

the natural resources, which help immensely in carbon sequestration, reduced tillage, improve soil fertility and combat land degradation and promote *in situ* conservation of aboveground and belowground biodiversity. From the economic sustainability perspective, science and technological efforts need to focus on helping poor and smallholder farmers while improving their income by enhancing agricultural and reducing production costs. Producing high-value organic products increases the sustainability of the farming systems on short- and long-term basis, Rawat said.

The policy dimension of the farming system must address the issues such as research and extension relevant to small farms, subsidies on farm inputs and credit policies, land-use policies, wildlife conservation policies, etc. The major focus of policies in the Central Himalayan region largely benefits farmers with large land holdings, as subsidies are provided to them for raising orchards, floriculture, chemical fertilizers, medicinal plant cultivation, chemical fertilizers, farm implements, irrigation, pisciculture, etc. However, farmers with small and fragmented land holding are deprived from this benefit.

R. K. Maikhuri (Garhwal Unit, GBPIHED) highlighted the issues and challenges with regard to conservation of traditional agrobiodiversity. He mentioned that many valley areas in the Central Himalayan highlands provide a unique opportunity for *in situ* (on-farm) management of agrobiodiversity because of the preponderance of locally developed traditional crop varieties (and associated wild and weedy species) in the farming system, based on traditional

knowledge and skills, high agro-climatic heterogeneity and local socio-cultural integration. Majority of the landrace diversity was maintained by marginal farmers. Farmers' loss of seeds is attributed mainly to crop failure and, in the case of poor farmers, sometimes the consumption needs of the household exceed production. When they lose their seeds, farmers may not be able to procure seeds of their choice for the next planting. Improving seed management and access to crop genetic diversity, could therefore contribute to *in situ* maintenance of materials which are of value to farmers. Maintaining community seed banks and complementing community conservation to *ex situ* institutional conservation of the existing landrace diversity is therefore essential, before more landrace diversity is lost from traditional agro-ecosystems. *In situ* conservation and crop improvement can complement one another in marginal areas. Breeding programmes that evaluate landraces and use them in local improvement efforts are expected to produce material of direct value for marginal agroclimatic zones, as well as achieving significant local conservation. Careful analysis and evaluation of various socio-economic, environmental and scientific challenges is essential, so that farming activities could be reoriented towards better use of local resources and their sustainable management in the Central Himalayan farming systems.

Therefore, efforts to be made to conserve traditional crop diversity-based Himalayan farming system will require creation of new incentives, developing appropriate policies, institutional arrangements, human capacity building and greater involvement of local people in

policy planning; this may help the farming system to be economically, socially and environmentally sustainable. Empowerment of women and gender dimensions of biodiversity conservation and management must also be addressed since they are the main conservationists and custodians of Himalayan agrobiodiversity and farming systems. Tapping the potential of traditional knowledge and wisdom of small farm families/communities will require keeping them in the central focus of research and development efforts and will require appropriate, mountain-specific, cost-effective technological interventions for actions to support equity, fairness and inclusion of small farm communities inhabiting the Western Himalaya in particular and Indian Himalaya in general.

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MEETING REPORT

Marine ecosystems*

The second international symposium on marine ecosystems (MECOS-2) consisted of lead talks, keynote addresses, oral and

poster presentations and discussions touching upon different services and goods provided by the marine ecosystems.

The symposium addressed topics like marine fisheries and management, aquaculture production systems, marine biodiversity, climate change and ecosystem assessments, responsible harvest and post-harvest, marine biotechnology, liveli-

hood and economics. The presentations were held in six sessions.

Inaugurating MECOS-2, Trevor Charles Platt (Fellow, Royal Society of London) highlighted the advantageous position of India in generation of remotely sensed data and the need for playing a lead role in data application in the region. Rudolf Hermes (Bay of Bengal

*A report on the second international symposium on 'Marine Ecosystem – Challenges and Opportunities (MECOS-2) organized under the aegis of the Marine Biological Association of India from 2 to 5 December 2014 at Kochi.

Large Marine Ecosystem Project (BOBLME)) in the lead talk emphasized the importance of the ecosystem approach to fisheries management (EAFM) and dwelt upon the Bay of Bengal large marine ecosystem as a case study. He observed that the Arabian Sea large marine ecosystem (ASLME) is another potential large marine ecosystem that makes for a challenging study in this part of the world. He also mentioned that Australia, New Zealand and to some extent the US have been successful in the implementation of EAFM. K. K. C. Nair (formerly at National Institute of Oceanography (NIO)) suggested that data from CMFRI and NIO may be considered while studying the ASLME, as most of the countries bordering the region lack reliable data collection system.

Delivering the keynote address in the session on marine fisheries and management, N. Venugopalan (International Collective in Support of Fish Workers, Chennai) discussed the different ways and means of implementing the FAO Small Scale Fisheries (FAO SSF) guidelines in India. He said that the first step is to examine how SSF could enhance its contribution to food security and nutrition. The second step is to ensure equitable development of small-scale fishing communities and the third step is to improve and implement legal and policy provisions to reduce conflicts between active and passive gear groups, to conserve and manage fishery resources. He suggested restriction of ownership of fishing vessels to family members of fishermen, and to ensure social and livelihood security to these small-scale fishers. The session covered 7 oral and 23 poster presentations on different aspects of marine fisheries. The need for regional bodies/boundary organizations to translate scientific information/build bridges among the stakeholders was acutely felt. The creation of a separate Central Ministry for fisheries and a Central Fisheries Act was suggested to ensure effective implementation and enforcement of fishery regulations.

Mariculture is seen as a potential sector that can meet the additional demand for fish in the near future, as capture fisheries is characterized by high fishing effort and overexploitation of certain fishery resources from the inshore grounds. In his keynote address, G. Gopakumar (formerly at CMFRI) suggested frontline demonstration of the integrated

multi trophic aquaculture (IMTA) to different stakeholders for increased biomass production. He said that there is need for domestication and farming of native species of shrimps and crabs and standardization of commercial seed production of species like the Scyllarid lobster *Thenus unimaculatus* and blue swimmer crab *Portunus pelagicus*. Keeping in view the future requirements of mariculture development in India, establishment of an International Centre of Excellence in Mariculture in CMFRI was suggested.

Unlike on land, different processes – chemical, physical and biological, in the sea are still a mystery. Further, climate change impacts on the ecosystem also complicate our understanding of the marine ecosystem processes. E. Vivekanandan (formerly at CMFRI) addressed the requirement of a new paradigm for marine fisheries management incorporating climate change into the EAFM plan. He said that the need of the hour is to formulate an adaptation framework that identifies vulnerability, prioritizes adaptation options, implements measures, monitors and evaluates effectiveness and reviews strategy. The session recommended awareness campaign among the fishermen along with efforts to understand the ecology of the habitats of endangered species of sea turtles, cetaceans and seabirds. As the total ban of sea cucumber exploitation has not helped increase recovery of the population due to illegal activities, detailed survey of the availability of sea cucumbers on a commercial scale from their areas of occurrence, followed by a controlled exploitation regime was suggested. Participatory approaches should be evolved for management of sea cucumber in the Gulf of Mannar (GOM), Palk Bay, and Andaman and Nicobar Islands with appropriate spatial, temporal and size controls as well as seed production, culture and sea ranching.

Market-based solutions to address sustainability in fisheries were the main theme of the talk by C. N. Ravisankar (Central Institute of Fisheries Technology), who mentioned that the major issues in the international markets are microbial contamination, histamine problems, antibiotic and pesticide issues, heavy metal contamination and emerging pathogens, which need urgent solutions to combat them. Eco-labelling from organizations like the MSC (Marine Stewardship Council, London) should be

explored for seafood, so that consumers can trace/identify sustainably produced products and make corresponding choices in the marketplace. The quality of fish in the domestic market should not be ignored and waste from processed seafood should be converted to value-added products. Another notable suggestion was the usage of non-conventional fishery resource for processing and value-addition.

I. S. Bright Singh (recipient of MECOS-2 S. Jones Award) (the National Centre for Aquatic Animal Health, Cochin University of Science and Technology), in his lead talk, emphasized the importance of focused research on the potential available in marine bioprospecting and bioprocess technology, marine genomics and proteomics, marine animal and plant cell culture technology, biotechnological interventions in aquatic animal health management, high health broodstock development, conservation of marine genetic resources and marine algal biotechnology. He suggested the need for a national policy on aquatic animal health management strategy as the way forward to achieve substantial progress in the field of marine biotechnology. The study on the genetic diversity of Indian oil sardine using mitochondrial control sequences suggested high haplotype diversity and low nucleotide diversity characteristic of populations having undergone a demographic expansion after a period of low effective population size. Molecular identification of barracuda and tiger shrimps using cytochrome *c* oxidase gene was also elucidated.

The session on livelihood and economics opened with a talk by Rashid Sumaila (Fisheries Economics, University of British Columbia). He spoke on property rights and classic fisheries management challenges, explained the role of ecological quotas, individual transferable quotas (ITQs), and impact of seasonal closures on fisheries management. He suggested that ownership rights should be restricted to fishers alone and to limit the amount of quota of each owner. According to P. S. B. R. James (formerly at CMFRI), property rights and management regimes can be applied only in temperate fisheries and may be difficult to implement in India. To a query regarding few good examples of ITQs for solving the intersectoral conflicts among fishermen, Sumaila cited the example of effective

quota management system in Namibia with large factory trawlers and small-scale trawlers. Understanding the need for promoting sustainable livelihood of coastal communities, open-sea cage farming and seaweed farming must be encouraged by providing necessary institutional finance and technical support. While promoting these culture systems, proper assessment of the carrying capacity of the water bodies has to be made and changes in the environment monitored at every increment. Recognizing the issues of gender and the need for promoting domestic fish marketing,

encouragement should be given to women self-help groups to take active part in fish value chain in domestic fish marketing.

A special session entitled '50 years after the International Indian Ocean Expedition (IIOE) – status of Indian Ocean studies' was held in the evening of 4 December 2014. Wajih Naqvi (NIO, Goa) spoke about the current status of Indian Ocean oceanographic research. Recognizing the need for taking stock of the current status of the Indian Ocean, the session recommended necessary steps to operationalize the second IIOE, draw-

ing the resources from all the marine research organizations in the country and abroad. The participants and contributors of the first IIOE were also felicitated.

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Smile with Science

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