CAGE AQUACULTURE IN ASIA 5

November 25-28, 2015 Kochi India

Report on

5th International Symposium on Cage Aquaculture in Asia

CAA5

November 25-28, 2015, Kochi, Kerala, India

Report on the 5th international symposium on CAGE AQUACULTURE IN ASIA Held at Kochi, India, from 25 -28 November, 2015

Background

The Cage Aquaculture in Asia (CAA) is a specialized symposium of the Society focused on the status and growth of cage aquaculture in the Asia Pacific region. The success of CAA1 held in Tunkang, Taiwan in 1999 resulted in the AFS 8th Council's decision to make the CAA into a regular symposium series of the Society hosting. The Society is of the view that sustainable and economic, coastal, near-shore and oceanic cage aquaculture will continue to expand in the coming decades and therefore AFS will be running symposia regularly to disseminate the latest information / technologies to meet the demand and interests of the Society's members and all key stakeholders involved in the industry. Thus, the CAA symposium will be a permanent symposium series of the Society. Since the CAA1, the AFS has held the CAA2 in Zhejjang University, Hangzhou, China in 2006, the CAA3 in Kuala Lampur, Malaysia in 2011, and CAA4 in Yeosu, South Korea in 2013. The CAA5 was held from 25 to 28 November, 2015 in Kochi, India and was hosted by the **ICAR-Central Marine Fisheries Research Institute (CMFRI)**, Kochi and the Indian Branch of the AFS.

Introduction

The Indian Branch of the AFS and the ICAR-**Central Marine Fisheries Research Institute (CMFRI)**, Kochi, Kerala joined hands to plan and execute the process of hosting the CAA5 in India. The website www.caa5.in formed the interactive platform for the Symposium where registration, payment of registration fee, abstract submission, exhibition stall bookings were handled. The venue was Radisson Blu hotel, Kochi. The organizers were able to rope in a large number of sponsors and exhibitors for the Symposium. Brochures were distributed across the Asia Pacific region through contacts and through electronic medium. Advertisements were placed in popular fisheries magazines. Special efforts were made to attract the young scientists and students to the symposium. Articles and advertisements were solicited for the Symposium Souvenir. Various committees were formed and responsibilities delegated and the entire team worked as one body for the successful conduct of the symposium, befitting the high standards established by the CMFRI and AFSIB.

Inauguration

The 5th International Symposium on Cage Aquaculture in Asia (CAA5), had a grand inaugural function at 9:00 hrs on 25 November. The function began with a welcome address by Dr.A. Gopalakrishnan, Convener, CAA5 and Director, CMFRI, Kochi. Dr. Gopalakrishnan welcomed the dignitaries, the invitees and delegates from India, Norway, Indonesia, U.K., Korea and Philippines to the Symposium. In his welcome address Dr.Gopalakrishnan highlighted that Cage aquaculture in Asia was one of the most successful conference series of the Asian Fisheries Society. This event was the 5th such symposium being held over the past 15 years. The interest was expressed by AFS in having CMFRI to host the event at Kochi, recognizing the contributions made by CMFRI in developing and popularizing sea cage farming all along the coasts of India. Dr. Gopalakrishnan thanked the Asian Fisheries Society for providing the opportunity to host this prestigious event at Kochi. Details of the symposium were also provided by the Convener which included a symposium theme talk, keynote address for each session and lead talk by eminent researchers and experts in the field of cage aquaculture. The Symposium has registered 117 presentations including oral & poster presentations under 6 different sessions pertaining to recent advances and research activities in the field of cage aquaculture. The response to the symposium was overwhelming with over 200 submissions received, the best of which were summarized in the Book of Abstracts.

CAA5 had participants from 10 countries including Norway, UK, Australia, China, Indonesia, Korea, Vietnam and Thailand, in addition to India. There was particularly good representation from Norway, the leading nation in cage aquaculture. Convener CAA5 expressed his hope that the Symposium would meet the objectives and initiatives of ICAR, MPEDA, SAUs GOs, in contributing to aquaculture growth in India and that it would provide a platform for India to take up cage culture in a sustainable manner. Continuing his address, he also invited active deliberations from all the participants during the sessions.

Reading of the Messages received from the Hon'ble President of India, Shri. Pranab Mukherjee, Vice President, Shri Mohammed Hameed Ansari, Union Agriculture Minister, Shri. Radhamohan Singh, Chief Minister of Kerala, Shri. Oomen Chandy and the President, Asian Fisheries Society, Prof. Shuolin Huang flagged the importance of the symposium .

After the Welcome address by the Convener CAA5, Dr. Alice Joan Ferrer, Vice President, Asian Fisheries Society, Malaysia spoke briefly on the activities of the AFS during the past. A two minute silence to as a mark of respect to the

departed souls of Dr. S. Z. Qasim, Honorary Life Member AFS, Prof. H.P. C. Shetty, Founder Chairman, AFSIB and past AFS Councilor and Shri. J. V. H. Dixtulu, Managing Editor of Fishing Chimes was observed.

In his Presidential address, Dr. J.K. Jena, Chairman, AFSIB and Director, National Bureau of Fish Genetic Resources, Lucknow emphasized the need for governmental policies to support cage farming in open waters. He said that the slogan at present was not only fish for all for today and tomorrow but also forever. He said that India could take cues from Norway, Chile, China.

Dr. Mohan Joseph Modayil, Former Member, ASRB and Member CAG, AFS, was the Guest of Honour for the function. Prof. Modayil expressed happiness at the response shown by the participants to CAA5. He said that there are 258 registrations with 18 foreign participants. He congratulated all those to worked to make this conference successful when cage aquaculture is still in its infancy in India. Prof. Modayil highlighted the prospects of cage culture to a developing country like India where fish is not only an item of food but also item of protein, employment opportunity, food and nutrition security. He further pointed out that Asia is now at the helm as the superpower in aquaculture. Continuing his address, Dr. Modayil flagged the issues of environmental safety, entrepreneurship, consumer health, and also highlighted prospects for Asian countries to gain from cage aquaculture. He emphasized that there are opportunities for all Asian countries to grow and prosper from cage aquaculture and there is no need for any competition between countries; rather what is needed is sharing of skills, knowledge and expertise; there is enough space for all he added. Further Prpf. Modayil mentioned that the present era calls for cooperation and concerted efforts of Asian countries to find commonalities, getting cues from end users and collective strength of scientists and technicians of the Asian region to take eco friendly cage culture forward.

Dr. Derek Staples immediate Past President, AFS, in his address stressed that the fisheries society in Asia needs to undergo a major reform with respect to connectivity among Asian countries.

The Book of Abstracts and Souvenir of the Symposium were released by the Chief Guest Dr. S. Ayyappan. In his Inaugural address, Dr. S. Ayyappan, calling Kochi the fisheries capital of India, opined that it was apt that CAA5 was held in Kochi. He recounted his first experiments in freshwater cage culture along with Dr. Kumaraiah, way back in 1982. He mentioned that the food basket is getting diversified from cereals to meat to fish and the biggest challenge now is climate change which CMFRI is also addressing. Dr. Ayyappan highlighted the achievements made by CMFRI in cage culture at Veraval, Karwar, Mandapam and Kochi. He mentioned that earlier everyone talked only of blue revolution but today everybody talks of green revolution, green fisheries, greening fisheries, green aquaculture, resilient fisheries, sustainable aquaculture and so on and incidentally this year is the Golden jubilee of the Green revolution in this country. Dr. Ayyappan expressed hope that the symposium would provide an opportunity for exchange of ideas between India and Norway the leaders in cage culture. The youth today in India is always looking forward to challenging ideas and opportunities and cage culture will be such an opportunity, he added. He further emphasized that multiple use of water should be resorted to and complemented the efforts of the youngsters from Jharkhand in their success in cage farming in the reservoirs. He also said that a strong combination of seed, feed, skill and will were the need of the hour for further development of cage aquaculture in India. He stressed that cage culture can provide opportunity for a paradigm shift from starch to protein since people are looking out for a healthy protein; given the pressures on land, people will surely turn to water for production . Dr. Ayyappan concluded his address by complementing AFS and CMFRI and the delegates and wished them fruitful deliberations.

The AFSIB R & D Innovation Awards were presented to experts who had significantly contributed for the development of cage culture in India. This included Mr. Sanjay V. Raut, President (Technical and New Businesses), Garware-Wall Ropes Limited, Pune, Dr. Thampi Samraj, Director, Rajiv Gandhi Centre for Aquaculture, MPEDA, Kochi, Dr. Mohan Joseph Modayil, Former Member, ASRB and Former Director, CMFRI, Dr. G. Syda Rao, Former Director, CMFRI, Dr. G. Gopakumar, Emeritus Scientist, CMFRI and Dr. P. Kumaraiah, former Principal Scientist, CIFA.

Dr. Mridula Rajesh, Treasurer, AFSIB proposed the vote of thanks.

PHOTOS OF THE INAUGURAL SESSION

Symposium Theme Lecture

The **Scientific presentations** began with the Symposium Theme lecture "Greening the Asian Cage Aquaculture Construct" by Prof. Mohan Joseph Modayil from India. An overview of the Asian cage aquaculture scenario, the present regulatory systems and guidelines for cage aquaculture in some of the Asian countries were highlighted in his presentation. Dr. Modayil suggested a way forward for greening the present technologies and urged the industry to do an introspection and assess whether the industry is really green; whether the cage culture practice is really sustainable and resource/environment friendly.

Scientific sessions

Session I: Marine Production Systems

Chairs: Dr. Ketut Sugama, Director (Seed Development), Directorate General of Aquaculture, Indonesia Dr. C. N. Ravishankar, Director, Central Institute of Fisheries Technology (CIFT), Kochi, India.

Rapporteurs: Dr. Sujitha Thomas and Smt. Muktha M, CMFRI

Mr. Trond Severinsen from Norway delivered Keynote Address on **"Automation in cage operations and new designs"-** Mr. Trond highlighted the advances made by Norway in large-scale salmon cage farming systems. The vast majority of technical inventions and developments in cage farming have come from the salmon cage farming industry in Norway during its 40 year history. Plastic cages, steel cages, nets, moorings, monitoring systems, feed systems, feed barges, production and process control software are some of the most important ones. Even though salmon farming contributes only 3.6% of the world's fish farming production, it is the clear technology driver and lead money maker in intensive aquaculture. Scale of economy has been a crucial success factor, and has only been made possible by fast moving innovation, automation and new designs into bigger and bigger cages for more exposed farm sites, large and efficient feeding barges, advanced video monitoring of feeding, extensive use of environmental sensors, customized heavy duty work boats etc.

There were tree lead talks in the session.

1. **Dr. G Gopakumar** from India elaborated on **"Development of a viable cage farming system for marine finfish production in India: the way forward"**. His talk threw light on the challenges and opportunities for open sea cage culture in India. He mentioned that in the recent past, marine finfish mariculture has been expanding rapidly with an average annual growth rate of 9.3%. Even though sea cage farming for finfish has expanded in recent years on a global basis, India is still in its infancy in cage farmed marine fish production. A good deal of R & D efforts have been undertaken in this sector, resulting in better designs of cages developed to suit the local conditions and successful participatory mode of sea cage farming were in the country carried out at several locations. The successful demonstration of cage farming of cobia integrated with seaweed carried out at Mandapam was highlighted a positive step towards the development of Integrated Multitrophic Aquaculture (IMTA). He also suggested that necessary precaution has to be taken towards the formulation and production of grow out feeds. The carrying capacity assessment of the cage farms in relation to environmental sustainability need essential precaution.

2. **Dr. Niels Svennevig** from Vietnam presented **"Prospects and challenges in sea cage farming in tropical Asia"**. Dr. Niels detailed on cage farming in Vietnam and also spoke about the challenges to cage farming in Asia. Fish farming in sea cages in the tropical region contributes very little to food production compared to the large and underutilized area with optimal sea conditions available in tropical Asia. According to the statistics, most of the tropical production took place in brackish water i.e. ponds (milkfish alone contributing to 977,000 tons). Only 155,000 tons of marine fish were produced in marine environment, likely using some sea cage farming technology. Statistics may likely be underreported or possibly the farming environment criteria has not been used stringently, but the paradox is clear, when compared to Norway's production of 1,245,000 tons of salmonids in sea cages in 2013 under more hostile climatic conditions and having a population of only 5 million people as compared to Asia's more than 4 billion people. Outside the tropical Asian region it has proven possible to

establish sustainable large volume farming in sea cages e.g. of salmonids in Europe and Americas, bass/bream in Mediterranean and carangids in China and Japan.

3. **Dr. Clive Jones** from Australia gave a talk on **"Cage culture of lobsters in Asia"**. Dr. Jones spoke about the lobster culture systems in Vietnam and Indonesia. He mentioned that development of spiny lobster culture is of increasing interest around the world, as demand increases and capture fisheries supply decreases. There has been two primary sectors of research and development activity supporting this development; firstly, they are utilizing natural settlement of lobster seed, and secondly, developing hatchery technology. Ultimately the two sectors will merge when hatchery technology is fully commercialized and price of hatchery produced seed is equivalent to that of the natural supply, but for the time being, lobster aquaculture is 100% reliant on natural seed supply. Spiny lobster farming is well developed in Vietnam and developing in Indonesia, Philippines and Malaysia. There is strong interest throughout Asia, motivated by the success of the Vietnam industry which generates around 1,500 tons of annual production of premium spiny lobsters, marketed to China and with a farm-gate value of US$150 million. The Vietnam lobster farming industry is based on a local supply of naturally settling seed that are captured primarily at the swimming puerulus stage. Grow out production however is negligible due to lack of farming skills and a preference to catch and sell the seed available. The Vietnam industry may benefit from this, as the bulk of seed exported from Indonesia are destined for Vietnam.

The lead talks were followed by seven oral presentations from India.

The presentation on **"Innovations in cage farming technologies along the west coast of India: A regional approach"** by Philipose *et al.*, has highlighted open sea cage culture activities of the Central Marine Fisheries Research Institute (CMFRI). Efforts were continuously made by CMFRI, with the involvement of the fishermen community, to standardize the cage culture technology. CMFRI had initially succeeded in designing 15 m dia HDPE cages in 2005- 2007. Later, after recognizing the problems faced with net exchange as well as stability of the 15 m diameter cages, a 6 m dia HDPE cage, with an additional base ring in the middle for more stability, was designed. CMFRI initiated culture of Asian seabass *Lates calcarifer* initially in these cages and achieved successful production during 2009. Developing affordable cage designs was one of the priorities of the Institute and Karwar Research Centre of CMFRI focused on

developing sustainable cage culture technologies, to help the local fishermen community in developing alternative livelihood options.

Damodar, P. N. presented "**Advances made by RGCA in open sea cage culture of Asian seabass *Lates calcarifer* in India**".

Dr. Dineshbabu, A. P presented "**An introduction to spatial planning for sustaining small scale cage culture and integrated aquaculture**". He pointed out that spatial planning of maritime activities will provide a desktop decision making tool for reducing conflicts and sustaining production. The areas of high organic load, where no culture practices can be attempted are also mapped to provide information useful for future entrepreneurs.

Dr. Felix, N. presented **"Preliminary study on cage culture of cobia *Rachycentron canadum* in Gulf of Mannar, Thoothukudi, Tamil Nadu"**. Effective utilization of near shore waters for cobia farming in floating cages will support the fishermen as an alternative livelihood as they can earn income even during fishing holidays and non-fishing seasons. Cobia *Rachycentron canadum*, a marine finfish of high quality with white meat and growth potential can be developed as a high value, export oriented species for mariculture sector of our country.

Dr. V.V.Singh presented results of the **"Culture of juvenile spiny lobster *Panulirus polyphagus* in open sea cages in Maharashtra"** Under the Tribal Sub Plan (TSP) Scheme of the Planning Commission, Government of India. The technology enabled tribal fishers of Maharashtra to utilize undersized juvenile lobsters for rearing in open sea cages to marketable size and thus gain higher returns.

Dr. Laxmilatha, P. presented **"Growth of hatchery produced green mussel spat integrated with finfish culture in open sea cage: implications for integrated multi-trophic aquaculture (IMTA)"**. Integrated multi trophic aquaculture (IMTA) is a multidimensional concept that utilizes the available unit space augmenting the production efficiency of the system. It also enables nutrient recycling among trophic levels and can be exploited by bivalves in integrated culture.

Dr. Johnson D' Cruz presented **"Advances made by RGCA in cage farming of cobia *Rachycentron canadum* in India"**. He pointed out that the faster growth rate (attains 6 - 8 kg per year), adaptability to captive breeding and acceptance of pellet feed are the major attributes which makes cobia an excellent candidate species for aquaculture. All culture experiments were carried out

exclusively using extruded pellet feeds and produced over 88 tons of cobia from its sea cage farm facility during the above period.

Poster Session

Fifteen posters were displayed and it covered aspects on growth rate of various fin fish and shellfish species in cage culture systems, performance of participatory mode of cage culture, use of remote sensing and spatial analytics for identification of cage sites, suitability of new species for cage culture, high density culture of exotic species in cages and validation of growth parameters of finfish through cage culture.

SESSION II: INLAND PRODUCTION SYSTEMS

Chairs: **Dr. Alice J Ferrer, Vice President, AFS, Malaysia and Dr. P. Jayasankar, Director, Central Institute of Freshwater Aquaculture (CIFA), Bhubaneshwar, India.**

Rapporteurs: Dr. Molly Varghese and Dr. Ritesh Ranjan (CMFRI).

The keynote address was delivered by **Dr. V. V. Sugunan on "Enclosure aquaculture in inland waters of India"**. Dr. Sugunan highlighted the need for proper management before inland cage culture systems are developed on a large scale. Fish, being accessible and affordable for the poor, plays a prominent role in meeting the protein requirement in the developing world. It is predicted that fish consumption in the third world will increase by 57%, from 62.7 million tons in 1997 to 98.6 million tons in 2020.Dr.Sugunan pointed out that the projected requirement of fish in India by 2021 is estimated at 12.0 million tons. In order to achieve this target, the sector needs to record a growth rate of about 6% per annum, a tough goal, but achievable. Fish production from natural water bodies are subject to the negative impacts of overfishing and habitat degradation. All these, coupled with the other environmental concerns including emerging issues posed by climate change, constitute the major constraints in meeting the future demand for fish. Considering the ever increasing demand for land and water bodies owing to diverse and often conflicting demands on them, there are limitations for growth in pond based aquaculture. In this context, culture of fish in enclosures such as cages and pens installed in open water bodies offer scope for increasing production obviating the need for more land based fish farms. In view of the dwindling production from natural waters, both inland and

marine, any substantial increase in production has to come either from inland aquaculture or mariculture.
The three lead lectures in the session were:

1."Responsible cage fish farming: Integrated Approaches" by **Dr. K. G. Padmakumar** (India). Dr.Padmakumar stressed that cage farming activity can be taken up as a responsible cluster activity and can be established and operated by local people of a particular area. Intensive fish farming in open water cages and enclosures is a relatively new development in India, with profound economic, social and environmental consequences. Dr.Padmakumar cited details of the first experiment on cage fish farming in Kerala which was started in 1998 in Vembanad Lake by the Regional Agricultural Research Station (RARS). The endemic cichlid *Etroplus suratensis*, or pearlspot, was demonstrated to be a supreme species. The success of this first venture was received with mixed responses. The success of artificial breeding and development of hatchery protocols for seed production of pearlspot boosted interest in cage culture. Later, a participatory entrepreneurship development program was initiated at RARS, Kumarakom and a cage farm was established and operated exclusively by a woman self-help group, viz. Vembanad Swayam Sahaya Sanghom, Kumarakom under the aegis and support RARS. Open water cage farming is often cited as a means to relieve pressure on wild fish stocks that are exploited beyond capacity. However, he added that carnivorous fishes, that form bulk of the farmed fish worldwide, are fed on wild caught fish, either directly or as fish meal in fish feed, increasing the pressure on ocean fisheries.

2. The second lecture was on the **Cage aquaculture in inland open waters of India: Retrospect and Prospect** by **Dr. A. K. Das** (India). Dr.Das highlighted the need for framing up of a National Policy on inland cage aquaculture in India. He mentioned that Cage culture was attempted in India for the first time in 1970, with air-breathing fishes in swamps, which are marked by low dissolved oxygen (DO) in water, major carps in running water in rivers Yamuna and Ganga at Allahabad and common carp, Catla, silver carp, Rohu, snakeheads and tilapia in still water bodies in Karnataka. In the seventies, cage culture in wetlands of Assam was attempted by researchers of the Central Inland Fisheries Research Institute (CIFRI) which later got a strong foothold in the nineties. A few trials on cage aquaculture were later attempted and some isolated work on cage culture for raising fingerlings as well as table fish in reservoirs. At present, a large number of cages have been installed in different reservoirs in a number of states. A number of entrepreneurs like Indepesca Overseas Pvt. Ltd. (IOPL), Das &

Kumars and Neelkamal including a number of feed producers are involved with cage culture projects across India with very modest results. Fish cage culture taken up by the Fisheries wing of Kerala University, with the support of Rashtriya Krishi Vikas Yojana (RKVY) and the Department of Fisheries, Govt. of Kerala is worth mentioning. In Nalbari District of Assam, cage culture in 1 m^3 bamboo cages installed in small rivulets with moderate flow for raising grow out fishes of *Anabas testudineus* and *Labeo rohita* (Jayanti Rohu) was tried.

3. **Mr. Uttam Kumar Subuddhi**, IFS presented on **"Cage culture in reservoirs: The Indian Experience"**. He spoke about real-life example of how a fishermen society through the state federation can be a successful model for managing cages in large reservoirs. Madhya Pradesh is a land-locked state with an average productive fisheries area of about 0.4 million ha in the form of reservoirs and ponds. Fisheries activity is a co-operative based venture in the state and the fishing rights of ponds/reservoirs up to 1,000 ha AWSA have been given to tri-layer Panchayat Raj System. Presently the per hectare fish production of village ponds is around 1375 kg and irrigation ponds is about 85 kg. Mr.Subuddhi gave details of stocking density and temperature fluctuations seasons wise in the state. Government of Madhya Pradesh has given the fishing rights of major reservoirs (above 1000 ha AWSA) to the Madhya Pradesh Fisheries Federation Co-operative Ltd. (Federation), which is scientifically managing and looking after the welfare of fishermen working in its reservoirs. He further added that to augment fish yield, the Federation has started cage culture in reservoirs with the support from Govt. of India under the scheme of National Mission for Protein Supplement (NMPS). Four cage units (each unit having 48 nos.) have been installed in 3 reservoirs (Indirasagar, Gandhisagar and Halali). The species opted for culture was *Pangasianodon hypothalamus*, as recommended by Project Implementation Committee of NMPS.

Dr. U.K. Sarkar presented **"Present status, potential and prospects of cage culture for fisheries enhancement in Indian Reservoirs"**. Indian reservoirs with water spread of 3.15 million ha and estimated yield potential of 100 - 150, 200 and 500 kg ha^{-1} $year^{-1}$ for large, medium and small reservoirs respectively offer enormous scope of enhancing the productivity through culture based fisheries. Cage culture in inland open waters is being looked upon as an opportunity to utilize existing reservoirs with great production potential to enhance fish production and is being posed as an answer to increasing demand for animal protein in the country. Various reports indicate that more than 15 states have already adopted cage culture technology in inland waters with varying levels of success.

Dr. Krishna Rao, D. S. presented **Cage culture of catfish *Pangasianodon hypophthalmus* in Krishnarajasagar Reservoir, Karnataka: a case study.** The sutchi catfish *Pangasianodon hypophthalamus* is a fast growing omnivorous fish. Commercial culture of this fish has been popular in land-based pond aquaculture in some states of India such as Andhra Pradesh and Telengana. Commercial cage culture in general is still in the nascent stage in India. Public agencies in several states such as Jharkhand and Karnataka are conducting large scale trials for production of table size sutchi catfish in cages in reservoir environment, with the intention to popularize this system of culture.

Dr. Uttam Kumar Subuddhi presented **Effect of stocking density on growth of *Tor khudree* fingerlings in floating cages at Kerwa Reservoir, Madhya Pradesh**. A study was conducted from December 2012 to April 2013 at Kerwa Reservoir near Bhopal, Madhya Pradesh, India to evaluate the effects of stocking density on growth, survival rate and food conversion ratio (FCR) of *Tor khudree*. Seeds (fingerlings) were reared at three different stocking densities (100, 200 and 300 fingerlings m^{-3}, *ie*.T1, T2 and T3 respectively) in floating cages of dimension 4 x 4 x 3 m with knotless HDPE net of 4 mm mesh size. The average size of fingerlings stocked was 36.52 mm and weight 0.71 g. There were four replications for each treatment. The present study is a modest attempt to demonstrate optimum rearing density of *T. khudree* in enclosure system to promote mahseer culture with better growth, production and survival as well as effort towards its conservation.

Dr. Das, B. K. presented **Prospects of cage culture of the exotic carp *Barbonymus gonionotus* in a freshwater composite fish farming system at Birbhum District, West Bengal**. The exotic carp *Barbonymus gonionotus*, commonly known as Java barb (length: 1.44 ± 0.08 cm and weight: 0.81± 0.12 g), was cultured in cages (3 m^{-3}) at six different stocking densities; designated as C1 (40 m^{-2}), C2 (50 m^{-2}), C3 (60 m^{-2}), C4 (70 m^{-2}), C5 (80 m^{-2}) and C6(90 m^{-2}); in freshwater pond along with the existing composite fish farming system for 105 days. The maximum mean length (16.15±0.18 cm) was recorded in C1 and the maximum mean weight (28.79±0.30 g) was recorded in C4. Fast growing and high valued carnivorous fish are available in West Bengal, but their commercial culture along with planktivorous or herbivorous carps in the existing composite fish farming system is not possible. This problem may be solved by the introduction of cage culture in the prevailing composite fish farming system. Further studies are required on the optimization of cage size, stocking density, supplementary feeding and species specific guidelines for the promotion of cage culture in the country.

Dr. Shoji Joseph presented **Cage culture as a new avocation for women empowerment: a case study**. Cage culture in backwaters has been developed to an advanced and user friendly technology that has opened the door of opportunity for women to easily get involved in fish culture along with other backyard operations like poultry rearing and goat rearing. Galvanized iron (GI) cages of 6 x 6 m size were used in the open backwaters of Vembanad Lake at Poothotta in Ernakulam, Kerala. The location is a meeting place of 3 Districts, Ernakulam, Alappuzha and Kottayam, where lot of backwater area suitable for fish culture is available. The cage site had a depth of 4 m with good water exchange. The studies conducted revealed that women can do many activities, including nursery rearing of seeds and operational works in cage culture activities in backyard water bodies. This was a boost to rural women who are already engaged in fishing as well as to the younger generation. Involvement of women in aquaculture proved beneficial for their socio-economic empowerment, improved income and provided an alternate livelihood option which ultimately resulted in an improved status of the women, their family and finally the society.

Poster Session

Posters included Engineering components for cage farming in inland open waters of India, Cage culture for rearing fish fingerlings in reservoirs, Effect of artificial substrates on the growth of *Macrobrachium rosenbergii* in floating net cages, Scope for enhancing reservoir fisheries productivity in Uttar Pradesh through cage culture, Survival and rearing of hilsa *Tenualosa ilish*a in floating cages at Ukai Reservoir, Gujarat, Density dependent growth, survival and lactate dehydrogenase activity in golden mahseer fry reared in floating cages, Cage culture of milk fish *Chanos chanos* in a brackishwater pond at Kochi, Kerala, Cage culture of se*abass Lates calcarifer* in brackishwater fish ponds at Kakinada, Andhra Pradesh, Asian seabass *Lates calcarifer* as the most promising candidate species for cage culture in brackishwater in kerala, Trimming of cheliped legs reduces cannibalism and increases survival in green mudcrab *Scylla serrata* reared in cage system, Sustainable intensification of production from pokkali farming system through cage farming and Scope of low volume cages in openwater brackishwater finfish aquaculture.

Session III: Breeding and Seed Production

Chairs: Dr. Neils Svennevig, Consultant in Tropical Aquaculture, Vietnam, Dr. S. D. Tripathi, Former Director, Central Institute of Fisheries Education (CIFE), India.

Rapporteurs: Dr. Rema Madhu (CMFRI) and Dr. Divya P R (PMFGR, Kochi).

The keynote address was delivered by **Dr. G. Gopakumar** (India) on **"Recent advances in breeding and seed production of marine finfish"**. Dr.Gopakumar highlighted the thrust areas for research in India as reproductive biology, broodstock development systems, broodstock conditioning, nutrition, hormonal manipulations, live feed, larviculture technologies and biotechnological interventions. Dr.Gopakumar highlighted that rapid growth in global marine finfish farming has been noted in recent years, with an average annual growth rate of 9.3% from 1990 onwards, which can be attributed chiefly to the development of breeding and seed production techniques that made possible a reliable supply of good quality hatchery produced seeds of many high value marine finfishes. He mentioned that for the expansion of sea cage farming, a good deal of research and development activities are being pursued internationally on breeding and seed production of candidate species and many innovative techniques have emerged in this sector. The chief areas of research thrust include: reproductive biology, broodstock development systems, broodstock conditioning, nutrition, hormonal manipulations, live feed as well as larviculture technologies and biotechnological interventions. Understanding the mechanism of oocyte growth and development as well as identifying the environmental influences on egg quality have led to major achievements in improving protocols for higher efficiency of egg production and viability of progeny. The introduction of Recirculating Aquaculture Systems (RAS), formulation of broodstock feeds, innovations in microalgal culture, improvements in larviculture through greenwater technique, advances in the high density mass production of rotifers as live feed, improvement in the production and utilization of Artemia and nutritional enrichment have played vital roles in the success of seed production of many species.

The lead talks in the session were:

1. **Dr. Asmund Bjordal** (Norway) presented **"Cage aquaculture in Asia: Can lessons be learned from the Norwegian salmon story?"** Dr. Bjordal spoke about salmon cage farming in Norway and highlighted several challenges and lessons learned in the

process. He had suggested that from the lessons learned from the major challenges of ectoparasites and viral infections could provide valuable inputs for cage culture development in Asia. From its start in the 1970s, cage farming of Atlantic salmon in Norway has grown considerably to a production of 1.2 million tons in 2014. Over the years mistakes were made and problems arose, like wrong location of farms and disease problems. Which can be overcome. However, two main problems restrict further growth of the industry: *ie* control of the ectoparasitic salmon lice and escape of farmed salmon. But the, lessons learned and technological developments in the entire production chain of salmon can serve as valuable input for the development of large scale, intensive cage culture in Asia.

2. **Dr. Ketut Sugama** (Indonesia) presented on **"Cage culture in Indonesia"**. He spoke about the species and systems of cage culture in Indonesia and highlighted the challenges posed by unplanned development of the sector especially with respect to environmental quality in Indonesia. He highlighted the licensing system for cages that is prevalent in Indonesia and mentioned about the recent development made by Indonesia in captive breeding of yellow fin tuna. Indonesia practices more of freshwater cage culture and in marine or coastal waters. There are a number of freshwater species widely cultured in cages such as carp, tilapia and catfish. Marine cage culture can be found throughout coastal waters including Batam, Aceh, West Sumatra, Lampung, Seribu Island, Bali, Lombok and Eastern Indonesia. Dr.Sugama touched on different species cultured as well as on the types of cages. Marine fish species cultured in cages are grouper, barramundi, red snapper, pompano, cobia and yellow fin tuna. Most cage farms are relatively medium and large scale operations (50 - 150 cages) and well-constructed, made of bamboo, wood and HDPE frames of various size, (2 x 2 to 6 x 6 m) and shapes (octagonal and round). Most of the farms are shaded, with a house for storing feed, nets, other equipments and equipped with electricity and high pressure pumps for net cleaning. Fish are reared in net cages for 4 - 24 months depending on the size of the cultured species. More than 300 freshwater and marine fish hatcheries as well as more than sixteen commercial fish feed factories are now operating to support aquaculture in Indonesia. The government of Indonesia targets an increase in aquaculture production from 16.9 million tons in 2015 to 31.5 million tons in 2019. However, there are several constraints to both freshwater and marine cage culture including irregular seed supply in terms of quantity and quality, and diseases (particularly Streptococcus infections and koi herpes virus (KHV) in freshwater fish; viral

neural necrosis (VNN) and megalocytivirus in marine fish as well as problems of access to market and fluctuating prices.

3.Dr. Ramchand C N and Dr. Dhinoth Kumar B (India) presented **DNA extraction and next generation sequencing applications in cage fish farming**. Dr. Ramchand spoke about magnetic nanoparticle based DNA extraction methods. Dr.Dhinoth spoke about the application of Next Generation Sequencing in fish cage farming. Cage fish aquaculture has flourished in various parts of the world including India. Traditional breeding programs based on the phenotypic traits were used to increase the productivity in the past. These techniques are slow and therefore there is a need to implement modern molecular and genomic approaches in breeding. Recent advances in molecular biology, genomics and genotyping technologies help us in rapidly predicting breeding merits, genomic selection, disease prevention and sex manipulation, thereby increasing the productivity and ensuring sustainable protein supply for the future population. The recent introduction of next generation sequencing (NGS) methods provides tremendous insight into the genome of fishes. Genetic variation studies of model fish systems are providing crucial data on adaptation and persistence mechanisms of great relevance for biodiversity assessment. Whole genome sequences can provide detailed linkage and physical maps of the genome which can be helpful in genetic analysis. Whole genome sequencing also generates large numbers of SNPs for the analysis of traits which in turn help in molecular marker based breeding to improve the nutritional quality and the yield of fishes. Genome analysis of fishes also involves efficient and contamination free extraction of DNA from fish tissues. The column based kits generally face the issue of “column blocking” during extraction of fish tissues. Recent development of magnetic nano particle based extraction techniques has solved this problem. These methods avoid the use of columns and lengthy centrifugation steps. This leads to pure and intact DNA which can be used for any further downstream application.

The lead talks were followed by six oral presentations in the session.

Dr. Thinesh Santhar, D presented **Hatchery seed production and cage farming of tiger grouper *Epinephelus fuscoguttatus* in Andaman and Nicobar Islands**. Groupers are generally associated with coral ecosystems and are traditionally classified under the sub-family Epinephelinae. Several species of

groupers are commercially important candidate species for aquaculture and are high valued commodities that cater to the live seafood market of Southeast Asian countries. In India, groupers are abundant in vast stretches of coral reefs along the entire coast including Andaman and Lakshadweep Islands. Recognizing the potential for cage culture of groupers in India, Rajiv Gandhi Centre for Aquaculture (RGCA) initiated a grouper project at the Andaman & Nicobar Islands during the year 2006 to develop technologies for breeding and grow out farming of groupers in cages in open seas.

Dr. Ritesh Ranjan presented **Development of a low cost recirculatory system for marine finfish broodstock maturation.** Recirculating aquaculture systems provide an opportunity to reduce water usage as well as to save energy used for water pumping. A low cost recirculatory system for finfish broodstock development and their breeding, with a 100 ton capacity tank provided with different components of recirculatory system viz. rapid sand filter (RSF), ventury type protein skimmer and biological filter was presented recirculatory system is able to maintain water quality required for the maturation of brooders and their natural breeding, in captivity.

Dr. Dhandapani, K presented **Advances made by RGCA in breeding and seed production of cobia *Rachycentron canadum***. The worldwide interest and success in cobia *(Rachycendron canadum*) aquaculture has encouraged aquaculture research institutes in the country to establish experimental marine finfish hatcheries. Rajiv Gandhi Centre for Aquaculture (RGCA) established its marine finfish hatchery at Pozhiyur in the southwest coast of India during 2009. Wild collected broodstock were maintained @ 1:1 male to female ratio in 100 ton recirculatory aquaculture system (RAS). In addition, 17,000 nos. of hatchery produced cobia juveniles were also ranched in the Arabian Sea as part of marine natural stock enhancement programme, since 2011.

Dr. Anil, M. K presented **Micron meshed cages for nursery rearing of hatchery produced green mussel *Perna viridis* spat**. The Asian green mussel *Perna viridis* is a significant molluscan resource of Indian coast; as they are one of the most sought-after edible bivalves found in the subcontinent. Recent years have witnessed an increased demand for mussels especially in Northern Kerala and Goa. Mass production of mussel seed in a technologically convenient and cost-effective manner is inevitable for increasing mussel production. Weekly cleaning/scrubbing of the cages was done to prevent silt accumulation and clogging by sponge and other epi-fauna growing on the cage, facilitating free flow of water and algae through the mesh. Seed grown in the nursery cages can be used for seeding nursery ropes for further growth.

Dr.Biji Xavier presented **Domestication and broodstock development of the orange spotted grouper *Epinephelus coioides* in land based recirculatory systems.** The orange spotted grouper *Epinephelus coioides*, is one of the promising species for farming in India, owing to its faster growth rate, good meat quality and high market demand. The present experiment was carried out to domesticate and develop broodstock of orange spotted grouper in land based 100 t capacity reinforced concrete tank with recirculation facility. *E. coioides* (24 nos. ranging in weight from 2 - 3 kg) were collected from the wild and after prophylactic treatment, fishes were PIT (passive integrated transponder) tagged and stocked in the tank @ 1 kg per cubic meter. The land based recirculatory aquaculture system would enable faster broodstock development of orange spotted grouper and year round supply of brooders with natural spawning, which would greatly help in seed production of the species.

Dr. Kailasam, M presented **Satellite nursery rearing of Asian seabass *Lates calcarifer* : bridging the gap between hatchery and the farmer.** Seabass is considered as one of the most suitable alternate species in brackishwater aquaculture sector in view of increasing incidence of disease issues in *Litopenaeus vannamei* farming. The demand for seabass fry is roughly estimated to be 25 million per year presently, but likely to increase many folds in future because of severe setback faced in shrimp farming due to several factors. Although, captive seed production and hatchery technology for seabass has been successfully developed nearly one and half decades ago by the Central Institute of Brackishwater Aquaculture (CIBA) and subsequently by the Rajiv Gandhi Centre for Aquaculture (RGCA), private hatcheries are reluctant to take up the commercial production of this species in the hatcheries due to various factors.

Poster session

The posters covered various aspects like Status and way forward in marine finfish seed production for sea cage farming in India, Induced maturation and spawning of *Lutjanus argentimaculatus* in open sea cage in the Arabian Sea, Quality seed: innovative hatchery design for healthy farming of *Mugil cephalus*, Captive breeding of lemon damsel fish *Pomacentrus moluccensis* in Andaman and Nicobar islands, Captive breeding of skunk clownfish *Amphiprion akallopisos* in Andaman and Nicobar islands, Genetic stock structure investigations on *Metapenaeus dobsoni* from Indian coast using mitochondrial

ATPase 6/8 genes, Captive maturation of Asian sea bass *Lates calcarifer* in open sea floating cages at Visakhapatnam, Andhra Pradesh.

Session IV: Nutrition and Feed

Chairs: Dr. Trond Severinsen, CEO, AKVA Group ASA, Norway and Dr. G. Gopakumar, Emeritus Scientist, CMFRI, India.

Rapporteurs: Dr. Joe K Kizhakudan and Dr. Biji Xavier (CMFRI).

The keynote address was by **Dr. P E Vijay Anand** (India), USSEC on **"Indian aquaculture feed industry and its support to cage farming"**. He gave an overview on feed industry in India and opined that species and habitats diversification in aquaculture would lead to more demand for artificial feeds. He also spoke about Low Volume High Density (LVHD) culture system and Open Cage Aquaculture Technology (OCAT). The Indian fish farming industry largely uses nutritionally poor, agri-byproduct based feeds with high feed conversion ratio. The usage of feeds from the modern feed mills which operate with the knowhow from competent foreign partners will improve the production and also feed conversion ratio. The U.S Soybean Export Council (USSEC) runs a worldwide aquaculture activity called the Soy-in-Aquaculture Program, and has been instrumental in demonstrating and developing the commercial aqua feed industry in India based on successes obtained in other parts of the world. Most of India's fish culture systems still use nutritionally poor, agri-byproduct based, mash feeds for feeding fish with high FCR's, which cannot support cage farming systems. However, at least 25% of the inland, pond based fish farming sector in India has adopted the use of pellet or extruded floating feeds. USSEC has played a major role in carrying out commercial feeding demonstrations to show better returns on investments when modern feeds are used. More fish species, more transformations from traditional methods to feed based methods, system diversification from pond based systems to cage systems and utilization of different aquatic systems (freshwater, brackishwater and marine systems) will create demand for feeds. USSEC has successfully established the LVHD (low volume, high density) systems for freshwater fish and OCAT (ocean cage aquaculture technology) for marine species in different parts of Asia.

The lead lecture was by Dr. **Kristoffer Lunde** (Norway) on **Global scenario of feed and nutrition in cage culture**. In the global scenario, Dr. Lunde highlighted the need for development of

alternatives to fish meal in feeds. He also spoke on the applications of functional feeds in the management of health in farmed fish species. Seafood represents the largest protein source globally, and demand is expected to increase in the coming years. This represents tremendous potential for the aquaculture industry, and farmed seafood is projected to grow at nearly 4% annually between 2013 and 2020. Nearly one fifth of this farmed seafood production is represented by tilapia, salmon and shrimp. A key contributor to successful aquaculture is the availability of high quality feed. Functional feeds not only promote growth, but improve health and immunity, induce physiological benefits and are economically and environmentally viable. Dried fish meal is a major component of traditional fish feed. The harvest of low value fish species for conversion to fish meal has been recognised as environmentally unviable in the long run. The library of nutritional and health improving compounds being developed also has wider applications beyond current target species.

Four papers were presented in the session.

Dr.M.A.Hassan presented **Evaluation of brewery waste based feeds on growth, feed utilization and body composition of cage reared striped catfish *Pangasianodon hypophthalmus* in a tropical reservoir in Maithon, Jharkhand**.Three isocalorific (gross energy, GE: 18.15±0.2 KJ g-1) and isonitrogenous (crude protein, C.P: 28.8±0.3%) feeds were tested to study the effect of replacement of soybean meal with brewery waste in feed and to evaluate the effect of different forms (floating vs sinking pellet) of brewery waste based feeds on growth performance, feed utilization, nutrient retention and carcass biochemical composition of the striped catfish *Pangasianodon hypophthalmus*. Total replacement of soybean meal in the feed did not yield any significant difference in growth parameters, feed utilization and carcass biochemical composition of the experimental fish. The feed cost was found to be reduced by 32.8% and 26.5% by feeding brewery waste based floating and sinking feed respectively, compared to soybean based floating feed.

Reshma, B. presented **Precision drone algorithm for feed delivery in sea cages.** Peninsular India, with its vast and unexplored marine water spread, promises a thriving future for cage farming industry. Seed production and grow out technology for a number of fish species and lobsters have been standardized by the Central Marine Fisheries Research Institute and successfully demonstrated at different locations along the Indian coast. Nevertheless, the remoteness of cage sites and the characteristic oceanographic upheavals of tropical Indian Ocean, demands several engineering interventions that can ease

the level of effort and cost required for farming in the open sea. Labour cost for the daily maintenance of farm especially that for the feeding activity, forms a major share of the working cost of the entire culture activity.

Dr. Felix N. presented **"Evaluation of brewers spent grain as feed ingredient in diets of GIFT tilapia cultured in reservoir cages".** Dietary supplementation of brewers spent grain was evaluated for its effect on growth of GIFT tilapia cultured in floating cages installed in reservoir. The experiment was conducted in 4 x 4 m size HDPE cages installed in the Poondi Reservoir in Thruvallur District of Tamil Nadu. GIFT tilapia seeds were procured from Rajiv Gandhi Centre for Aquaculture (RGCA), Sirkali, Tamil Nadu and stocked in cages at the rate of 50 m^3. The floating feed was fed twice daily for a period of 4 months at the recommended rate based on body weight. A level of 20 to 30% brewers spent grain was successfully used in GIFT tilapia diets. It was also found that inclusion levels of dietary brewers spent grain can be increased by supplementation of limiting essential aminoacids.

Dr. Vikas Kumar presented the **"Effect of *Gracilaria* sap supplementation on growth, proximate composition and hematological parameters of *Labeo rohita*".** The study was conducted to evaluate the effect of *Gracilaria* sap supplementation in the diet on growth performance of *Labeo rohita* fingerlings. *L. rohita* fingerlings having average weight of 250 g were stocked in fifteen FRP tanks (2 x 2 x 1m) at a density of 10 fingerlings per tank. The crude protein and fat levels significantly improved in *Gracilaria* sap supplemented diets. Hematological parameters viz. WBC count, RBC count, platelets, hemoglobin, MCHC, MCV and HCT were also significantly improved in all the treatment groups fed *Gracilaria* sap supplemented diets.

Poster session

Eleven posters were presented in the Session. The posters covered: Efficacy of formulated feeds on growth and body composition of *Etroplus suratensis* reared in cages, Growth response of spiny lobster *Panulirus homarus* fed on formulated experimental diets under confinement, Sodium/iodide symporter cloning and expression response to dietary potassium iodide inclusion in yellow catfish *Pelteobagrus fulvidraco*, Growth and plasma distribution of phosphorus and magnesium in far eastern cat fish *Silurus asotus* fed graded levels of magnesium hydrogen phosphate, Suitability of cyclopoid copepod *Diacyclops* sp. from

Karwar waters as a potential live feed for larval rearing of marine finfish and shellfish, Bacterial flora of rotifers fed with different microalagal diets in outdoor mass culture tanks, Growth and feeding performance of sea urchin *Salmacis virgulata* in an indoor minicage grow out system, Bioencapsulation of Artemia nauplii using medicinal plant extracts for growth promotion in *Danio rerio* fry,Toxic impact of coal mine effluent on nutritionally important biomolecules in different organ systems of the catfish *Clarias batrachus*, Microalgal diversity in a tropical estuarine ecosystem with special reference to its potential use in finfish and shellfish larviculture, Effect of biofloc on growth, proximate composition and digestive enzyme activities of *Etroplus suratensis*, Efficacy of *Chaetoceros calcitrans* enriched Artemia salina, *Bacillus stratosphericus* (AMET1601) and nitrifying bacterial consortium as probiotics in *Litopenaeus vannamei* culture, Improved growth and reduced cannibalism in Asian seabass *Lates calcarifer* fed with estradiol enriched feed.

Session V: Health and Environment Management

Chairs: Dr. Asmund Bjordal, Director of Centre for Development Cooperation and Fisheries at Institute of Marine Research (IMR) Norway and Dr. K.K. Vijayan, Director, Central Institute of Brackishwater Aquaculture, Chennai, India.

Rapporteurs: Dr. Geetha Sasikumar and Dr. Divu D (CMFRI).

The keynote address was delivered by **Dr. Brit Hjeltnes**, (Norway) on **"Fish health: a Norwegian Experience"**. Dr. Brit gave an overview on fish health, major challenges like bacterial diseases, outbreak of infectious anaemia, sea louse and infectious pancreatic necrosis outbreaks and their control. She also highlighted the lessons learned which can be used for success of aquaculture. The aquaculture industry experienced considerable fish health problems during this period, but these problems have been solved in different ways. From 1980-1993, the major challenges were bacterial diseases. Diseases like cold water *vibriosis* and furunculosis caused high mortality and economic losses. Introduction of vaccines has been an essential precondition to improve fish health, control and reduce the use of antibiotics and develop the industry. Vaccines are an essential part of Norwegian fish health management. Throughout the nineties, viral infections became the most important Norwegian disease problem. Outbreaks of infectious salmon anaemia (ISA) spread to main aquaculture areas and increased in numbers. ISA was defeated by important measures such as early harvesting of fish, allowing restricted movement of fish and introduction

of sanitary slaughtering. Selective breeding has traditionally been used for selection of fast growing fish. Recently Norwegian researchers have found markers for disease resistance against infectious pancreatic necrosis (IPN). Salmon eggs which are selected by means of this marker have probably been an important reason why the number of outbreaks of IPN has been significantly reduced within a few years.

The four lead talks were:

1. Dr. Trevor Platt (Plymouth, Presently Jawaharlal Nehru Science Fellow at CMFRI, India) on **"Use of remote sensing in the context of cage aquaculture"**. Dr. Platt highlighted the application of remote sensing for cage site selection and cage management. The defining characteristic of cage aquaculture is that food is provided to the cultured organisms, independently of the food available in the environment itself. When organisms are cultured on the food available *in situ* (for example, in the culture of filter feeding bivalves), an important consideration is the carrying capacity of the environment, which is readily accessible to remote sensing through the calculation of phytoplankton production. However, in cage culture, estimation of carrying capacity based on food requirement is not relevant, and we have to look elsewhere to see where remote sensing, supported by oceanographic information, might be of help. We shall find that the limitations relate mainly to the dispersal of toxic metabolites and unconsumed food; to cage damage by storms; to transient water masses of temperature outside the tolerance range of the cultured species; and to the incidence of harmful algal blooms. Another consideration is the availability of essential fatty acids, for which remote sensing methods have recently been developed.

2. Dr. K. K. Vijayan, (India) spoke on **"Fish health management in cage aquaculture".** He presented the diseases, pathogens, parasites and control measures in cage aquaculture systems and adoption of proactive strategies to prevent disease outbreaks in cage farmed fishes. The growing global population, dwindling natural fish stocks, and increasing demand for quality fish products have been the major drivers for increasing fish production through aquaculture, and by 2030 the share of aquaculture in total fish production is projected to rise to 62%. However, considering the limitations posed to traditional brackish and freshwater aquaculture systems due to environmental issues, carrying capacities and disease problems, it has been recognized that cage culture, especially mariculture has many economic advantages. Cage farming has many economic

advantages, like any other animal production system, diseases are one of the major limiting factors to the successful production. Both infectious and non-infectious diseases act as significant constraints to the industry, as high density rearing always paves the way for frequent disease outbreaks. The diseases with infectious aetiologies, viral diseases are the most consequential in aquaculture systems, and in the Indian context, viral nervous necrosis (VNN) virus remains the most important viral pathogen reported from the country. Though numerous species of bacteria are reported from coastal waters, those belonging to genera of *Vibrio, Pseudomonas* and *Aeromonas* are considered pathogenic for aquatic animals. A thorough understanding of pathogens, disease process, diagnosis, epidemiology and control measures are essential for better health management of farmed fishes in cages.

3. Dr. Indrani Karunasagar (India) presented **"Microbial diseases of Asian seabass *Lates calcarifer*.** The marine aquaculture fish production, especially of Asian seabass has increased rapidly during the past several years, owing to their high market demand and economic value. However, rapid expansion and intensification of aquaculture has led to disease outbreaks. Among the infectious diseases, viral diseases are the most serious since they cause severe losses to production. Many viral diseases of fish have been reported worldwide, of which infection caused by Betanodavirus, a RNA virus of family Nodaviridae is a major concern. The disease is associated with high mortalities (up to 100%) particularly in larvae and juvenile fish species and has been reported by different names such as viral nervous necrosis, fish encephalitis, viral encephalopathy and retinopathy, by various investigators. Bacterial pathogens such as those of the genus *Vibrio*, *Streptococcus*, and *Chlamydiales* are important infectious agents. Several bacterial outbreaks are diagnosed in fish annually, creating hurdles to the successful management of fish farms. The microbial outbreaks are focused mainly in floating cages which in turn comprise the major portion of marine fish culture. These outbreaks are usually induced by environmental fluctuation or overstocking. Parasites are also known to have harmful effects on aquacultured animals, resulting in infections to almost all marine fish farmed in cages. Prominent among the parasitic pathogens are the protozoans, monogeneans and some trematodes.

4. Dr. Murwantoko (Department of Fisheries, Faculty of Agriculture, Indonesia) on **"Diseases of grouper in sea cages in Indonesia".** Dr. Murwantoko emphasized the effectiveness of freshwater treatment for

controlling parasitic infection, vaccines against *Vibrio* and *Betanoda* virus infections in cage cultured groupers. The total aquaculture production increased significantly from 6.27 million tons in 2010 to 14.51 million tons in 2014. Groupers are one of the most important fish species in mariculture and have been cultured intensively. The intensive culture of fish is faced with several constraints including disease. Grouper diseases in Indonesia are caused by nutritional/physiological factors, parasites, bacteria and viruses. Disease incidence and mortality due to environmental factors have also been recorded. Disease conditions due to *Vibrio* spp., are common in various species of groupers in Indonesia. Betanoda virus has been confirmed to cause viral nervous necrosis (VNN) in hatchery, nursery and growout culture in various species of grouper. At least two clusters of megalocytivirus i.e. infectious spleen and kidney necrosis virus (ISKNV) and red sea bream iridovirus (RSIV) clusters have been found in various species of grouper, and mainly in growout cage. Freshwater treatments have been applied to control parasite infection with the frequency of treatment depending on many conditions. Polyvalent vaccine has been developed and applied to prevent *Vibrio* infection. Laboratory trials showed that a recombinant coat protein of betadonavirus showed high efficacy when used as a vaccine in tiger grouper to overcome infection of nervous necrosis virus. The production of recombinant proteins of megalocytivirus is in progress.

The lead talks were followed by four oral presentations.

Dr. Grinson George presented on **"Utilizing satellite remote sensing data and oceanographic information for identifying cage aquaculture sites and scheduling the cage maintenance activities"**. Cage aquaculture relies on food artificially supplied to the cultured animals. Hence the local levels of primary production are not critical to the success of the enterprise. Rather, the risks to be avoided are those arising from severe weather; from toxic phytoplankton; and from accumulation of waste products of metabolism. Protection from severe weather requires analysis of local topography in the context of the prevailing wind and wave fields, as well of the vulnerability to extreme events such as the passage of cyclones. Protection from the toxic phytoplankton requires analysis of the spatial distribution of toxic blooms, such as could be established through remote sensing. Dispersal of toxic wastes is a function of local residence time (tides, currents, estuarine circulation wherever relevant) of the waters at the site under consideration.

Dr. Santhosh, B. presented **"Experimental studies on community structure and succession of foulers on cages in Vizhinjam Bay, Kerala"**. Biofouling on suspended cages is one of the biggest problems in sea cage farming. The communities of organisms that develop on suspended, fish cages result in added weight and cause drag to the cage, reducing water flow and affecting cage behaviour and serious problems in cage farming. It is essential to know the succession of fouling communities for effectively controlling the biofouling. Most of the fouling organisms reproduce seasonally and if the community structure and succession pattern is known, we can plan certain management measures for effectively controlling them at the early stages of their development.

Dr.Remesh Kumar B presented **"Outbreak of *Vibrio alginolyticus* infection in cobia *Rachycentron canadum* cultured in floating cages".** Cobia (*Rachycentron canadum*) culture offers great possibilities in aquaculture because of its fast growth rate and high demand. Cobia farming would presumably become an emerging aquaculture sector in India in the near future. Fish cultured in floating cages become particularly susceptible to diseases. The outbreak of disease started with typical classical clinical signs, surfacing, corneal opacity, abnormal swimming behaviour followed by acute mortality. The gills were pale with profuse mucous secretions and abdomen distended with yellowish ascites fluid accumulation. Heart showed hydropericardium and fibrinous type of inflammation. The 16S ribosomal RNA of the isolate was amplified and BLAST analysis of the sequence confirmed that the pathogen as *Vibrio alginolyticus*. The confirmation was also correlated with its cultural as well as biochemical characteristics and also with pathomorphological changes in the infected fishes.

Dr. Jigang Chen presented **"Non-specific immune response in mud crab *Scylla serrata* induced by cells or lipopolysaccharide extracts from *Altermonas stellipolaris* strain ANT82"**.Antarctic marine bacteria have adapted to the low temperature and oligotrophy of the environment using special metabolism and cell structure. Present study investigated immunomodulating effect of whole cells or lipopolysaccharide (LPS) of an Antarctic marine bacterial strain, in the mud crab *Scylla serrata*. Healthy mud crabs were injected with whole cells or LPS extracts from the Antarctic marine bacterium *Alteromonas stellipolaris* strain ANT82.

Dr. Ranjan K. Manna presented **"Hydrobiological investigations during cage culture of striped catfish *Pangasianodon hypophthalmus* in Saroda Sagar Reservoir, Chattisgarh"**. Saroda Sagar Reservoir (30°35'17"N; 78°48'47"E)

(approx. 231 ha) in Kabirdham District of Chattisgarh State observed a recent introduction of pangus (*Pangasianodon hypophthalmus*) cage culture from 2013, wherein a battery of 99 cages (6 x 4 x 4 m) are being installed. Being a supplementary feed based intensive aquaculture practice, it may have an impact on overall aquatic environment of the reservoir. The Central Inland Fisheries Research Institute (CIFRI) made an investigation during June 2015 to understand the present ecological environment inside as well as outside the cages in order to assess the impact of cage culture if any, on the overall water environment.

Poster session

Fourteen posters were exhibited during the Session,

Topics covered were Impact of cage aquaculture on the plankton community in Kabini, a large reservoir in Karnataka; Harvest of farm associated wild fish assemblages in estuarine cage farms: implications for farm management and livelihood, Does sea cage farming influence carbon sequestration in the sea? Assessment of carbon sequestration capacity of plankton near cage farming sites at Mandapam, Gulf of Mannar, Tamil Nadu, Occurrence of ichthyophthiriasis in *Pangasianodon hypophthalmus* cultured in cages in Maithon Reservoir, Jharkhand, India, Ecology and biodiversity of open sea cage farm at Mandapam, India, Fouling of cage nets at Villundi in Palk Bay, south-east coast of India, Encrustation by bivalves in a tropical marine cage farming system, Biodiversity of macrofouling organisms in a marine cage farm at Karwar, west coast of India, Microbial quality of water around open sea cage farm sites on the Arabian coast of India, Stereomicroscopic and high resolution SEM studies of gill, mouth cavity and lateral line of pompano Trachinotus blochii using chemical method of tissue drying, Establishment and characterization of two morphologically different cell lines from fin tissue of the pompano *Trachinotus blochii*, Bacteriophage based control of bacterial infections commonly encountered in farmed flounder *Paralichthys olivaceus*, Accurate identification of parasitic infestations for effective management and treatment in aquaculture, Keratinization of epidermis in the ornamental catfish *Chaca chaca*: histological and scanning electron microscopic investigations, Dynamics of Vorticella sp. Infestation in cobia *Rachycentron canadum* larvae and specific growth rate of the parasite, Effect of asiaticoside on the proliferative activity of epidermis during healing of cutaneous wound in the Indian major carp *Cirrhinus mrigala*.

Session VI: Economics, Livelihood and Policies

Chairs: Dr. Clive Jones, Principal Research Fellow, College of Marine and Environmental Sciences, James Cook University, Australia and Dr. P. S. B. R. James, former Director, CMFRI, Kochi, India.

Rapporteurs: Dr. Vinod K and Dr. N. Aswathy (CMFRI, India).

The keynote address for the session was by **Dr. Marius Dalen,** (Norway) on **"Aquaculture governance: balancing increased food production and environmental sustainability".** Dr. Dalen spoke on the licensing system in Norway for cage farming. He explained that a licensing system acts as a source of information to the authorities, is a tool for financing for the industry and is necessary for regulating farming systems operating on a large scale. He also pointed out that good spatial planning reduces conflicts between several stakeholders in a common area. To engage in aquaculture activities requires a license. This means that aquaculture and sea ranching activities without a license are illegal. Salmon farmers needs one license to produce salmon (typically 780 tons), issued by the Ministry of Trade, Industry and Fisheries, and one license from the county that in detail defines the site where the aquaculture production can take place. The process to acquire a site for production involves several authorities. The county processes the application based on comments and decisions made by the municipality, the Directorate of Fisheries regional office, the Norwegian Food Safety Authority, the Norwegian Coastal Administration and the County Governor. The Aquaculture Act has a strong environmental profile. At the same time, the relationship between the use of the coastal zone and different user interests is taken into account. The environmental and land use provisions are intended to contribute to a good coexistence between the aquaculture industry and other public interests.

The three lead talks were:

1.Dr. P Ravichandran, Coastal Aquaculture Authority, India on **"Aquaculture policy and legislations in India"** has highlighted the need for a regulatory policy for mariculture in India, as the existing acts focus on land based aquaculture activities only. He had stressed on the importance of preparing a legal framework for aquaculture before initiating any future course of action in the sector and

the necessity for including CCRF in the general policy for the fisheries sector. The freshwater aquaculture contributed nearly 90% with major contributions from carps followed by Pangasius and Tilapia. Shrimps were the major contributors in marine aquaculture production. The total aquaculture contributions are hardly 15% of the total resources available and there is a very high potential for increasing aquaculture production in the country. The major issue is the lack of a comprehensive aquaculture policy at the National level. This is mainly because India is a federal Union of States comprising of 29 States and 7 Union Territories (UTs) with legislative powers for policies of land and water, which are the major requirements for aquaculture development, vested with the States and UTs. State level aquaculture policies with supporting legislations are few in number.

2. Sri. Suresh Kumar, NABARD, India presented **"Institutional credit support for cage aquaculture in India: policy interventions".** Sri. Suresh presented the issues of Non-Performing Assets and their dampening effects on credit support to fisheries and aquaculture sectors. He pointed out the challenges of financing cage farming as lack of policy, limited technology standardization and security issue of cages. He suggested that credit support could be extended to innovative fisher SHG groups as an alternative. The share of inland and marine sectors in world fish production accounted for 34% and 66% respectively the same in the Indian context is just the reverse i.e. 65% and 35% respectively. It is amply clear from the preponderance of inland sector in total fish production in India, that India is not able to make use of its vast marine and coastal resources, despite having a long coastline and extensive Exclusive Economic Zone. The productivity of inland open water systems is also very low compared to their potential, though species like Pangasius have been introduced and farming systems like cage culture in reservoirs are being attempted on a limited scale. Realising the need to diversify aquaculture species and practices, which is currently dependent on carps in inland sector and shrimps in the coastal/marine sector, research institutions have focussed their attention on new species, culture systems and evolved breeding and seed production and farming systems covering Asian seabass, cobia, pompano, seabreams, lobsters and crabs. Though cage aquaculture is emerging as the technology of the future for India to expand aquaculture production, the package of practices are yet to be standardised keeping in view, specific species and grow out systems.

3. Sri. Jacob Joseph, Assistant Professor, NUALS, India spoke on **"Cage aquaculture in India: legal perspectives"**. Sri. Jacob pointed out the lacunae in existing fisheries legislations in covering mariculture and suggested the development of a comprehensive and clear legal framework taking into consideration the stakeholders, location and environmental impacts of cage farming. Mr. Jacob Joseph of NUALS, Kochi while explaining the legal perspectives of cage aquaculture in India listed the issues before formulating the policy for mariculture. He also expressed concern on the need for a clear policy on the use of non-indigenous species in cage culture. He has stressed on the need for licensing, public water user rights and use of exotic seed. Cage aquaculture in India was only developed in the latter half of the first decade of the 21st century. Therefore, it is not surprising that one does not find any reference to the said activities either in the Constitution of India, 1950 or in the Territorial Waters, Continental Shelf, Exclusive Economic Zone and Other Maritime Zones of India Act, 1976. The Marine Fishing Regulation Acts of various states are also silent at this point. Further, there is very little case that deals with how the existing legislative regime applies to aquaculture activities. The interpretation of how current legal measures apply to aquaculture is complicated and uncertain. The Cage aquaculture has become an integral component of Indian fisheries and it is therefore necessary that clear policies and comprehensive legal regimes are developed so as to facilitate sustainable development of cage aquaculture in India. In this context it is pertinent to examine whether the current legal framework in India is capable to address the multi-dimensional issues presented by the adoption of cage aquaculture in India and what is the way forward, in so far as the establishment of a legal and institutional framework which facilitates the development of responsible aquaculture in India.

There were twelve oral presentations in the session.

Dr. Jayashree Loka presented **Marine cage farming to empower fishermen self-help groups in India: a perspective.** Cage farming of marine finfish and shellfish was first initiated in India by the Central Marine Fisheries Research Institute (CMFRI) during 2007 at different locations along the Indian coast. Later Karwar Research Centre (KRC) of CMFRI succeeded in developing farming technologies for Asian seabass *Lates calcarifer* in marine cages. The centre intensified farming of marine finfishes viz. Asian seabass *Lates calcarifer*, cobia *Rachycentron canadum* and pompano *Trachinotus blochii* along the Karnataka, Goa and Maharashtra coasts. As part of expansion of open sea cage farming in India and employment generation for the fisherfolk, CMFRI initiated participatory demonstration programmes at Goa with support of the

Department of Fisheries, Government of Goa from 2013 - 14 onwards in three different areas viz. Polem, Talpona and Nuem.

Dr. Swathi Lekshmi, P. S presented **Information source utilisation by farmers involved in cage culture of finfishes: a study in coastal Karnataka.** Cage aquaculture is gaining prominence as an alternate source of livelihood for the traditional fishermen of coastal Karnataka. The transfer of technology programmes of the Mangalore Research Centre of Central Marine Fisheries Research Institute (CMFRI), has led to the adoption of cage culture of finfishes such as seabass and red snapper in the estuaries located in the backyard of their households on a subsistence scale. It has provided the traditional fishers with an alternate source of income generation during the lean fishing season. The study analyses the information source utilisation behaviour of these fishers since it is an important socio-psychological variable influencing the adoption of cage culture practices.

Dr. Joe K. Kizhakudan presented **Cage aquaculture: a tool for participatory management of coastal waters and fish stocks.** Sustainable fishing, conservation of fishery resources and preservation of coastal ecosystems form a complex triad of necessary activities that need to be juxtaposed in the best possible way to provide the ideal formula for fisheries management. India today faces the threat of increasing fishing pressure, depleting fish stocks and steady degradation of many coastal ecosystems due to a combination of anthropogenic and natural factors. Cage aquaculture presents a solution to these issues as it is a platform widely acceptable to fishing communities and easily adapted by them as an allied or alternate activity. Moving from hunter to farmer, they are quick to appreciate the opportunity cage aquaculture offers towards regulating their dependency on wild stocks and of working together towards replenishing the sea instead of only taking from it.

Dr. Abdul Nazar, A. K. presented **Techno-economic viability of open sea cage farming of cobia *Rachycentron canadum* undertaken by a fishermen self-help group**. Mariculture of commercially important marine fishes like cobia *Rachycentron canadum*, pompano *Trachinotus blochii* through open sea cage farming has gained momentum in the country due to their fast growth rate, high market demand, availability of stockable size fingerlings, easy farming methods and better economic returns. The techno-economic viability of open sea cage farming of cobia has been successfully demonstrated by the Mandapam Regional Centre of Central Marine Fisheries Research Institute (CMFRI) through public-private partnership (PPP) programmes with fishermen self-help groups (SHGs).

Dr. Kripa.V presented **Women empowerment through aquaculture in India: strengths and weaknesses.** Aquaculture is one of the major sources of livelihood for coastal villagers and women in the families have taken up responsibilities ranging from seed collection to marketing of farmed produce. During the past two to three decades, women from low income group families have been given opportunities to expand their sphere of activities and they have started earning and contributing to family income through their own group or cluster activities. In this phase change from a 'supportive' mode to an independent style of functioning, women have received considerable support from development schemes promoted by banks and developmental agencies. The country has very high potential for aquaculture development, and this can be advantageously used for empowering women, but there should be slightly different approach for each type of technology. Exploring the market and selling the product through varied marketing strategies should be a new activity and it is suggested that village or semi-urban youth having wider contacts are motivated to market the farmed produce of women self-help groups. Thus aquaculture can become village-semiurban-urban job provider and youth with more communication skills can support women empowerment in villages. The profit earned can be increased substantially through simple management measures, advertisements and development of markets.

Dr. Shyam S. Salim presented on **"Open sea cage culture in India: policy requirements and opportunities".** The Indian fisheries sector has undergone a paradigm shift in the last three decades and it contributes to the food security, employment opportunities and export earnings. Amidst reaching a 10 million tons production there exists numerous demand-supply mismatches coupled with technical and institutional constraints. The issues of fish availability, accessibility and affordability resulted in higher prices causing fish food security concerns for the ever growing consumers. The contribution of the marine fisheries sector has been showing a decelerating trend which necessitates the need for harnessing alternative fisheries production system. The technology adoption is operational under the following phases viz. site selection, location testing, technology demonstration, technology evaluation (output maximization and cost minimization with stakeholder participation), commercialization and development of alternative livelihood.

Dr. Mohammed Koya, K. presented on **Empowerment of sidi adivasi tribes through sea cage farming technology**. The *Sidi adivasi*, an exotic primitive tribal group from African-sub continent living in Gujarat who fall under below poverty line (BPL) were selected for the sea cage farming technology transfer and demonstration under the Tribal Sub-Plan (TSP) of the Government of India

implemented by the Central Marine Fisheries Research Institute (CMFRI). Majority of the tribals work as labuorers in fishing vessels, agriculture fields and industry, which provides very meager unsustainable income leading to poor livelihood standards. Open sea cage farming technology developed by CMFRI gained importance and is widely spreading across the country in recent years. The farming technology was used as tool to provide livelihood option and uplift. The *Sidis* are identified as potential target group for cage culture technology transfer and demonstration.

Dr. Daisy C. Kappen presented on **Cage culture of pearlspot *Etroplus suratensis* for livelihood enhancement of the fisherwomen of central Kerala.** *Etroplus suratensis* known as pearlspot or green chromide is widely distributed in the fresh and brackishwaters of south India and Sri Lanka. It is a delicious table fish with good flavour and taste. Due to market demand, herbivorous feeding habit, non- predatory and hardy nature it has been identified as one of the most suitable candidate species for pisciculture. This indigenous fish of Kerala has been declared as signature fish during the year 2010 by the Government of Kerala and concerted efforts are being made to increase its production. With a view to empowering the womenfolk and providing gainful employment, Kerala University of Fisheries and Ocean Studies (KUFOS) made an attempt to standardize cage culture of *E. suratensis* under the Rashtriya Krishi Vikas Yojana (RKVY) Sustainable Fisheries Development for Rural empowerment and Food Security in Puthenvelikkara Grama Panchayath, Ernakulam District, Kerala during 2010-2014 with the involvement of Department of Fisheries, Government of Kerala.

Dr. Vipinkumar, V. P presented **Gender mainstreaming and impact of self-help groups on cage farming in Vembanad Lake: a case study.** Vembanad Lake is conspicuous for brackishwater cage culture undertaken by the self-help groups (SHGs) of fisherfolk. As much as 27 fishermen mobilized under Vembanad Kayal Samraskhshana Samithy, Srayithodu Unit as SHG accomplished the farming of commercially important fishes in 20 cages in Vembanad Lake with financial assistance from Agency for Development of Aquaculture-Kerala (ADAK) as a part of Kuttanad package. The technical inputs were provided by experts from Central Marine Fisheries Research Institute (CMFRI) under the project gender mainstreaming and impact of self-help groups in fisheries sector. The success of the case study elucidated can be used as a case model and practical manual for promoting group action for mobilizing SHGs on a sustainable basis.

Dr. Chavan, B. R. presented on **Community based fish cage culture: an employment generation option for rural youth at Palasawada and Kadavai villages in Maharashtra.** "Fingerling Bank" concept initiated by the unemployed rural youth of Therawadi and Kadavai villages in Maharashtra are worth mentioning. This project was funded by the Rajiv Gandhi Science and Technology Commission (RGSTC), Mumbai. In the first phase, beneficiaries were selected from the Therawadi and Kadavai villages and formed a self-help group (SHG), and were registered in the office of the Taluka Magistrate. One battery of 4 and 3 cages each (each cage 6 x 4 x 2 m) were fabricated and installed in the Palaswada and Kadavai reservoirs, respectively. Hands-on training on fish cage culture in underutilized water bodies were given to the SHG at project site, covering all aspects of seed stocking, feeding, cleaning of the cages and counting of the seed

Dr. Johnson, B presented **"Adoption of CMFRI technology for sea cage farming: a success story from Ramanathapuram District, Tamil Nadu".** Marine fisheries sector in Palk Bay and Gulf of Mannar region is witnessing overexploitation of trawling grounds, declining catches and consequent reduction in profit. Other burning issues of this area are inadvertent crossing of International Maritime Boundary Line (IMBL) by the Indian trawlers and loss of livelihood of fisherfolk due to the biodiversity conservation measures of Gulf of Mannar. In order to address the issue of declining capture fisheries, the major management strategy followed worldwide is the adoption of fishing holidays. Another option is to ban trawling in a phased manner. Alternative options should be provided to these fishermen for the livelihood. Globally, increasing demand for seafood is forcing for additional seafood production through farming of fishes in open sea cages, coastal ponds and pens.

Dr. Sujitha Thomas presented **Small scale cage farming initiatives in Karnataka: a case of successful technology adoption leading to rural livelihood transformation.** Karnataka State has 300 km coastline with unpolluted brackishwater area of about 8000 ha. Over the years, a decline in estuarine fish production has occurred and the fishermen depending on estuaries were deprived of their livelihood. To address the livelihood issues, finfish culture of red snapper, seabass and pearlspot in small cages was initiated and cage culture techniques were demonstrated in the saline creeks and estuaries in the year 2009. The demonstration started with 5 cages in 2009 - 10. The grow out was successful and at the end of the culture period of 10 months, about 1.8 tons of fishes were harvested from the cages. The technology was disseminated successfully and it involved technology demonstrations through participatory approaches, focused group discussions,

training by experts, technical assistance in site selection, cage fabrication, management, sharing of information and development of linkages between stakeholders, governmental and non-governmental agencies.

Poster session

Eight posters scheduled were exhibited in the Session. They were Comparative assessment of conventional and cage fish farming in Ernakulam District, Kerala; Socio-economic dimensions and SWOT analysis of sea cage farming in Goa; Cage culture as an option for alternative income and livelihood: the experience of the traditional aquafarmers of Kerala, India; Polyculture of fishes in open water cages: a better option for year round fish production and income; Participatory approach for standardizing cage culture of giant trevally *Caranx ignobilis* in Thiruthipuram backwaters, Kochi, Kerala; Open sea cage culture of pompano *Trachinotus blochii*: an alternative livelihood approach for coastal fishers at Achara, Sindhudurg District, Maharashtra; Participatory trial on pen farming of milk fish *Chanos chanos* in Pillaimadam lagoon of Palk Bay, Tamil Nadu, Participatory demonstration of sea cage farming of spiny lobster at Thirumullavaram, Kollam, Kerala.

Plenary and Valedictory Session

The Plenary and valedictory session of CAA5 commenced in the afternoon of 27th November, 2015 at the Symposium Venue. Dr. S. D. Tripathi, Dr. K. K. Philipose, Coordinator, All India Network Project (Mariculture) Dr. Imelda Joseph, Head in Charge, Mariculture Division, CMFRI, Kochi and Dr. Derek Staples, expressed their views about the Symposium and appreciated the success of the symposium. Dr. J. K. Jena, President, AFSIB presented the concluding remarks and the recommendations of the symposium. Prof. (Dr) Mohan Joseph Modayil announced the awards for the Best three papers and posters. The awards were jointly presented by the President AFSIB, Member CAG, AFS and the Convener, CAA5. Matsyafed was presented with an Award in recognition of their support to the cage culture programmes in the country by supplying the nets at nominal rates to the fishers. The Chairman Matsyafed also assured that their organization will continue supporting CMFRI

and the community in their future endeavors. The Dr. A. Gopalakrishnan, Director, CMFRI and Convener, CAA5, proposed the formal vote of thanks.

RECOMMENDATIONS OF CAA5

1. Considering the emerging importance of cage aquaculture on the economy and life of the Asian region, the CAA5 recommends a precautionary development agenda for environment and resource friendly, sustainable and inclusive way forward for Asian countries by sharing information and experiences for the benefit of all.
2. The CAA5 recommends collective efforts between Asian countries to foster a green approach by following best management practices for providing safe fish.

3. The CAA5 recommends development of breeding and grow-out technologies of indigenous candidate species, specific to each country, with emphasis on diversification in both inland and marine cage aquaculture.

4. The CAA5 recommends greater focused research attention on feed development, with emphasis on reduced use of fish meal and fish oil, and feed management approach for prospective candidate species for cage aquaculture in the Asian region.

5. The CAA5 recommends development and implementation of country-specific disease surveillance and management plans for addressing existing diseases and preventing future outbreaks.

6. The CAA5 recommends a greater thrust on R&D on multispecies farming; involving fish, molluscs, seaweeds and scavengers for utilization of multi-trophic food niches for preventing environmental deterioration.

7. The CAA5 recommends development and adoption of National policies for each country, taking into consideration harmonized approaches delineating maximum biomass production for sites in inland and marine water bodies, so as to prevent adverse impacts on the aquatic environment of neighbouring countries.

8. The CAA5 recommends mapping of sites for cage aquaculture, taking into consideration local area development plans, environmental safeguards and user rights; further, notifying and demarcating culture sites must receive attention in each country so as to promote harmonious development.

9. The CAA5 recommends facilitation of private-public participation in commercial cage farming to attract increased investment and entrepreneurial development.

10. The CAA5 recommends sharing of knowledge and skill for development of cage aquaculture through collaborative programmes in research, training and human resource development.

Report on the 5th international symposium on
CAGE AQUACULTURE IN ASIA
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