National Seminar on

HARMONIZING BIODIVERSITY AND CLIMATE CHANGE: CHALLENGES AND OPPORTUNITY (NSBC-2015)

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17-19 April, 2015

Organized by

ANDAMAN SCIENCE ASSOCIATION
Port Blair, Andaman & Nicobar Islands
in association with
Society for Plant Research, Meerut
Association for Coastal Agricultural Research, Goa
Indian Society for Pulses Research & Development, Kanpur

SOUVENIR

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Venue

ICAR – Central Island Agricultural Research Institute
Port Blair – 744 105, Andaman & Nicobar Islands

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Marine fishery resources and food security

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It took thousands of years for the global human population to touchone billion. Once that milestone was reached, based on various growth models, the population grew sevenfold in just 200 years. In 2011, the global population reached the 7 billion mark, and it is projected to climb to over 9 billion by 2050 (http://www.unfpa.org/population-trends#sthash.DLo8FNea.dpuf). India has around 190.7 million undernourished people, out of a total population of 1,252 million — a 15% prevalence rate. More than 2 billion people are suffering from micronutrient deficiencies (http://www.hindustantimes.com/india-news/world-food-day-india-home-to-190-million-hungry-mouths/article1-1276105.aspx). Global food production needs to increase by 70%, while developing countries need to double production by 2050, to meet the demand of an additional 2.3 billion people and an increasingly affluent middle class. For achieving the increased demand for food estimates indicate cereal production needs to increase to 3.0 billion t from the present 2.1 billion t; Meat production must increase by 200 million t to 470 million t; Food Fish production mustincrease by 40-50 million t to 160 million t. FAO estimates 80% of this increase has to come through intensification in existing farms and 20% from expansion of area. But there are stumbling blocks on the road to meeting the future food demand. Increased urbanization has led to a decrease in cultivable area, water and productivity. Adding to the woes, climate change has also inflicted serious damage on food production processes. The diversion of excess cereal production by developed nations for biofuel manufacture (*Boban and Grinson, 2011*) also contributes to the problem.

Economic access to food is a reality onlywhen households generate sufficient income or have livelihood security. Food insecurity is linked with poverty and lack of rural development. The experience of countries that have succeeded in reducing hunger indicates economic growth does not necessarily lead to reducing hunger, while growth in agriculture, especially in small-holder sector, is twice as effective. India has made tremendous progress in terms of food production. However, average rate of growth inagriculture yield per year declined from 4.4% during 1980-90 to 2.8% during 1991-98 to 0.6% during1999-2009; farm sizesare decreasing; public investment in agriculture has declined over the years: from 4% in 1980s to 1.9% in 1990s; natural calamities (droughts and floods) are on the increase; predicted impacts of global warming on crop failures are evident and farmer suicides are increasing. We need to produce enough food at affordable prices to keep people away from hunger and livelihood insecurity. Technological innovations are needed for the island communities to adopt to climate change impacts. Aquaculture provides the primary source of income and can be the starting point for improving livelihoods inisland/coastal communities. This paper addresses the relevance of marine fishery resources in ensuring food security of the island/coastal states. The issue of food security is addressed from a marine fisheries point of view, discussing in detail marine capture fisheries, climate change and mariculture.

Marine capture fisheries

India's marine fisheries sector is at a crossroads today. Our coastal stocks are optimally fished and, in some cases, overfished. On the other hand, a potential expansion of our EEZ to 350 nautical miles will increase our marine area and resources. In the years to come, the marine sector will have

to meet the protein requirements of the increasing population of our country. The sector will also have to account for intensified climate change. Hence a 'business-as-usual' scenario will not work anymore. We need to change our thinking and attitude towards marine fisheries management in order to sustain our resources and ecosystems in the challenging period ahead.

It is important to have robust estimates of fishery potential as an aid to manage fisheries resources in the EEZ. However, so far, we have been unable to arrive at figures that are widely acceptable to experts in the field. Prime focus on future fisheries resource research will be oriented towards building a spatio-temporal database on the GIS platform as a decision support tool. Numerical and time-series model data and databases from RS-GIS sources have taken a priority over real time observations and have revolutionised our research. But the evident gaps in *in-situ* observation and assessment of fishery resources have to be nullified through regular surveys, 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, the resource vulnerability to climate change, resource economic evaluation and international trade policies impacting our resources are some of the research areas to be given due attention in the next few years. With 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 fora thorough revalidation involving interdisciplinary efforts in marine fisheries research to point out the lacunae and set-right the contradictions between predicted and harvested resources.

It has been recognized that coastal fish stocks are fully exploited and there is limited scope to increase their production. For sustaining production from coastal fish stocks, a transformation to a well-managed fishery is needed. For an effective transition, strengthening the database on fisheries statistics and scientific assessment is critical, so that decisions concerning management and development options could be more rational and well informed. So as to reduceoverfishing and overcapitalization of coastal fisheries, effective fisheries management plans, acceptable to all stakeholders, are required, along with a strong will to implement them. There is a need to shift from open access fisheries to regulated fisheries. The current management regime is based on input control such as seasonal and spatial closures, mesh size regulations etc. In addition to strengthening these input control measures, we have to implement output control measures such as catch quotas and certification. Vulnerable species need to be identified and protected by following standard methodologies. The performance of management interventions should be reviewed from time-to-time and adapted.

Climate change

Climate change is projected to negatively impactthe availability of the coastal fish stock and is bound to act as a major factor in triggering collapse of stocks in the near future. Warming of waters and sea level rise are two such pervasive factors, which may severely impact the fishery comprising both the resource and its tappers. The patterns exhibited by this environmental upheaval warrant concerted efforts by various domains to study, understand and counter them. Hence, a multipronged research initiative has been set on motion focusing on all the natural resources including fishery resources. The Central Marine Fisheries Research Institute (CMFRI) is trying to address the research issues in climate change related to marine fisheries through its multi-disciplinary project on National Initiative on Climate Resilient Agriculture (NICRA) component dealing with marine fisheries.

The marine fish production in India has increased six times in the last six decades. However, there are sustainability concerns such as production approaching the potential yield, overcapacity in the fishing sector, open access to the fishery, degradation of habitats and trade-related issues. Climate change exacerbates the situation.Sea surface temperature has increased by 0.2 to 0.3° C along the Indian coast in the last 45 years, and is projected to increase by 2.0 to 3.5° C by 2099. The projected sea level rise is 30 cm in 50 years. During the South West monsoon, the wind speed, coastal upwelling strength and chlorophyll concentration are also undergoing changes in the Indian Seas. These changes are likely to influence the structure and function of marine ecosystems, evidence for which are accumulating. Species response to elevated temperature is different, showing changes in composition and abundance at the base of the food web.

Among marine fish, the more mobile species should be able to adjust their ranges over time, but less mobile and sedentary species may not. Depending on the species, the area it occupies may expand, shrink or be relocated. This will induce increases, decreases and shifts in the distribution of marine fish, with some areas benefiting while others lose. The small pelagics such as the oil sardine and the Indian mackerel have extended their distributional boundary to northern and eastern latitudes contributing to fisheries in the last two decades. They have extended their distribution to mid-water as well. The threadfin breams off Chennaihave beenfound to shift their spawning towards cooler months. These distributional and phenological changes may impact the nature and value of fisheries. If small-sized, low value fish species with rapid turnover of generations are able to cope up with changing climate, they may replace large-sized high value species, which are already showing declining trends due to fishing and other non-climatic factors.In mariculture, elevated water temperature and changes in salinity and pH are likely to affect the spawning season, spawning strength and larval growth of candidate species. Seed and feed availability are also likely to be impacted due to climate change. Phytoplankton, which are the primary larval food of culturable organisms, grow faster at elevated temperature, but the decay setsin earlier. Generally, it is believed that elevated temperature may enhance spawning success and growth rate of culturable organisms. Hence there is scope for harnessing the benefits of elevated temperature.

Despite the uncertainties and potential negative impacts of climate change on fisheries and aquaculture, there are opportunities to reduce vulnerability to climate-related impacts. As the first step, projections on fish distribution, abundance and catches need to be developed; and for mariculture, suitable candidate species, which would benefit from elevated temperature, need to be identified for planning better management protocols.

Mariculture

A balanced growth of mariculture and enhancements along with conservation of marine ecosystems is needed to meet the future demands. The country has always recognized the importance of fish as a cheap protein food for human consumption to address malnutrition, especially in the rural areas. It has long been apparent that the fish caught from the seas and raised in cages could meet demand for food to a considerable extent. Consequently, the planners and policy makers have attempted to take advantage of the natural resources in the form of aquatic and biological wealth. Fisheries have now become a dynamically developing sector of the food industry. However, in recent years, signs of over-exploitation of important fish stocks, modification of ecosystem, significant economic losses and inter-sectoral conflicts on management and fish trade have become discernible.

Mariculture, the farming and husbandry of marine plants and animals in the marine environment, is the fastest growing subsector of aquaculture. Globally, mariculture produces many high value finfish, crustaceans, and molluscs. In India, the potential of mariculture production remains largely untapped. It has been realized that the vast coastal areas of our country are suitable for mariculture where high value finfish, shellfish and sea plants could be farmed. Presently, standardized hatchery and farming technologies are available only for a limited number of marine finfish and shellfish species. Hence there is a need to enhance mariculture production from a large number of marine species, extend areas of marine farming, and introduce new production systems. The increased application of biotechnological tools such as transgenesis, chromosome manipulation, cryopreservation, gene banking and marker-assisted genetic improvement can revolutionize production of farmed marine fish. By 2050, the proportion of production from coastal and marine aquaculture should be aimed at 40% and in terms of value, at 70%.

Mariculture has to emerge as a significant sector of seafood production to meet the additional requirement of fish in the near future. It is required to plan for an annual production target of 1 million tonnes of fish from mariculture in the next 10-15 years. The challenges with regard to seed availability and farming aspects have to be addressed by keeping this target in mind. The development of commercial level seed production technologies for a few species of high market value finfish and shellfish, establishment of finfish hatcheries by fisheries development agencies, identification of appropriate cage/coastal farming sites, development of economically viable farming protocols, formulation of suitable grow-out feeds, health management protocols, development of mariculture policies, evolving suitable extension methods and appropriate marketing strategies can go a long way to promote mariculture as a substantial contributor of sea food production of India.

The seed production technologies for three species of high-value marine finfish viz., seabass, cobia and pompano and cultivable marine and brackishwater shrimps have beendeveloped and standardized for commercial level production. In addition, methodologies are also available for the hatchery production of mud crab, blue-swimmer crab, bivalves such as mussels, edible oyster and pearl oyster. Recirculation aquaculture technology has beensuccessfully adopted for the year-round spawning of cobia and pompano by photo-thermal conditioning. Appropriate methods for sea cage farming and coastal mariculture have been developed and demonstrated at suitable locations. Techniques for production of marine pearls and mabe pearls have beendeveloped. Breeding and seed production of more than a dozen species of marine ornamental fishes which are in high demand in the international trade and artificial propagation methods of selected soft coral species have also beendeveloped. The techniques for integrated farming of finfish with seaweed have been developed for enhanced biomass production from a unit area and the same was successfully demonstrated in the field.

Conclusion

It is being increasingly recognized that marine ecosystems have manifold services, much beyond what we have been using so far. Aquatic resources are now regarded as major contributors to provisioning services that include health-food supply and pharmaceutical products. There are tremendous opportunities to advantageously make use of the rich biodiversity; and the provisioning, regulatory, cultural and supporting services of our seas to meet the emerging demands of humankind. Since biodiversity and ecosystem functioning is inextricably linked to human societies, we have to value the services of marine biodiversity and ecosystems, considering the growing costs of

biodiversity loss and ecosystem degradation. A greener environment with enhanced ecosystem services will be beneficial to the ecological and human well-being.

By following state-of-the-art practices and effective planning, it is possible to achieve the blue revolution. The government's role is to manage the fisheries assets on behalf of societies and to derive maximum benefits for future generations. The role of research institutions such as Central Marine Fisheries Research Institute (CMFRI) and Central Island Agricultural Research Institute (CIARI) is to provide scientific support and suggestions to the governments, and do reality checks while undertaking the journey. A sustainable fisheries sector is essential for ensuring seafood for all and forever.

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