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STATUS OF MARINE FISHERIES RESEARCH IN INDIA – CAPTURE TRENDS, COASTAL VULNERABILITY ISSUES AND SUSTAINABLE PRODUCTION PLANS

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Introduction

Marine fishery resources have supplemented the much needed protein requirement globally and earned the status of 'cheap protein' during the last five decades. With the increased awareness about quality protein available in fish and other fishery resources there has been an exorbitant demand for marine fish during the last two decades. This period witnessed a spurt in the fishing efforts resulting in dwindling marine fish catches as the exploitation rates were higher, affecting sustainability. Globally, there were several instances in the temperate waters where certain species and their fishery collapsed. Better diversity, higher fecundity and varied spawning peaks helped the Indian marine fishery to thrive the challenges driven by mechanized crafts in pursuit of high quantity 'cheap protein'. Even though there are ups and downs in the inter-annual abundance of fishes landed along the coastal waters of India and other global fishing nations; the trends differed in terms of their decadal growth averages.Marine fisheries in India followed the global trends except the fact that there were no instances of a collapsed fishery here, unlike the temperate waters where operational fishery collapsed several times due to various factors. Similar concerns and situations simulated for Indian marine fisheries created a school of thought redeeming marine capture fisheries research to a conservationist mode studying more on sustainability neglecting many a time the possible production process. The present review calls upon the various aspects on marine fisheries research and development critically examining the existing system of conservation research and proposes a viable alternative of production research for a carbon smart world.

Capture fisheries scenario

National Marine Living Resource Data Centre is instrumental in managing the database generated by Fishery Resources Assessment Division of CMFRI since the inception of the Institute. Marine resources of Indian shores have been exhibiting thorough heterogeneity and complex inter-relationships over years. The contribution of marine fishery sector during pre-independence period restricted to 0.5 million metric tonnes only.

Fisheries emerging as a thrust sector from subsistence to mechanization with new fishing crafts and gears during post-independence era propelled the research initiatives on estimation of resource-wise marine fish landings. Pilot studies by Bannerji and Chakraborty (1972) during the early 50's till 70's over a span of two decades established the Multistage Stratified Random Sampling Design for building up a time-series database on season-wise, gear-wise and species-wise marine fish production.

The harvest of marine fishery resources doubled from a subsistence level of 0.5 million tonnes during 50's to 1 million tonnes during 1970 during this period of research interventions. With the advent of gears and crafts in a geometric progression during the 70's resource assessment studies started radiating signals of potential dangers involved in unregulated fishery and management of Indian fisheries which triggered new initiatives in resource assessment research. Estimated marine fish landings indicated an increasing trend with the marine fish production reaching 2 million tonnes by the beginning of 90's and increasing steadily afterwards. For establishing a sustainable and enhanced productivity from Indian Seas there were lot of initiatives in the 70's for rightly predicting the resources, regulating the fishery, policy directives, enactment of legislations and development of stock assessment models for the diverse fishery in Indian waters. Heavy investment in harvest and post-harvest sectors in Indian fisheries during 80's rendered vulnerable exploitation of many marine resources. Landing to the tune of 3.06 million metric tonnes, a record reckoning achievement could be ensured by the end of this phase. The latest landing data touches a record of 3.94 million metric tonnes provisionally for the year 2012 as estimated by CMFRI, which is the highest ever in the history.

Total catch is an important indicator to monitor and assess the status of the fishery. The decline in the catch is a signal for appropriate interventions from the managers. Annual growth rate in marine fish production on a decadal average scale indicate that there has been a steady increase in marine fish production in the coastal waters of India. But globally the production has been in a retrogressive phase.There is a biological contrast in the fish available in Indian waters too. Unlike the abundant single species fish stock biomass of nearly 50% replenishing the fishery in temperate waters; most of the multispecies fishery in the coastal waters of India is supported by fishes with high fecundity, continuous spawning ability, protracted spawning season and faster growth rates.

Satellite retrieved ocean colour data (chlorophyll) can act as a surrogate for most shoaling phytoplankton feeders especially oil sardine off the west coast of India.Indian Remote Sensing Satellite P_4 Ocean Colour Monitor (IRS P_4 OCM)/MODIS derived chlorophyll concentration and National Oceano graphic Aerospace Administration Advanced Very High Resolution Radiometer (NOAA AVHRR) derived Sea Surface Temperature (SST) images have been used to characterise the relationship between the biological (Chlorophyll) and physical variables (SST) in coastal waters and potential fishing zones are delineated. The spatio-temporal fluctuations of the plankton richness which can be remotely sensed have long been established as a major factor in predicting fisheries resource richness. Taking cue from these established models, patterns can be designed to predict the resource availability from the easy to observe parameters after a thorough validation of the prediction scenarios put together with the estimated catch from various fishing grounds. The change in the pattern of fishing, period of absence and the

composition of fish caught per haul, when analyzed for a range of geo-spatial expanses would help refining and augmenting a comprehensive prediction algorithm. Further, such models would come in handy in the assessment of marine resource potentials and their periodic revalidation on a homogenous platform with a proper measure of confidence interval. Such exercises are of immense importance to the government and policy makers. The history of co-integrating plankton availability and resource landings were initiated at CMFRI since the early 1960's. Collaborative efforts between marine fisheries research and space applications resulted towards the identification of potential fishing zones (PFZ) in the 1980's and 90's. With the climate change impacts making Indian fisheries sector vulnerable to forces other than over-exploitation, the ChloRIFFS (Chlorophyll based remote-sensing assisted Indian Fisheries Forecasting System) programme calls upon a systematic revalidation and interdisciplinary efforts in marine fisheries research to point out the lacunae and set-right the staggering contradictions between predicted and harvested resources.

Present capture fisheries estimates have only landing centre details. Proper geo-referencing of the data is required for establishing the scientific relevance. Prime focus on future fisheries resource research will be oriented towards building up of a spatio-temporal database in GIS platform as a decision support tool. Numerical and time-series models have taken a priority over real time observations such as surrogate databases from RS-GIS sources and have revolutionized our research. But the evident gaps in observation and assessment of fishery resources have to be nullified through regular survey, sampling and analysis. Automation of landing data estimation, Geo-referencing of fish catches, local spawning and fishing ground delineation, resolving physical process supporting the fishery resources for better understanding of the resource vulnerability to climate change, resource economic evaluation and international trade policies impacting our resources are few focused research areas to be given a due attention in the next few decades to augment the fisheries resources and sustain their present level of exploitation.

Sea food export from the country is a major FOREX earner. But with the imposition of quota regulation measures as an account of proper fisheries management, there is a necessity to rightly geo-reference each and every fish landed without any duplicity in their entire supply-chain. Subsidy supports to exports are inviting countervailing duties without supporting the socio-economically impoverished fisher folk in the coastal region. It is imperative to divert the direct-subsidies provided in support of exporters to sector based infrastructure development so that capital intensive works of this type will augment the export earnings without any issues on countervailing duties. If we need to rightly divert the money, a geo-referenced data base on existing infrastructure is required. Further, the quantum of earning by the relevant sites also is essential while diverting the funds. GIS databases on such relevant information are essential in the context of quota regulations, subsidies and issues on countervailing duties for sector based funding.

Vagaries of climate change in fisheries-vulnerability assessment vis-à-vis adaptation strategies

Climate change is one of the biggest global challenge facing mankind and governments are looking for practical and time-bound strategies and plans for mitigation and adaptation. Vulnerability has emerged to a central concept for

understanding the impacts of climate change and natural hazards and for developing adequate risk management strategies. Coastal vulnerability describes the susceptibility of the natural system and of coastal societies (persons, groups or communities) towards coastal hazards. It is a condition resulting from a system's social, economic and ecological properties and is a function of its natural and social coping and adaptive capacity to adverse impacts, namely its resilience. Assessing coastal vulnerability is an important prerequisite to determine where there are areas of high risk, why they are at risk and what to do to reduce the risk. The climate change effects have multidimensional impacts on environment, fishery, social, economic and development drivers. The perception of the primary stakeholders- fishers plays a major role in proactive participation in disaster management, adaptation and mitigation plans. The development of the conceptual framework progressed with identification of the coastal district, villages based on the different environment, fishery and socio economic parameters.

CMFRI focused on PARS methodology - Parameter, Attribute, Resilient Indicator and Score a conceptual framework developed for assessing the climate change vulnerability of coastal livelihoods. The methodology provides prioritisation and ranking of the different impacts as perceived by the fishers. The fisher's perception on climate change effects across fishing villages' vulnerability assessment revealed that fishery was the most impacted parameter followed by economic and environmental impacts. Social impact is the least impacted parameters as perceived by the fishers. The study indicates that the long term effects of climate change aren't realized/perceived impacted much among the fisher households. Fishers perceive that the fishery and economic parameters are of importance in the climate change adaptation and mitigation plan.The level of awareness is minimal which indicates that the fishers couldn't correlate environmental changes consequent to climate change to their livelihood. The fishers were more prone to loss in fishing days due to erratic monsoon. The work done by CMFRI suggests the immediate need to improve on the awareness of the primary stakeholders knowledge to climate change by involving them in the disaster preparedness, management and mitigation planning and implementation process.

Conserving the blue carbon ecosystems

Sustaining/ rebuilding the marine ecosystems; tidal mudflats, wet-lands, mangroves, marshes, estuaries, beaches, lagoons and coral reefs; have also become a prime responsibility in marine fisheries management. Along with the fishing pressure there is a concern on habitat degradation also. CMFRI for the last 6 decades has contributed immensely on biodiversity conservation and continues to do it. A major activity by CMFRI in this direction is with respect to artificial reefs.

Artificial reefs will automatically reduce unwanted fishing as crafts like trawlers cannot operate in areas of artificial reefs as trawl operations in such areas will result in severe gear damage. Under Indian circumstances the best measure is to deploy the artificial reefs along inshore areas around 20 m depth contours. Artificial reefs are triangular concrete structures/modules deployed to the bottom of the sea bed. They provide shelter to brooder fish and juveniles. They also offer surface areas for attachment of eggs after spawning. The major seed resources like seer fish, mackerel, tuna and the like are available only at shallow depth of less than 10 m. Thus we can protect the nursery grounds of these fishes

by installation of artificial reefs and thereby enhancing the recruitment for entire Indian EEZ. Deployed artificial reef areas becomes unfit for trawling and purse seine operations rendering the area as a natural "Marine Protected Area" (MPA) thus protecting the biodiversity, habitat and brood-stocks. Healthy brood stock of fishes will be a spawning stock biomass for supplying young fish to the fishing areas on a sustainable manner (recruitment).It is emphasized here that the major aim of marine fisheries management is mainly to sustain the fisheries with limited scope to increase production by at least 1% cumulatively in the next 35 years (by 2050).

CMFRI in association the Govt of Tamil Nadu has deployed the artificial reefs in coastal waters near 50 villages resulting in the enhancement of traditional fisheries by 2 to 5 times over the last ten years. Consequently there is an increased in demand from the traditional fisher folk to install more artificial reefs in Tamil Nadu. This example can be taken as a national model for creating more awareness among the fisher folk in other states and for conducting awareness training programmes. Each module cluster may cost about Rs 30 lakhs and is sufficient for about 1 km. If the entire coastal line is provided the same impetus over a period of at least next 10 years costing Rs 10,000 crores, the marine fish catch is likely to reach at least 6 million tonnes by 2050.

Production systems for the future – cage culture options for clean mariculture

CMFRI has undertaken the large scale demonstration of open sea as well as backwater cage culture in most of the maritime states of India. The technology is purely indigenous and highly economical and sustainable. It is very easy to adopt. Capital investment for a 6 m diameter circular cage in the sea is about Rs 3 lakhs initially, including the cost of cage frame, nets, mooring, seed and feed. By adopting culture of high valued species the production of 3-5 tonnes/ cage can be attained with an economic return of 6 to 10 lakhs per harvest, spreading over a period of 6-8 months depending on the species. The life of cage frame is above 5 years. Since the MoA/NFDB have recognized this as a government scheme eligible for 40% subsidy the technology is gaining lot of popularity among coastal fisher folks. Seed inputs are abundantly available along the coast and fisher folks are skilled in garnering them. Feasibility of several species emerging as candidate species for cage culture is due to the on-going breeding programmes and the possible collection from the sea may deem to be sustainable in the long run. Similarly there are about 5 large feed mills in Andhra Pradesh with high production potential for manufacturing suitable feed for marine fish.

Recent research findings from CMFRI's grow out experimental feed for Pompano based on feed formulation by the company produced commendable results. Results of this study indicated the highest observed omega-3 fatty acid composition (16.98%) in the fish meat fed by this feed. Hence, the feed is not only available on demand but also is efficient in the fish meat quality it produces. Similarly there are millions of hectares of flow lying saline areas which are not utilized and can be brought under mariculture with suitable incentives from the government/ NFDB. CMFRI has established the first Recirculating Aquaculture System (RAS) of laboratory in India and marine fish brood bank in these RAS acts as a model for establishing some more RAS in public sector to maintain the quality and quantity for sustainable seed production. The approach is for production of fertilized eggs/first day larvae and their supply to the hatcheries at a nominal cost, so that

private hatcheries can raise them further and deliver them to the needy farmers at a price. Marine fish brood stock maintenance is bit complicated and risky. Hence, private entrepreneurs may not be enthusiastic in marine fish seed production. Further, a regulation of fish seed production under public sector also ensures quality seed production.

Conclusions

Sustainable fisheries management options if implemented without fallacies indicate possible enhancement of harvestable potential in Indian EEZ to a possible extent of 6 million tonnes or more, than reducing it. Opportunities in open sea cage culture and related developments in the field of mariculture during the last 5 years show a way forward in open sea mariculture practices and propose a production ideal to the tune of 4 million tonnes in the coming years from mariculture sector alone. High mariculture production in countries like China owes to production of sea weeds and molluscs. But Indian sea food market comprises of fin fishes of edible standards. If properly implemented there are possibilities that the marine fish production may be enhanced to the tune of 10 million tonnes (6 million tonnes from