand for fish and fishery products is very limited. The marine capture fisheries production statistics indicates a stage of stagnancy and the current level of exploitation is fast approaching the potential of exploitable level. One of the most important factor for aquaculture development is the failure of wild fisheries to meet market demand. Aquaculture helped increasing the supply of fishes, improving the quality of fishes, developing new products for consumers which all in turn increased the per capita consumption of seafood.

Capture based aquaculture uses wild seeds or juveniles to stock in aquaculture facilities for ongrowing purposes. Capture Based Aquaculture accounts for about 20% of the total quantity of food fish production through aquaculture – mainly mollucs and some high valued finfish. Capture based aquaculture constitutes an alternative livelihood for local coastal communities and can contribute significant economic returns in those regions with depressed marginal economies. The collection of adult organisms is a special case related to the development of captive broodstock used for breeding in hatcheries.

Conflicts between aquaculture and commercial fisheries have been reported on space-related issues from various locations around the world. There is general fear that development of open water aquaculture will hinder the fishing activities of the traditional/local fishermen. Despite the potential for conflicts, adequate coastal zone management can lead to the development of synergies between aquaculture and traditional fisheries. In areas with declining wild catches and increasingly restrictive fishery regulations, aquaculture may help increasing production and providing livelihood opportunities for fishermen. Open ocean aquaculture may also provide unique opportunities for commercial fishermen either as a new occupation or a business that could complement their fishing practices since they already own vessels and have the maritime skills and knowledge of local oceanic and weather conditions.

Worldwide aquatic wild stocks and their ecosystems are in a fragile state. The growing importance of aquaculture production should be a way to relieve the fishing pressure on wild stocks and foster the maintenance of biodiversity whilst satisfying the growing market demand for aquatic products. Aquaculture can influence fish stocks through its use of wild fish stocks for inputs, such as feed, broodstock or juveniles. Dependence of fish meal for the production of aquaculture feeds is one of the major negative effects of aquaculture on fisheries. Aquaculture can also influence wild fish stocks through intentional releases. It has been used to replenish or enhance fisheries through purposeful release of juvenile or adult fish. Aquaculture can enhance fisheries habitat through development of infrastructure like oyster farms, fish cages and pens, or in some cases displace wild fish through its use of habitat. Aquaculture may cause the transmission pathogens to wild population and accidental escape of non native fishes from culture facility may affect the biodiversity of the farming region.

Fisheries socio economics and welfare

Marine fisheries sector in India provides employment to about three million people comprising 1.3 million of active fishermen, 1.50 million in the secondary sector and the rest in the tertiary sector of fisheries. The sector also supports the livelihood for about 18-20 million people.

The estimated marine fish landings in 2010 was 3.07 million tones (CMFRI, 2011). The gross value of the marine fish landings at the landing centre level is estimated at Rs.19,753 crores and at the retail level at Rs.28,511 crores (SEETTD, 2011). The private capital investment in fishing equipments has increased from Rs.10,352 crores in 2003-04 to Rs.15,496 crores in 2009-10. The per capita investment per active fisherman estimated at Rs.3,11,799 in the mechanized sector, Rs.38,870 in motorized sector and Rs.17,205 in the non-mechanized sector.

Fish & fish products recorded the highest increase in price among all food commodities-transforming from a poor man's food to the luxurious food item. The percentage share of fishermen in consumer rupee (PSFCR) ranged from 40% for Oil Sardines to 80% for Seer fish in private marketing channel. Wherever Self-Help Groups (SHGs) or cooperative fish marketing exists, PSFCR is consistently above 70% for all varieties.

Domestic marketing system requires more attention on modernization including quality control. There exists inadequate coastal infrastructure for domestic fish marketing compared to the commercial landing centres. This has led to polarization of harbour based infrastructure development and isolation of small centres.

High level of occupational risks are reported and also inter and intra sectoral marginalization. There is a lack of positive attitude towards non-fisheries livelihood options. The following aspects of fishery socio economics have to be considered for marching ahead.

- Formulation of a cogent Marine Water Leasing Policy
- Identification of suitable mariculture sites and central sector schemes for community oriented mariculture enterprises (as Open Sea Fishery Estates)
- Biomass augmentation through FADs, artificial reefs and marine parks
- Promotion of export oriented marine ornamental fish culture as a cottage industry and development of Special Fishery Enterprise Development Zones (SFEDZ)
- Empowerment of fisher women capacity building interventions through training programmes
- Incentives for value addition enterprises
- Investment for coastal infrastructure development (through PPP mode)
- Modernization of domestic fish markets
- Special banking schemes for small scale fishery-related enterprises
- Compulsory registration of craft and optimization of fleet size
- Mandatory sea safety measures
- Introducing new insurance schemes focusing fishery sector
- Development of bio-shields, installation of early warning systems and strengthening PFZ delivery
- Integrated Coastal Zone Development including Responsible Coastal Tourism

Training and capacity building

Great many people are dependent on marine fish as a livelihood source and the fish resources are being over-exploited. Any natural resource which is continually exploited at such high levels needs administrative and management inputs.

Management of marine fishery resources is a complex science. The large knowledge base and expertise built up over the years by CMFRI can be used to enlighten the interested stakeholders through short term training course of 1-2 months duration on topics such as marine fisheries management. Such courses will benefit fisheries managers and administrators and entrepreneurs in fisheries sector and will result in the creation of a new generation of fishery managers.

Milestones reached during the eleventh plan (2007-12)

1. Mariculture through open sea cage culture:

Open sea culture of fin fishes and lobsters was initiated at Veraval, Mumbai, Karwar, Mangalore, Cochin, Kanyakumari, Chennai, Kakinada, Visakhapatnam, Srikakulam and Balasore. Very good success was achieved for farming of seabass at Balasore and lobster at Vizhinjam. Other experiments with mullets and polyculture are in progress.

a. Farming of spiny lobster, the most sought after species of shellfish in the international market, was carried out in open sea cages and successfully

harvested in February 2010 at Mandapam and Kanyakumari for the first time in the southern coast of the State of Tamil Nadu. The cost of production per crop was Rs.95,000 including Rs.67,000 as the production cost which included the cost of juveniles, feed, labour and others. The yield of lobsters through a crop could be sold for Rs.2.40 lakh, realizing a net income of Rs.1.46 lakh. It had been proved that cage farming of spiny lobsters could pave the way for the development of commercial level farming ventures in the region through Self-Help Groups. CMFRI would provide assistance for an economically viable and alternate livelihood option for fishermen.

b. **The harvest of the integrated fish farming in cage under** the NFDB sponsored project was carried out by CMFRI at **Moothakunnam** near Cochin during **June 2010**. The seedlings of mullet *(Mugil cephalus)*, seabass *(Lates calcarifer)* and the pearlspot *(Etroplus* spp.*)* with an average weight of 40-60 g were stocked in 6m dia HDPE cage. The fishes attained 300 - 600 g in weight during a period of six months. The harvested fish were handed over to the beneficiaries who auctioned them at the site.

c. CMFRI achieved record growth rate for seabass at Karwar (June-July 2010). The Asian seabass *Lates calcarifer* stocked in the cage under the project "Open sea cage farming of finfishes/shell fishes" in the marine cage farm of CMFRI at Karwar achieved a record growth rate with a high FCR which is considered as one of the best FCR obtained anywhere in the world for seabass culture. The 2,500 number of seeds introduced in the cage with an average weight of 9 g reached 850 g in weight in 135 days.

2. At Mandapam Regional Centre of CMFRI a major breakthrough in Cobia *(Rachycentron canadum)* breeding and seed production was achieved. Successful broodstock maturation of Cobia was obtained in sea cages for the first time in India by feeding with suitable broodstock diets. Methods for induced breeding were also developed and successful spawning and larval production were achieved. The rearing of larvae is in progress and shortly the techniques for successful seed production will be standardized. The hatchery production of Cobia fingerlings can pave the way for large scale seacage farming of Cobia in our country.

   Cobia F1 : The Cobia seed, which were produced during March 2010, attained a size of about 15 kg by September 2011. They also matured and spawned resulting in seed production. Cobia seeds are also continuously produced and the farm trials are being carried out at different locations. This is an excellent species for open sea cage culture.

3. **Pompano *(Trachynotus blochii)* broodstock and seed production:** This is achieved for the first time in India. It is a rare fish and the world aquaculture production is only 300 tonnes. The species tolerates wide salinity, grows fast and highly suitable for pond farming. Continuous seed production is being carried out and farm trials are going on at different locations.

4. **Oceanic squid:** The Indian marine fisheries industry has little room for growth, with most coastal stocks fished to their maximum potential base. One among the oceanic fish stocks of India with huge potential is the oceanic squid with a fishable stock of nearly 1.5 million tonnes from the Arabian Sea alone. The ommastrephid deep sea flying squid, *Sthenoteuthis oualaniensis*, is known as the master of the Arabian Sea, because of its high abundance, large size, short life-span, fast growth and near monopoly of the higher trophic niche.

5. **CMFRI data base recognized:** CMFRI's marine fisheries data base is recognized by the Ministry of Agriculture as the official marine fisheries data of the country. This recognition was regained after a gap of 40 years.

6. **E-prints@cmfri:** CMFRI launched Open Access Institutional Repository, 'Eprints@CMFRI' for its scientific publications since 1948. More than 9,000 scientific publications by the Institute's staff members are digitized and uploaded in 'E-prints@ CMFRI'. The repository can be accessed from the Institute website; "www.cmfri.org.in" and users anywhere in the world can freely download the articles. 'E-prints@CMFRI' features the facility of searching the articles by year, author, subject, document type or division. Users can freely download full-text as most of the documents are directly accessible. 'Request Copy' forms can be used for documents to which direct full-text download is restricted due to publishers' embargoes. The significance of the repository is that it acts as a showcase for Institute research and enhances the professional visibility of the scientists of the Institute. Now all CMFRI publications are available online and the scientific output of the Institute is reaching global audiences.

   Repository was created using open source software developed by the University of Southampton at UK. For global visibility, the metadata of the repository is made available to search engines like

Google, Google Scholar, OAlister, Base, Scientific Common and Scirus. This Repository is listed in the Registry of Open Access Repository, UK, Open DOAR (Directory of Open Access Repository-http://www.opendoar.org/), UK and Avano OAI Harvester. This has placed CMFRI as the first ICAR Institute to reach this stage. CMFRI also ranks first at national level and fifth at global level among the open access repositories on marine sciences. It ranks 304th place in Web of World Repositories. In India CMFRI is in 3rd place as published by the *Consejo Superior de Investigaciones Cientificas* (CSIC) – the largest public research body in Spain. The repository places 90th World Rank in Google Scholar Search.

7. **Fish Watch:** CMFRI has initiated a new system of field information dispensation on a near real time basis. As the first phase of this effort, the fish landing figures and the landing centre price range of important resources at six major fishing harbours of the country are being published as "Fish Watch" in CMFRI website. The landing figures are given in kg starting from 12.00 noon of the first calendar day to 12:00 noon of the subsequent day. These figures are updated at 1600 hrs on working days.
8. **National Marine Fisheries Census-2010:** The National Marine Fishery Census was commenced on April 16, 2010 across the country and was completed on May 15, 2010.
9. **Launching of CMFRI Trademark 'Cadalmin':** The Central Marine Fisheries Research Institute has officially registered a trademark entitled 'CADALMIN' for the products and services of the institute.
10. **CMFRI launched two products namely, Cadalmin TM Green Mussel extract (GMe) and Cadalmin TM Varna-Ornamental Marine Fish Feed.** The Cadalmin TM Green Mussel extract (GMe) was launched in March 2010. The product contains 100% natural marine bioactive anti-inflammatory ingredients extracted from green mussel. GMe is an effective green alternative to synthetic non steroidal anti-inflammatory drugs (NSAIDs) to combat joint pain/arthritis and inflammatory diseases in humans.
11. **Hatchery production of the green mussel *Perna viridis*:** Nearly one lakh spat of *P.viridis* were produced in the marine hatchery at Regional Centre, Visakhapatnam. This is done for the first time in India where large scale spat production in the hatchery has been achieved. This is significant to the mussel farming industry since farmers are now looking forward to the supply of mussel seed from hatchery to meet the increasing demand of seed for the expanding farming activities especially in northern and central Kerala.
12. Preparation of National Plan of Action on sharks was initiated in collaboration with Bay of Bengal Programme – Inter-governmental Organization with Sri Lanka, Bangladesh and Maldives as other participating countries.

The way ahead…..

Marine fisheries, though stagnant now, will continue to be the significant component of the capture fisheries sector in the days to come. In future it will become mandatory to shift from an open access to a regulated regime which in turn demands the establishment of a scientifically informed marine fisheries management system. In the Indian context, management regulations are possible only by considering the socio-economic conditions as well as the intricacies of the multi-species tropical ecosystem. There is need to develop such stock assessment tools that are more sophisticated but sensitive not only to the tropical bio-social reality being manifested both in the inshore and offshore sectors but also the looming effect of climate change. It is also a fact that the major portion of Indian marine fisheries is contributed by the artisanal sector. Providing alternate options of production of fish for the coastal fishermen will be the prime requirement. The orientation of research needs to be on production technologies. A concerted effort by the Institute on development of viable farming methods by taking into account the environmental considerations, biotechnological interventions, biodiversity implications and socio-economics is needed with a vision of enhancing coastal production through seafarming. The Institute has identified appropriate strategies to overcome these constraints and achieve our goal. The fundamental tenet that guides the envisaged vision is "Better Science for Better Fisheries". A networked constituency of informed stakeholders holds the key for future developments in the sector. Some of our thrust areas to achieve the above development initiatives are given below:

- Development of a model for chlorophyll based forecasting of fish and potential yield
- All India Coordinated Research Project on mariculture
- Facilitating a scientifically informed marine fisheries management system. Establishment of a National Fisheries Grid-GIS Platform for strengthening the National Marine Fisheries Information System
- Assessing the health of marine environment and the impact of climate change on marine fisheries and mariculture

- Developing a comprehensive model on climate change and marine fisheries to build different scenarios and predict fish abundance and fish catches. The impact of climate change on mariculture also needs to be addressed
- Estimation of biological reference points (or optimum harvesting strategies) for realizing long-term sustainable yields of large pelagics
- Scaling up sea farming: to establish mariculture as a substantial seafood production sector
- Stock enhancement of depleted finfish and shellfish stock
- Establish a number of bio-secure brood bank to produce seeds of important high value marine fin fishes at a cheaper rate on a large scale to facilitate large scale open sea cage farming
- Conservation of endangered, threatened and vulnerable marine living resources
- Capacity building for process optimization and product development of fish feeds using the state of the art technologies leading to the imitation of nutrigenomics
- Development of health management packages for the targeted candidate species while formulating viable technology packages for these species
- Explore and exploit the possibilities in marine bioprospecting
- Developing molecular markers of finfish and shellfish of commercial and mariculture importance
- Valuation of ecosystem services
- Assessing the social cost benefit impacts and the economic performance of fishing methods
- Constant monitoring of the emerging value chain dynamics, globally as well as regionally
- Policy frame work for marine capture fisheries, deep sea fisheries, island fisheries, coastal mariculture, environmental security, common property resource utilization, sustainability issues, food safety and WTO commitments for India