[1]What is the Need for Research in Marine Fisheries?

Mohan Joseph Modayil
Director
Central Marine Fisheries Research Institute
Kochi - 682 018

At no point of time the question "what is the need for research in marine fisheries" would be more appropriate and poignant than it is today, as the country's marine fisheries are passing through a period of stagnation and uncertainty. A question quite often asked by many knowledgeable persons with varying levels of understanding of marine fisheries is "why research in marine fisheries should be done at all when it cannot lead to increase in fish production from the seas and catches continue to stagnate? Can the research result in doubling fish production from the seas? Why mariculture of all major species can not be carried out to increase production? Of course, these questions represent the concerns and the understanding or the lack of it about the characteristics of marine fisheries and the role research plays and must play in marine fisheries development and management as the country is transforming itself into a developed nation.

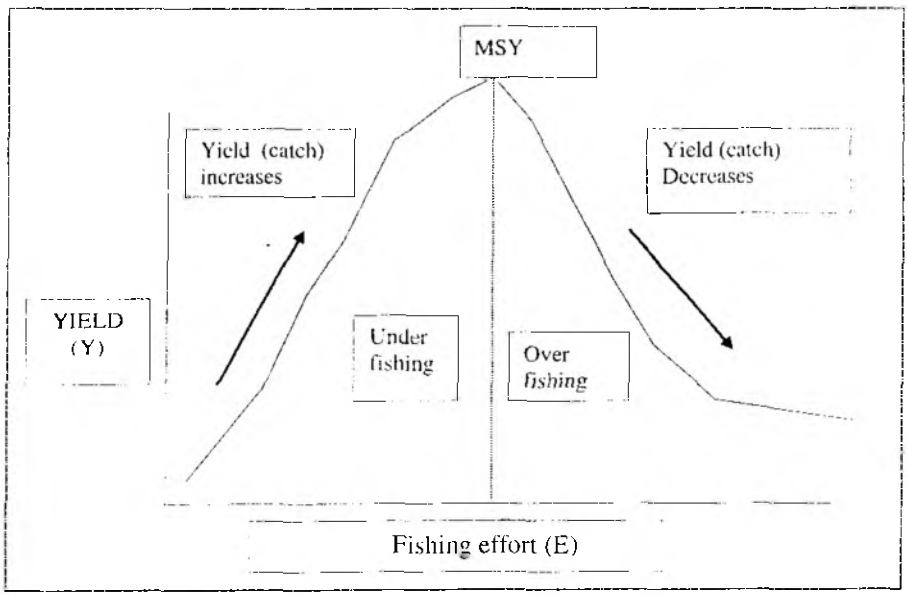
India, like every other growth-oriented country, has been spending huge amounts of money in monitoring the weather and carrying out research on climate. Have these resulted in increasing the rainfall or preventing the droughts and floods? If not, why are we still spending huge sums on these activities? You know the answer. Yes, it is the information and knowledge emanating from this research that is important to the country and the money spent is well justified for the information, which is relevant and important for understanding the weather and for modeling, forecasting and predictions. Drought, rainfall, floods, higher summer temperatures, colder winters all have direct and indirect impacts on agriculture, natural resources and overall growth. The information derived from monitoring is thus vital for the country. We have a similar situation in marine fisheries. Marine fisheries are essentially the exploitation of natural living resources. Unlike the land-based resources, the fishery resources are invisible, migrating and easily affected by the characteristics of the fluid medium in which they live. Also, the resources are migratory, subject to their own dynamics and fishing pressures and natural mortalities. Man has a lot of control on land-based resources through interventions, but in the sea there are no inputs from man, other than exploitation. In other production systems such as crops, man can increase production by adding fertilizers, resorting to irrigation, pest management, using genetically selected seed etc. In marine fisheries exploitation, there is no opportunity for man to intervene except through management of the capture process, which is the only process he has control upon. These characteristics of the marine fishery resources make them unique and difficult to understand, monitor, manage and intervene. It is this uniqueness of the marine fisheries that is important and fascinating to the resource managers for management interventions and even exciting to the scientists to explore the dynamics and uncertainties through information generated through data collection and trend analysis and modeling. This is all the more important in a country like India where the marine fisheries are multi-species, multi-locational, multi-gear in nature and are being exploited through an open access regime without any serious control or management interventions.

Can we double fish production from the seas? A deep understanding and lot more space and time to analyse and infer are needed for a reasonably convincing answer. Therefore, I shall confine only to basic minimal theoretical analysis of fish population dynamics and highlight the inferences and logical deductions. We understand that when there is adequate fish in the seas, fish yield is directly proportional to fishing effort, provided the fish is accessible and vulnerable to the gear. So, as the fishing effort (fishing vessels, power of boats, duration of fishing, number of nets, size of nets, mesh sizes, manpower etc.) is increased, the fish caught (yield) also will increase. However, when we consider the fish yield (in weight), there is an upper limit and beyond that even if we increase the fishing effort, the yield will not increase but decreases. This curve of yield in weight against fishing effort is the classical curve telling us whether we are underfishing, overfishing or optimally fishing. When the yield decreases, the tendency of fishers, operators and ill-informed fisheries managers is to increase the number of boats, number of nets or use smaller nets. All these will result in catching smaller and smaller fishes. A situation arises where the total number of fish caught increases, but total weight decreases because the bulk of the total number is formed by undersized/juvenile fish of low weight. This results in a situation where the total yield in weight remains same, increases marginally or even declines. The panic reaction of the operators/ managers to increase in the fishing effort further results in decreasing fishing yields. All these happen within a defined fishery. If the increased fishing efforts are diverted to presently unexploited or new fishing grounds, the results would be different. The catch from multi-day fishing is landed along with single day fishing and if data are not properly collected and analysed, the conclusions would be erroneous and decisions taken inappropriate. Informed fisheries managers who are managing

[1]*The views presented here are personal to the author and do not reflect the opinion of the institution he represents.*

regulated fisheries take appropriate decisions to increase or decrease fishing effort by taking clues from the classical fishing curve of Y against E (Fig. 1). So, if we are at the top of the curve or have already crossed the top and are on the right side of the hilltop, then any increase in fishing WILL NOT result in increased catches, instead, will result in lowering the catches and catch rates. For most of our captured marine fisheries resources, we are near this situation.

Figure: 1



Therefore, if you have to increase fish production from the existing fishing grounds and fisheries, increasing fishing (effort) is not the answer. On the other hand, if the fishing effort is gradually reduced so that the yield moves back to the top of the hill, then the catch (yield) will slowly increase. Only reduction in the number of boats, reducing the efficiency of the nets, increasing the mesh sizes, introducing alternate day fishing cycles etc. can do this. The effect of F on Y/R (Yield by Recruitment) should be viewed in conjunction with the biomass per recruitment (B/R) and also spawning stock biomass per recruit (SSB/R). The predetermined threshold values for the above reference points or the biologically tenable values for these reference points need also to be specified. The concerns are: Are we fishing at safe levels of Biomass and SSB? Can the stock regain its earlier level of Biomass even if F is reduced? Therefore, overfishing should be looked at from Y/R, B/R and SSB/R. It must also be reckoned that as Y/R is a long-term model based on equilibrium assumption, giving a time frame for the events that may happen if F is changed, will be difficult. There are many options for fisheries managers to regulate the fishery. So the fact remains that by increasing the number of boats or by introducing more efficient nets, we are not going to increase production, but we will be killing the fisheries. If we allow each fish caught to grow for a bit more time by delaying its capture, then we are providing the fish to reach a larger size at capture. A 25% increase in mean size will result in some increase in weight and the total yield will also marginally increase depending on the natural mortality M. There is thus no point in thinking of doubling or increasing the yield in a well-exploited fishery. The only conceivable action plan is to restore it to the normal position where the yield can be sustained at maximum levels. However this requires time, patience, sacrifices and regulatory measures like 1) Reducing over-capacity in fishing; 2) Increasing mesh sizes (This may result in a sudden drop in yield and gradual increase subsequently); 3) Introducing closed seasons, closed areas; 4) Reducing by-catch and discards; 5) Stopping juvenile fishing; 6) Stopping destructive fishing methods, destruction of bottom fauna; 7) Following the Code of Conduct for Responsible Fisheries (CCRF); and 8) Harnessing the unexploited and new fishing grounds. If they are available, they can contribute to some increase in yield.

Mariculture is a production system which can produce more marine species, particularly finfish. However, at the present levels of fish prices and costs involved in production, the open sea mariculture will not be economically feasible unless many more processes and mechanisms also fall into place, such as a coastal water leasing policy and licensing regime, insurance and protection from poaching, assured price for farmed fish, availability of formulated feed, scientific management regimes and conducive business environment. At best, mariculture at the present stage of its development can only supplement fish production to the tune of a few thousand tonnes. It cannot make any significant increase in total fish production in India as at present for various reasons. This is a reality all of us have to reckon with.

Thus, the picture emerging is rather bleak and disappointing. In the light of the above, what is the role of research in marine fisheries development in India? A look into the past, present and future of fisheries research will give us a better understanding.

History of Marine Fisheries Research in India

It will be of interest to trace the history of marine fisheries research in India. Fisheries being a transferred subject, the Government of India did not take any direct interest till the early 1940s, except enacting the Indian Fisheries Act 1897. In the pre-independence and immediate post-independence years, the Fisheries Departments of the Provincial Governments were attending mainly to revenue collections. The naturalists of the Marine Survey of India, the Officers of the Zoological Survey of India and the teachers in some universities were conducting studies on fishes and other aquatic fauna. Organised fisheries research, however, was absent in the country then.

Lack of adequate supplies of good quality fish during the Second World War, especially for the British, American and other Allied army personnel made the then Government of India to realise the need for taking direct interest in research and development of fisheries in the country. This resulted in initiating some fisheries research schemes by the Indian Council of Agricultural Research. The Industrial Commission of 1916-1918 recommended that the Central Government should promote studies on fish and fisheries by strengthening the Zoological Survey of India to give expert advice in fisheries to the provincial Governments and others and it was implemented by the Central Government for a few decades.

All of us in the fisheries sector should be indebted to the great visionary – Dr. Baini Prasad, the then Director, Zoological Survey of India, who in his Memorandum on the "Post-war Development of Indian Fisheries", submitted in 1943 to the Government of India, first proposed the establishment of Central Fisheries Research Institute. By that time the Indian Agricultural Research Institute at New Delhi, Veterinary Research Institute at Izatnagar and the Forest Research Institute at Dehra Dun were already established. Agriculture, Veterinary and Forestry, like Fisheries, were also transferred subjects and Dr. Baini Prasad observed in his proposal that "the Government of India are maintaining fully equipped and well-staffed research institutes for the study of the problems related to these subjects, and there seems to be no reason why the development of Indian Fisheries, which in their importance are second only to agriculture and animal husbandry, should not be taken up along similar lines". He also rightly asserted, while being the Director of the Zoological Survey of India, that he was "definitely of the opinion that it would be best if a central research department of fisheries of the Government of India is constituted instead of tagging it on to the Zoological Survey of India". He also observed "it would not be in the best interests of fishery research in India to make it a subsidiary of the activities of the Zoological Survey of India". One would agree that in the present context of governmental set up, no Officer of the status of the Director of a large reputed organisation would recommend or even suggest that a portion of his organisation could be developed into an independent institute except those with vision and having larger interest in the nation. The Fish Sub-Committee of the Policy Committee on Agriculture, Fish and Fisheries endorsed this proposal in their report in 1945, thus paving the way for considering the establishment of a Central Fisheries Research Institute. Some time elapsed after the submission of this document to the Government of India. Later, on the basis of the "Memorandum on the proposed Fishery Research Institute" submitted in 1946 by Lt. Col. Dr. Seymour Sewell, the Central Marine Fisheries Research Station was established.

Although under a different name, the Central Marine Fisheries Research Institute was established at Madras in the temporary laboratory accommodation provided by the University of Madras at the Zoological Research Laboratories, prior to independence, on 3rd February 1947 under the then Ministry of Food and Agriculture, Government of India. On the basis of the report of an expert committee on relocation of the institute, the headquarters was shifted later to Mandapam Camp in September 1949. The buildings, constructed originally for the Naval Hospital by the Defence Department during the World War II which were lying abandoned in a dilapidated condition overgrown with thorny jungles and infested by reptiles, were acquired and converted into laboratories and temporary residences for the staff. Subsequently about 100 acres of land by the side of the institute was acquired and permanent residential quarters were constructed in 1958. The marine aquarium and fish farm were developed in subsequent years. However, the Mandapam region was a remote locality without adequate transport, medical and schooling facilities. This mainly prevented the expansion of the activities of the Institute, as there was lack of willingness to serve at Mandapam Camp by many staff members; besides, the major marine fisheries activities were concentrated along the west coast, particularly along the Kerala coast, necessitating the shifting of Headquarters to Ernakulam (now Cochin) in July 1971. At Ernakulam, the Institute was located in rented buildings for a period of 15 years but in 1986 it was moved into the present building of its own.

The head of the institute was originally designated as Chief Research Officer; in 1961, the designation was changed to Director and the name of the institution from Central Marine Fisheries Research Station to Central Marine Fisheries Research Institute. In 1967, the Government of India transferred the Administrative control of the Institute to the Indian Council of Agricultural Research. The research work on Fisheries Technology (craft and gear and processing) being carried out in the institute was separated and merged with the newly formed Central Institute of Fisheries Technology, Ernakulam in 1958. Much later, in 1985, the research work on brackishwater aquaculture being carried out at the Institute was also separated and merged with another newly established Central Institute of Brackishwater Aquaculture, Madras.

Indian fisheries have evolved from a traditional low input livelihood artisanal fishery upto the 1950s to the present industrialised highly capitalised status through a natural process of investments on a business opportunity. There has been no well-informed national plan or agenda or guidelines for development or control of the development process. Like in any untapped or underutilised resource, the resource was abundant, and with more and more fishing effort by adding fishing crafts, the catches increased proportionately. The early introductions were the bottom

trawls, which brought in the valuable shrimps and the export trade bloomed. With the international demand and high prices the commodity commanded, the investment on fishing trawlers increased resulting in a sudden spurt in the number of trawlers from a meagre few numbers in early 1950s to 1,000 nos in 1960s and 5,000 nos in 1970, 11,300 nos in 1980s, 25,000 nos in 1990s and presently 29,200 nos all along the coastline. Introduction of gill-netters and purse seiners in the 1970s added much more fishing capacities to the capture fisheries sector. There was no national agenda for well laid out guidelines on the size of the vessels, engine capacity, gear types, mesh sizes, fishing power etc. This led to an uncoordinated and even unscientific designs of 'efficient' fishing gear with small mesh sizes. This type of uncontrolled and unregulated fishing in various maritime States of the country has now resulted in a plethora of fishing gears most of which are resource and /or environment unfriendly and destructive. Since there has been no attempt for governmental interventions and control till very recently, the craft and gear developed, and on which huge investments were already made. This has put burden not only on the economy but also on the exploited marine fishery resources.

Therefore, no other time in the history of the marine fisheries development in the country is more appropriate than the present phase of uncertainties, threats and bleak future to take upon ourselves a process which will enable us to review, assess, appraise and plan the kind of interventions needed for ensuring sustainability of the fishery resources, fishery operations, employment, profitability and economic viability and effective resilience. Especially at a time when the premier fisheries research institute in the country, the Central Marine Fisheries Research Institute is celebrating its Diamond Jubilee Year in 2007, the questions and concerns disturbing the minds of the scientists and policy makers in the country must be adequately addressed in a way that will not only make all concerned fully aware of the various dimensions and perspectives of the issues but also allow proactive thinking and planning to put the marine fisheries of the country in the right path.

Growth and Status of Marine Fisheries Research

If we have to understand the role of research in marine fisheries, then we need to review and evaluate what was carried out so far, what was its relevance and what were its outputs and impacts. To trace the history of marine fisheries research, we need to go back to the history of India.

The pioneering research in India carried out in what I would call the first scientific fisheries research in India was the monumental work of Sir Francis Day, a British medical doctor, who brought out a very elaborate, well illustrated comprehensive account of the fishes of India which is till today the only exhaustive document describing both fresh and marine fishes of India. Other remarkable outputs were those of Hornell, Hora and others most of which were taxonomical accounts. The Research Centres of CMFRI were established in Chennai (1949), Calicut (1947), Karwar (1948), Mumbai (1947), and Tuticorin (1948), Vizhinjam (1951),Veraval (1954), Kakinada (1956), Mangalore (1957), Visakhapatnam (1961) and Minicoy (1965).

The role of marine fisheries related research work carried out by organisations like the Central Institute of Fishery Technology, Central Institute of Brackishwater Aquaculture, National Institute of Oceanography, Institute of Science, Mumbai, Zoological Survey of India, Bombay, Natural History Society, Madras Museum, Fishery Survey of India, the maritime universities such as the Bombay University, Karnataka University, Mangalore University, Calicut University, Cochin University of Science and Technology, Kerala University, Madras University, Andhra University, Annamalai University, State Agricultural Universities especially University of Agricultural Sciences, Bangalore, Konkan Krishi Vidyapeeth, Tamil Nadu Veterinary and Animal Science University, Kerala Agricultural University, Acharya N.G. Ranga Agricultural University, Hyderabad, Andhra Pradesh and numerous research projects funded by the various departments under Ministries of the Govt. of India were remarkable. However, these research attempts were mostly *ad hoc* approaches and not with a well focused target and mostly basic and in no way comparable to the massive research outputs during the past six decades from the nodal marine fisheries research organisation in the country, the CMFRI.

The first research focus of the CMFRI was to carry out pilot surveys to estimate marine fish production, conduct studies on the biology including food and feeding habits, maturation, spawning, growth, age etc of commercially important species of marine fishes and shellfishes. Taxonomic studies on plankton, finfish, crustaceans, molluscs, echinoderms, sponges and corals followed. The major research achievements of this period were the outputs from the pilot surveys on estimation of marine fish production, information on the biology and taxonomy of major species of marine fishes of commerce such as the Oil Sardine, the Indian mackerel, Bombay duck and Penaeid prawns. The period between 1951 and 1960 also witnessed attempts on experimental mechanised fishing by trawlers. The marine fisheries research focus revolved around the new initiatives and estimation of resource-wise marine fish landings, commenced in the Institute. Studies were carried out on the biology (food and feeding habits, maturation and spawning, growth and age) of commercially important fish and shellfish, taxonomic studies (finfish, crustaceans, molluscs, echinoderms, sponges, corals, and plankton. Occanographic investigations in relation to fisheries surveys followed. A significant research output was the Multistage Stratified Random Sampling Design

developed by the Institute to build up a time series database on season-wise, region-wise, gear-wise and species-wise marine fish production. Along with this, oceanographic investigations in 1957 and the first Marine Fisheries Census were carried out in 1957-58. During the 1961-70 period, a major initiative was made to study the Indian Ocean through the International Indian Ocean Expedition organised by UNESCO. The period also witnessed the annual marine fish landings crossing the one million ton mark in 1970. Mechanised fishing commenced in the Indian seas on a commercial basis during this period. New materials were used for nets and the export of marine fishery products commenced. The research focus in marine fisheries resulted in the establishment of a nationwide system of collecting and interpreting data on the marine fish landings of India. Information on Biological Characteristics of major exploited stocks in the inshore waters was consolidated and monographs/memoirs (oil sardine, ribbonfish, goatfish etc.) were published. Efforts were made for mapping of fishery resources in offshore/deeper waters based on exploratory surveys which laid the foundation for development of trawl and purse-seine fisheries. Detailed studies on the ecology and fishery resources of Lakshadweep seas were conducted along with exploratory longline fishery survey for highly valued and untapped resources of tunas, billfishes and sharks. Pioneering tagging studies were initiated to study migration patterns (*Hilsa* in Hoogly estuary, Grey mullet in Chilka, oil sardine, mackerel and penaeid prawns in inshore waters). The second Marine Fisheries Census was carried out in 1961 - 62. The period 1971-80 witnessed much progress in marine fisheries development. Declaration of Indian EEZ was a major event. The introduction of a new type of gear, the Purse seine, was an epoch making development. The trawl fishery expanded further and the High Opening Trawl Net was introduced. The research thrust during this phase was on developing database on resource-wise and region-wise marine fish production for developing management measures for fisheries from the Indian EEZ. Resource surveys for new fishing grounds, new resources etc were carried out. Biological studies on exploited commercial species were strengthened. Studies on the role of oceanographic parameters in relation to fisheries were carried out. Research also focused on taxonomic studies. For the first time, new initiatives in mariculture were taken up to develop hatchery technologies for commercial species of shrimp from breeding to hatchling and early fry production. Major achievements during this period were the first estimate of potential yield from Indian EEZ made as 4.7 m t based on primary/secondary production, exploratory surveys and data on exploited resources. A comprehensive yearlong Indo-Polish Industrial Fishery Survey was carried out between 15° to 24° N at 55-360 m depths and abundance of important groups (threadfin breams, large carangids, ribbon fishes, pomfrets, horse mackerel and eels) was mapped. Estimates of coastal tuna landings provided to IPTP (Indo-Pacific Tuna Programme) for the first time. Environmental parameters and primary/secondary productivity of the Indian seas were charted. A major achievement was the development of breeding and grow-out techniques for shrimp through which India entered in to a new era of mariculture in the subsequent years. Another feat was inventorying 270 marine fish species and 240 gorgonid species and a breakthrough in developing indigenous technique of pearl culture. Experimental raft culture for molluscs such as pearl oysters, marine mussels and edible oysters was initiated in the country. The period 1981-90 witnessed further progress in the marine fisheries development in the country. Technology induced intensification of fishing effort and quantum leap in fishing efficiency (Introduction of multi-day fishing and motorised craft and ring seines) was the hallmark of this period. The period also witnessed sectoral conflicts. Maritime States enacted Marine Fishing Regulation Acts (MFRAs). The research thrust now shifted to rendering advice on biological and economic sustainability of the resources and research support for policies for effective development and management of fisheries, assessment of commercially important stocks, research on conservation of sea turtles, development of HRD in Fisheries Statistics and Fish Stock Assessment, further thrust on mariculture technologies and strengthening of inshore and offshore vessel-based [*Cadalmin* (13.1 m OAL), *R.V. Skipjack* (32.6 m) and *Sagar Sampada* (71.5 m)] research. Many scientific documents on Tuna, Cephalopods, and stock assessment of major exploited stocks were brought out. A scientific document "Monsoon fisheries of the west coast of India – Problems, prospects and management" was another important research contribution. Development of software for processing the data on marine fish landings in India was a major development. Also scientific advice to various Committees constituted by different State Governments to address vexed issues/problems in the marine fisheries sector were provided. Socio-economic studies were carried out to study the impact of introduction of new technologies in fisheries.

The recent past from 1991 to 2000 witnessed a worldwide increasing awareness on need for conservation of marine resources and responsible fisheries (Cancun & Kyoto Declarations). Research thrust now shifted to development of Ecosystem based Models for fisheries management, conservation and enhancement of fish stocks, awareness creation about sustainable fishing, use of remote sensing technologies and advanced mariculture techniques. Research achievements include EBFM models developed for southwest coast, development of Biological Reference Points for number of species, sea ranching (prawns, clams, pearl oysters), FAD and Artificial Reefs installations, awareness creation regarding destructive fishing practices and juvenile fish destruction, validation

of PFZ advisories, economic valuation of marine fisheries, assessment of ornamental fish resources of Lakshadweep.

The period from 2001 onwards has been witnessing a shift in the marine fisheries scenario. The hallmark of this shift was the stagnating marine fish production and increasing inter-sectoral conflicts, juvenile fishing, increased demand for by catch, diversion of low value food fishes to the animal feed industry, emergence of destructive fishing gear, methods and practices, decreased profitability of fishing operations and uncertain yields. The recent past has also witnessed many uncertainties emerging in the marine fisheries sector consequent to the WTO regime and trade barriers. The Govt. of India released the National Marine Fishing Policy in the year 2004. In view of these developments, marine fisheries research thrust is now focused on evaluation of fishery and resource status of all maritime States, impact of climate change in marine fisheries, conservation and promotion of sustainable fishing practices, conservation of biodiversity, socio-economic studies in the marine fisheries sector, and research on several resource enhancement interventions. The major research outputs include assessment of marine ornamental fish resources and quantification of their stock size and commercial potential, a comprehensive compilation of status of 22 commercially important exploited finfishes, shellfishes, marine mammals, turtles and seaweeds with suggested management measures and policy guidelines for sustainable exploitation and the much sought after publication on the resource-wise and region-wise database of marine fish landings developed for the period 1984-2005. Changes in the area of distribution and spawning activity of fishes due to climate change have been recognised through research. Further, a National Marine Fisheries Census-2005 was carried out all along the maritime States in a short span and the latest demographic, social, economic, craft, gear and other infrastructure data generated, documented and disseminated. Special publication on methodology for the estimation of marine fish landings in India has been brought out. Based on CMFRI's recommendations, Minimum Legal Size (MLS) declared for lobster exports was fixed by the Ministry of Commerce. There was the association of CMFRI in the formulation of Marine Fishing Policy by the Government of India. Also, steps were taken to popularise the FAO Code of Conduct for Responsible Fisheries. Communication tools meant for Responsible Fisheries Extension Module (RFEM) were designed, validated and disseminated. Research also resulted in ecopath and trophic model for NW coast and Gulf of Mannar ecosystems, trophic analysis of exploited marine fishery resources. Breeding technology was developed for marine ornamentals such as clownfish and blue damsel, sand lobsters, besides popularisation of mussel culture along Kerala and Karnataka coasts. Extensive studies were conducted on marine mammals in the Indian EEZ and contiguous seas.

Thus, overviewing the growth, we come to realise that the marine fishery research history in India had five distinct phases: Phase 1, with research focus on taxonomy, fishery Biology, pilot surveys, population biology; Phase 2, with focus on resource estimation, taxonomy, marine Biology, oceanography, exploratory surveys; Phase 3, with focus on stock assessment, policy inputs, conservation, breeding techniques; Phase 4, with focus on fish stocks, conservation research, ecosystems, remote sensing; and Phase 5, with focus on mariculture, awareness, social impacts, conservation, biotechnology, resource enhancements, hatchery protocols and mariculture commercialisation.

Impact of Research on Fisheries Development and Management

It would be interesting and appropriate to briefly underscore the impact of research on the growth, development and management of marine fisheries in India. The taxonomic research carried out in the country provided a basic understanding on the resource biodiversity, their distribution and species abundance, which was a very basic necessity in development agenda. Indian marine biodiversity has been reasonably indexed and placed in one of the topmost hotspots in biodiversity. This information has been valuable and must be further upgraded especially in view of the current worldwide interest in biodiversity research, marine census, bar-coding of life and global initiatives against biopiracy. The basic research carried out by Sir Francis Day and since then by others is one of the most valuable treasures we have. The initiatives by the CMFRI for carrying out pilot surveys and ultimately developing a well designed, field-tested and internationally accepted sampling methodology for estimation of marine fish landings was a major scientific contribution. This has opened up a new branch of scientific research and development where statistics and sound inferences from biological research helped in decisions leading to knowledge based interventions. The major outcomes from application of the research outputs are the MFRAs, assessment of stocks of major species of commercial fisheries, revalidation of marine fish stocks, advisories for fishing efforts, introduction of new fishing vessels and future planning process. The biological research has provided very valuable inputs from the studies on growth, maturity, fecundity, breeding seasons, food and feeding habits, trophic relationships and migrations for designing many marine fisheries regulatory instruments such as closed seasons, mesh size regulations, closed fishing areas, ecosystem based management plans, predictive modeling, assessment of marine fisheries and it will also aid in the emerging concerns in areas such as certification, Ecolabeling, and biodiversity conservation which will impinge on the trade and export of marine products from India. Understanding of the major pelagic and demersal fishery resources and

their dynamics are vital in forecasting of fishery yields, especially of the major marine fisheries. Such information is very vital for the planning process for investments on infrastructure like harbours, jetties, and new vessels, processing plants, fishery industrial estates, financing, trade development and resource economics. Biology of species undergo changes depending on many external factors and therefore such research must be carried out on a continuing basis as long as fishery exists and the feed back from the angles of requirements of the research must be used in the planning and intervention process. Research on biodiversity is of prime importance not only from the conservation angle but also from the angle of mariculture, trade, commerce, export and biopiracy. For example, the research carried out by the CMFRI and the inputs provided by the Institute to the Government of India for developing policy interventions on marine turtles, marine mammals, marine ornamental fishes, corals, seahorses, sea cucumbers, elasmobranchs, on import of exotic fish species, export of endangered species, and on fisheries related aspects of the Coastal Regulatory Zone (CRZ) Act have all been significant and much valuable. All these would not have been possible without the research back up. Similarly, the inputs for the Government of India's guidelines for 'Precautionary approach and polluter pays principles in shrimp farming' for the Aquaculture Authority of India was developed by the CMFRI, based on its research strengths. The research based inputs to world organisations for conservation of marine organisms such as IUCN, WWF, CITES have been very valuable. The IOTC is depending on CMFRI for data on coastal Tuna. The new initiatives in Certification of Indian Fisheries by the Marine Stewardship Council (MSC) of the United Kingdom will have to depend largely on the research outputs from CMFRI, which could be the accredited agency for this process. Similarly, the worldwide Marine Census has shown keen interest in associating with the CMFRI in bar coding of marine life. These international initiatives and processes should be viewed as 'must activities and business opportunities' for India if we have to compete in the international playing ground under the WTO regime. And research data are the essential foundation for these processes. Another significant output from the marine fisheries research is the generation of the basic technology for the breeding of shrimp in India which eventually led to the large scale shrimp mariculture in the country. This further caused a boom in marine exports leading to an annual export earning of over Rs.7500 crores, which is much more than our agricultural exports. Another significant breakthrough is the marine pearl culture technology developed by the institute through which India has entered the elite club of the rare marine pearl culturing countries of the world. Tissue culture technology for marine pearls developed by CMFRI has a world patent and will in due course open up avenues for custom made marine pearls. About a dozen of marine ornamental fishes have been successfully bred and the breeding technology of at least six species are ready for commercialisation. This new area will result in not only development of the live fish trade and export industry, but will also attract investment. The success made in breeding and nursery rearing of the sand lobsters is another significant achievement of CMFRI, which will also result in large scale farming of the sand lobsters in the country. All these are research outputs of significance and consequence, which will be realised, in good time. Research on marine biotechnology leading to locating bioactive compounds of pharmaceutical and medicinal importance is a very potential area of research, which will also place India in an enviable position because of the rich biodiversity India has in its seas.

Research on the marine environment is another area of consequence to the marine fisheries of the country. Monitoring marine pollution and health of the seas is important not only from the fisheries and human health point of view but also from the sustainability of the ecosystem which will have compounded impacts on the marine life and indirectly affect the population, industry and economy. Impact of the climate change on marine life, coastal ecology, marine fisheries, species diversity and coastal livelihoods is another area of importance for research attention. Such research should be on a continuing basis as the scenarios keep changing and new issues keeping emerging. Research attention must also focus on the social, economic, environmental costs and benefits of marine fisheries and mariculture interventions. Changes in the fishing patterns, market trends, changing demand - supply patterns, emergence of new technologies, products, consumption patterns, all will have indirect consequences on the coastal poverty and livelihoods and these will need continued research attention, analysis and interventions. Thus, we must realise that research has an essential and continuing role in the marine fisheries of the country.

Is Fisheries Research Valued and Appreciated in India?

This question can only be partially answered because of the complexities involved in the perceptions of end users, public and others. If research is viewed as a tool for increasing production directly as in the case of agriculture, animal sciences, then such expectations from marine fisheries, which are a natural resource for exploitation, cannot be answered. In other areas such as crop sciences, there are many direct inputs by man for increasing production, which is simply not there in the case of marine fisheries. As explained elsewhere in this write-up, research and production cannot be linked directly in the case of marine fisheries. Research must lead to advisories to the Government and it is the role of the Government to design policies and regulatory measures to advise the State governments who are the enforcing authorities to

implement these regulations, which ultimately should result in a better management regime of the marine fisheries. A better management will, in turn, result in a better production and sustained growth. It is the lack of this basic understanding that has resulted in the misconception that marine fisheries research should result in higher fish production. The effectiveness of research will be felt only when, repeat only when, the fisheries are well managed through technically sound regulatory measures and a well structured and informed fisheries governance aimed at ensuring growth, and sustainability is in place. What is currently happening in India is the inadequacy in the fisheries management in the coastal States. Until and unless the coastal fisheries are well regulated, the marine fish production will not increase. Instead the present trend of stagnation and decline are bound to continue and may reach a point of no return in course of time. This realisation is important and vital for the survival of the marine fisheries of the country. Therefore, awareness of the above situation is important at all levels and such awareness only can bring about the appreciation and valuation of marine fisheries research in the country. As of now, such awareness is doubtful.

The Road Ahead

Future research in marine fisheries must focus on spatio-temporal analysis of fisheries resources, short-term and long-term forecasts of fishery yields, survey and assessment of fish eggs and larvae, trophic modeling of major marine ecosystems, tag - recovery studies on straddling and migratory stocks, GIS based information system on marine fishery resources and mariculture sites, impact of climate change on marine fisheries, commercialisation of hatchery technologies of marine shrimps, crabs, lobsters, sea cucumbers, pearl oyster, clam and mussels, genetic improvement of marine cultivated species through selective breeding and hybridisation, bioinformatics and gene library of existing and emerging marine pathogens, molecular taxonomy of marine organisms to develop PCR based identification tools, development of black lip pearl oyster farming in A&N Islands involving local fishers, cage farming in open sea, marine policy research in the context of WTO, CBD, IPR, TRIPS, demand and supply scenarios and also infrastructure needs to make the marine sector economically viable, utilisation of the marine resources data to develop the policy guidance and to strengthen the research system by assessing the impact of technologies and by prioritisation of research, monitoring of the sustainability of the marine sector and assessing the returns from investment, monitoring of the socio-economic conditions of fishers livelihood and quality of life, strengthening and widening of the linkages with the fisherfolk, coastal rural folk and the Industry, and scaling up of extension interventions for Responsible Fisheries.

The road ahead should therefore target at creating awareness and developing partnership with end users for a co-management of marine fishery resources, developing policy advisories and management options for ensuring a sustainable and information driven resource utilisation, monitoring and surveillance of resource utilisation patterns, impacts of fishing and other human interventions, and emergence of new resources and fishing patterns, social and ecological benefits and costs of marine fisheries, improving the coastal productivity through sea-ranching, FADs, conservational mariculture and enhancing the coastal livelihoods through responsible fishing and alternate livelihoods, conservation of marine genetic, taxonomic and ecosystem biodiversity, conservational mariculture and protection of endangered species and threatened habitats, vessel-based research on straddling species, fish eggs and larvae, non-conventional resources, policy research, WTO impacts, non-trade barriers, certification and eco-labeling and repositioning Indian fisheries to face emerging world scenario.

The world is fast changing over to a knowledge driven environment. In this change over, unless the marine fisheries are researched, knowledge generated and applied for management, its global competitiveness and acceptance will be doubtful. Therefore not only the survival of marine fisheries, but the survival, food and nutritional security of several lakhs of coastal poor and the entire export trade of marine fishery products will have to dovetail with research outputs which are eventually converted to applications. The deeper we look at it, the clearer it is that only research based interventions can sustain marine fisheries and therefore proactive research is the need of the hour.

Is There a Future for Marine Fisheries Research in India?

If marine fisheries in the country are to sustain, then it cannot happen without research support. It has also to be carried out on a continuing basis in order to assist the process of sustaining the fisheries. Such an understanding is already there in countries where knowledge driven management of marine fisheries is in place. For India to enter into such a regime, we have a long way to go and a lot of political will, courage and preparedness are needed. In the absence of these, the future for marine fisheries is bleak and as time passes, more and more uncertainties, inter-sectoral clashes will arise and scenarios will worsen. It is upto the informed citizens and the like-minded organisations to take up the cause of effective management of marine fisheries for the sake of posterity.

Call for More Support to Fisheries

The Working group of the Sub-committee of the National Development Council on Agriculture and related issues has called for increase of Budgetary outlay for fisheries from 0.22 per cent to 0.88 per cent and for animal husbandry from 0.4 per cent to two per cent. Dr Y.S. Rajasekhara Reddy, Chief Minister of Andhra Pradesh and Chairman of the group, wanted the Government to peg institutional credit at not less than Rs 1 lakh crore, with interest subsidy from the Government.

Source: MPEDA News Letter, February 2007.