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National Innovations on Climate Resilient Agriculture [NICRA]

ClimFish

NICRA Newsletter, CMFRI, Kochi

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Marine Cage Culture

Farmgate Sales

Overview of NICRA Project Progress

Climate related research on trophodynamics, phenology, spawning, distribution and resilience of selected fish species reveals several significant changes.

Dispersal and abundance of small pelagics (oil sardine and mackerel) were found to increase in northern latitudes which shall have implications on capture fisheries.

Changes in spawning season (*Nemipterus* spp) and diet composition (Indian oil sardine) were found to have relation with rising sea surface temperature.

Favourable climate driven changes in some small pelagic fish population distribution/ abundance were also identified.

Adaptive capacity of Zoanthids and its distribution related to climate change was affirmed.

Carbon footprint in life cycle of marine fisheries were assessed from Mangalore, Tuticorin, Veraval and Visakhapatanam and highest emissions were recorded in harvest phase in all cases.

Compendiums on ITKs of fishermen to climate change were made and several trainings were provided for fishermen empowerment so as to harness the positive impact of climate change.

Successful demonstration of integration of finfish with pokkali farming resulted in doubled income of paddy farmers of Kerala

Integrated Multi-Trophic Aquaculture of seaweed and Cobia resulted in improved outcome and is promising for further development.

Resilient strategies identified includes

- Seaweed farming along Indian coastal waters
- Regional wetland restoration and Scientific fish farming
- Multivendor Ecommerce solution

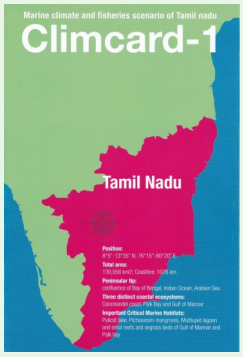
The NICRA project implemented at CMFRI could make significant progress in climate change impact identification, adaptation and mitigation for Indian fisheries sector.

Principal Investigator's Desk

Dr. P.U. Zacharia, Head & Principal Scientist, Demersal Fisheries Division, CMFRI

As envisioned, research newsletter 'CLIMFISH' could evolve as a platform to publish highlights of multidimensional climate research carried out by CMFRI.

It is of glad to announce that the NICRA team advances well with significant research outputs



along with technology demonstration and resilient strategy development.

Owing to the project outcome, it could be asserted that, goal of climatic resilience in fisheries sector could be attained in a faster phase.

I wish upcoming volumes also shall bring out further key research findings related to climate change in marine fisheries sector.

Research Highlights

Capture Fisheries

Carbon Foot Print of Marine Fisheries Activities at Andhra Pradesh Fishing Harbours

Dr.Shubhadeep Ghosh and Dr. Muktha Menon

Vishakapattanam Regional Centre

Contribution of marine fisheries at all stages of its life cycle, to climate change was studied by determining their carbon footprint at four major fishing harbours/ fish landing centres in Andhra Pradesh viz., Visakhapatnam, Kakinada, Nizamapatnam and Machilipatnam.

Functional unit was 1 kg of marine fish to the consumer. Fuel and electricity consumption per kg of marine fish was on an average 0.43 l and 0.24 kWh at Visakhapatnam, 0.41 l and 0.15 kWh at Kakinada, 0.52 l and 0.26 kWh at Nizamapatnam and 0.48 l and 0.21 kWh at Machilipatnam.

The harvest phase (88-93%) burnt the most fuel, while the post-harvest phase (51-62%) contributed the most to the electricity consumption.

Emission intensity per kg of marine fish was 0.34 kg C and 1.26 kg CO_2 in Visakhapatnam, 0.31 kg C and 1.16 kg CO_2 in Kakinada, 0.41 kg C and 1.50 kg CO_2 at Nizamapatnam and 0.37 kg C and 1.37 kg CO_2 at Machilipatnam.

Assessment of Hydrological Parameters at Tuticorin

—Dr. Asha P.S, Tuticorin Research Centre

Qualitative studies were carried on depth-wise as well as seasonal variations of surface and bottom water-hydrological parameters like temperature, pH, salinity, density, dissolved Oxygen, turbidity, chlorophyll, nutrients (nitrite, nitrate, phosphate and silicate) and transparency at different depths off Tuticorin.

The depth-wise variation in the biomass and density of zooplankton constituents from the surface waters of varying depth off Tuticorin were also estimated..

Scientist's/Investigator's Desk

Dr. Dineshbabu, Principal Scientist, CMFRI, Mangalore Research Centre

Distributional shift of marine species to climate change

Climate change related distributional shift of the marine resources is one among the major factor that influence the livelihood of fishermen as well as the economy of nation's fisheries sector.

In a recently published study, researchers from USA and Canada found climate change as responsible for the distributional shifts in 70 to 75% of the 360 species or species group studied.

Availability of the database on historical spatial distribution of the species are of essential to undertake such research analysis.

Through the NICRA project, CMFRI is strengthening the database on spatial distribution pattern of important marine fish species of Indian coastal waters.

Under NICRA project, we are assessing the adaptability and vulnerability of important species representing north-west, south-west, south-east and north-east coastal zones of India for the climate change preparedness.

Research Highlights

Mariculture

Dr.A.K.Abdul Nazar, Dr.R. Jayakumar, Dr.G.Tamilmani, Dr.M.Sakthivel, Dr.P.Rameshkumar, Dr.B.Johnson

Mandapam Regional Centre

Effect of temperature on growth of silver pompano (*Trachinotus blochii*) fingerlings, associated bacterial populations and histological alterations in their organs

• Effect of temperature (ambient (30°C, 31°C and 32°C) on silver pompano fingerlings growth was studied.

• Standard increase in body weight of fingerlings was observed in ambient temperature (29°C), whereas the growth performance was good at 30°C.

At 32°C, pompano fingerlings

Normal growth of pompano fingerlings at 30°C

showed musculo-skeletal abnormalities.

• Associated bacterial populations of pompano during the exposure to variable temperatures were studied.

Pseudomonas aeruginosa was the predominant beneficial bacterial population associated with the slimy mucus layer in fish kept at ambient, 30°C and 31°C.

However, the fishes kept at 32°C showed dominant bacterial populations like *Pseudomonas chengduensis.*

Bacterial population changed significantly with an increase in temperature.

At 32°C pompano fingerlings showed musculo-skeletal abnormalities

• Fishes reared in 31° and 32°C showed moderate cellular reaction in different organs.

Kidney showed acute tubular necrosis compared to the fishes reared in ambient temperature (29°C).

The less specialized renal epithelium was changed to more specialized epithelium.

Liver showed bile duct hyperplasia and fatty changes compared to fishes reared in the ambient temperature (29°C).

Gill revealed secondary lamellar fusion and cellular reaction.

Carbon sequestration potential of seaweed (*Kappaphycus alvarezii*) in Ramanathapuram coast

• Experiment was initiated to investigate the carbon sequestration potential of seaweed (*Kappaphycus alvarezii*).

• Experiment involved culture of seaweed in bamboo rafts. In each of the rafts, 3 pre-weighed bunches of seaweed were tagged and periodically weighed. Further sub-samples from each bunch are being collected, dried and preserved until further analysis for measuring C, H, and N elemental composition of the seaweed.

• The specific growth rate of the seaweed multiplied with % composition of carbon (C) and 3.666 (mass of CO_2/ mass of C) gives an estimate of specific rate of sequestration (per unit mass of seaweed per unit time) of carbon dioxide by seaweed.

Seaweed Rafts

Shift in the spawning season of Cobia?

Cobia (*Rachycentron canadum*) normally spawns between March to October and the months of November to February are considered as off-season.

However in the past two years it was observed at CMFRI Mandapam Research Centre that more number of mature females occured during November - February in broodstock cages.

Those females were successfully induced to spawn and seeds produced.

Whether this phenomenon indicates a shift in the spawning season of Cobia? or is it an adaptation to captivity?

Research Highlights

Criteria developed for long term vulnerability assessment of Indian marine fishes

Scientific criteria on exposure, sensitivity and adaptive capacity of Indian species in relation to climate change were developed to enable the vulnerability assessment of fish stock and for long term prediction of fisheries change along Indian coast using 40 year's data on fishery biology and environmental parameters.

So far there were no criteria available which can be reasonably attributed to Indian species.

Impact levels were classified as low, medium and high and assessment could be done independently for four zones (NE, NW, SE and SW) along Indian coast.

Shrinking Seagrass Ecosystems

Dr. P. Kaladharan, Cochin

⇒Regular monitoring on biomass and density of seagrass vegetation in the reef and lagoons of Agatti (10° 52' N & 72° 11' E), Chetlat (11° 42' N & 72° 42' E), Kavaratti (10° 34' N & 72° 39' E) and Kiltan (11° 29' N & 72° 50' E) Islands of U.T. Lakshadweep since December 2011 indicated gradual but steady shrinking of seagrass meadows.

⇒The percentage reduction in seagrass meadows since December 2011 to August 2014 was estimated to 61% in Agatti, 77% in Chetlat, 35% in Kavaratti and 70% in Kiltan.

⇒Decline of seagrass meadows in the Laccadive atoll systems would affect the distribution of tune live baits, shellfishes, turtles and marine mammals as seagrass meadows are their habitat and feeding as well as breeding grounds.

Carbon Stock Assessment in Mangrove Sediments

Dr. K. Vinod, Calicut Research Centre

Field surveys for assessing the plant density and species diversity of different mangrove species in Kadalundi estuary were carried out.

Five species of mangroves were recorded during the surveys: *Avicennia officinalis*, *Rhizophora mucronata*, *Acanthus ilicifolius*, *Sonneratia caseolaris* and *Bruguiera cylindrical*.

Species *A. officinalis* dominates covering more than 90 % of total mangrove area.

Plant height and girth of stem of different species were measured and classified as adults, saplings and seedlings based on size.

Estimation of the organic carbon in sediments of different mangrove patches for various depths were done. Organic C % varied from 0.84 to 5.46.

Species	Dominance	Remarks
Avicennia officinalis	******	Large area, forming dense forests
Rhizophora mucronata	**	Forms small patches in some places
Acanthus ilicifolius	**	Found fringing in many areas
Sonneratia caseolaris	**	Only one small patch on the western side of the estuary
Bruguiera cylindrica	*	Very few in number

Diversity of mangroves in Kadalundi estuary

Dense growth of Avicennia officinalis

Sediment sampling

Research Highlights

Technology Demonstration

Integrated Multi Tropic Aquaculture (IMTA): Successful harvest of the seaweed *Kappaphycus alvarezii* and cage farmed cobia

Mandapam Regional Centre

♦ The second demonstration of Integrated Multi Trophic Aquaculture (IMTA) under NICRA by integrating the seaweed *Kappaphycus alvarezii* with cage farming of cobia was carried out at Munaikadu (Palk bay) in a participatory mode with fishermen self help group from May 2015.

♦ Two successive seaweed harvests on 17th September 2015 and 5th November 2015 respectively were made.

♦ In two harvests of seaweed, an addition of 110 to 140 kg of seaweed per raft was achieved due to the integration with cobia cage farming.

♦ It was found that a fragment of 200 g of seed material had grown to 650 g in 45 days from the seaweed rafts integrated with cobia cages, whereas it has grown only 350 g from the rafts which were not integrated.

♦ Moreover there was more numbers (average 88 nos.) of newly emerged apical portion/tips in a bunch of harvested seaweed from the rafts integrated with cobia cages, whereas the same was less (average 33 nos) from the rafts which were not integrated.

View of portion of harvested seaweed Kappaphycus alvarezii

Scientists and farmers holding the harvested rope of seaweed from rafts which was integrated and not integrated with cobia cage

More numbers of newly emerged apical portion/tips from a bunch of harvested seaweed

♦ The fishermen group expressed that bunches having more numbers of newly emerged apical portion/tips when used for replanting the crop will be ready for harvest within 40 days, whereas if the seaweed with less numbers of newly emerged apical portion/tips is used, the crop will be ready for harvest by 55 days.

♦ The harvest of cage farmed cobia which was stocked on 10th May 2015 was carried out on 27th November and 6th December 2015.

♦ A total of 1,792 kg of cobia was harvested.

The length ranged from 52 to 72 cm and weight ranged from 1.4 to 3.5 kg.

The farm gate price of cobia realized was Rs.270 per kg.

♦ The fishermen group expressed their sincere thanks to Mandapam Regional Centre of CMFRI for getting good harvest of seaweed and cobia.

Handing over the harvested cobia

Research Highlights

Researcher's Desk

Sonia Kumari, Research Associate, NICRA, CMFRI, Veraval

Climate change may lead to Zoanthid outgrowth over their cousins, the Corals

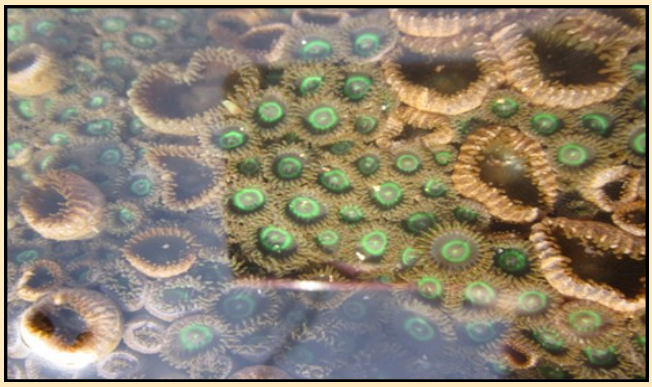
Research under NICRA project carried out at CMFRI indicates high adaptive capacity of some Zoanthid sp. to changes in environment.

Coral reef ecosystem support great diversity of marine organisms, of which Zoanthids forms an integral part.

Zoanthids are dominant among the observed fauna in the degrading reef ecosystems and some of these species are sources of highly potent biotoxin known as 'Palytoxin'.

The distribution pattern of Zoanthid species along three coastal villages of Saurashtra coast, Gujarat werer studied against environmental parameters.

Out of total seven species of Zoanthids recorded during the survey. *Palythoa mutuki* formed the abundant species in the area with 46% coverage, followed by *Zoanthus sansibaricus* with 33.7% and *Zoanthus cf.sansibaricus* with 12.26% coverage.



Zoanthis sansibaricus (green in colour) with Intermittent growth of Palythoa mutki (brown)

Palythoa tuberculosa at the intertidal region of Veraval coast, Gujarat

Among abiotic parameters and nutrient data, higher levels of DO was found to be favoring the growth of *Palythoa mutuki* and *Isaurus tuberculatus*, whereas increased SST was tolerated by *Palythoa tuberculosa.*

Ammonia and phosphate were negatively impacting the growth of *Palythoa mutuki* and *Zoanthus* sp.

The study provides first of its kind information on quantitative Zoanthid distribution and the dynamic changes exhibited by Zoanthids in relation to various environmental parameters.

The above results in the context of changing climate indicate that the community structure of Zoanthids might be dominated by species, which can withstand high SST and high nutrients levels.

Study further reaffirms the adaptive capacity of Zoanthids to environmental changes, which similar species such as corals are lacking.

Published in Journal of the Marine Biological Association of the United Kingdom, December 2015.

NICRA Research vessel F.V.Silver Pompano completed 100 cruises

F.V. Silver Pompano, the 19.75 m OAL Research Vessel procured under the NICRA project in July 2013 completed 100 cruises as on March 2016.

Vessel was regularly conducting cruises off Cochin to assess and measure in-situ environmental parameters, primary and secondary productivity, plastic pollution, current direction and pattern along with trawl fishing operations.

Apart from these, special cruises were made to study karikkadi fishery along Quilon, mud-bank studies off Alleppy and oceanic squid survey off Lakshadweep. The cruises helped to gain significant research inputs for the NICRA project.

Resilient Strategies

- Dr. G. Rojith and Dr. P.U. Zacharia

Wetland Restoration and Scientific Fish Farming for Enhancing Regional Climate Resilience of Indian Fisheries

Several wetlands of the nation are in degraded state mainly due to aquatic weed infestation and its restoration along with incorporation of scientific fish farming at village level was identified as a prospective climatic resilient strategy.

Degraded 12 acre regional wetland

Geospatial techniques could be employed for mapping village level wetlands of size below 2 ha, which could enhance the focus on regional resilience along with better eco management and monitoring.

Geospatial analysis provides qualitative assessment whereas implementing fish farming could provide quantitative assessment of wetland leading to a comprehensive approach.

During eco-restoration, 'Aquatic weed harvester' equipment is proposed to be advantageous over tedious manual weed removal approach.

Aquatic Weed Harvestor

Harvested aquatic weeds could be converted into climate resilient products such as biochar or as value added products.

Biochar from Aquatic biomass

Bag from Aquatic weed

Climate resilient fish species identified through NICRA project could be farmed along with native species. Vulnerable community groups as well as traditional dependent local groups could be the project beneficiaries. Fisheries related scientific bodies could provide implementation assistance for suitable aquaculture techniques.

Silver pompano Trachinotus blochii, Photo: CMFRI, Mandapam.

Pearl Spot Etroplus suratensis; Photo by Rojith

Cage culture technology demonstrated by KVK, Ernakulam

Wise use of wetlands could ensure food and nutrition security at village levels, and the surplus production could be offered to global supply chain.

The concept model thus includes regional level wetland resource mapping and restoration, climate resilient product development, farming of climate resilient fish species, improved capture fisheries along with technical assistance of scientific bodies.

The effective implementation could contribute towards climate resilient coastal villages.

Seaweed farming along Indian coastal waters

Seaweed farming was identified as a prospective climate resilient strategy with multiple advantages of Carbon sequestration, coastal pollution abatement, coastal livelihood supplementation, co-farming of mussels, oysters and fishes, feedstock for fish feed and marine product development.

Multivendor E-Commerce solutions for Indian Fishermen Communities

Though E Commerce solutions for fish products are available, gap still exists to develop multivendor platform for directly engaging various self help groups of fishermen communities as multiple vendors.

NICRA project team is ambitiously working out on the concept to develop such a system for fishermen community livelihood improvement and empowerment.

Technology Demonstration

Socio-economic technological perception on cage farming by fishermen / entrepreneurs / SHGs

Mandapam Regional Centre

♦ Data collection tool was developed to study the socio-economic technological perception on cage farming.

Data was collected from 16 fishermen groups in Ramanathapuram district of Tamil Nadu.

♦ Information about the technology has spread to different parts of the country.

Awareness about the technology was created among aqua farmers/entrepreneurs and the officials of Central and State Government through mass media (TV, videos, magazines, Journals, news stories, newspaper, internet etc.), group contacts (meetings, lectures, demonstrations, workshop, seminar and trainings) and individual contacts (farmer to farmer approach).

Several hands-on training programmes were also conducted on hatchery and farming techniques in order to develop technical man power and to disseminate the technology.

♦ The important attributes which attracted the fishermen groups to take up the farming were fast growth rate of cobia, shorter culture period, good farm gate price, high market demand, farming near the seashore, easy farming methods and better economic returns and technical guidance from CMFRI.

♦ The fishermen group expressed that the farming is ideal in Gulf of Mannar and Palk Bay region during November - April and May - October respectively.

♦ Fishermen group also strongly agreed that sea cage farming can increase the marine fish production and can supplement capture fisheries and provide additional income to the households.

It could serve as a fish aggregating device and integrating the seaweed with cage farming of cobia will serve as bio-mitigation along with the increased biomass production.

♦ Almost all respondents stated that the non-availability of seed and high cost of feed as the major constraints.

DDG visited NICRATech demo fields

Dr. A. K. Singh, Deputy Director General (Agricultural Extension), ICAR, New Delhi visited the ICAR– KVK (Ernakulam), CMFRI, Njarakkal on 12th August 2015 and further extended his visit to KVK-CMFRI NICRA project farmer's field at Kadamakkudy and Pizhala.

DDG expressed hope of Cage farming of fin fish in open brackish water for the livelihood and nutritional security of the poor island community.

DDG at Pizhala pokkali field with farmers and KVK members

Technology Demonstration

Training Programs

Karwar Research Centre

♦ Karwar research centre organized a hands-on training programme on Open sea cage farming of marine fishfish and shell fish during 1-7 December, 2015 for Kerala State Govt. officials.

Participants were given a hands-on training on cage fabrication, mooring, net exchange and all the protocols to be followed for cage culture management.

♦ Initiated a brackishwater cage culture demonstration programme on 19th of December, 2015 at Halga, Karwar.

A battery type cage with 6 number of cages (4x3x2m) were stocked with 1000 number of Asian seabass per cage.

Regular monitoring of all the parameters are being carried out and also extended all the technical services to the fishermen group of Halga.

NABARD to sponsor Pokkali Farmer Producer Company

Dr.Shinoj Subramannian and Dr. Vikas P.A

KVK, Ernakulam

♦ Introduced Asian Seabass (*Lates calcarifer*) in three fileds-Kadamakkudy, Nayarambalam and Pizhala in small floating cage along with Paddy. Fishes reached an average size of 300±50 gm after 4 months of culture.

♦ NABARD sanctioned Pokkali Farmer Producer Company (FPC) as an outcome of the NICRA technology demonstration.

FPC aims to develop a premium marketing avenue for Pokkali produce through supermarkets.

MoU was signed between CMFRI and NABARD for initiating the programe.

Orientations & Publications

Overseas Training: Climate Change Adaptation in Agriculture and Natural Resource Management

Uganda—25th January—5th February 2016

NICRA Research Associate at Veraval regional centre, Smt. Sonia Kumari was selected and participated in an overseas training held at Uganda in East Africa.

Concepts of vulnerability and adaptation strategies with multidisciplinary approach were conceived by visits to local fields, agriculture farms in Rakai district of Uganda.

The problems faced by agriculture farmers, their resources, indigenous knowledge and coping strategies were understood.

Various vulnerability tools like VCA, CMDREE, CVCA and PRA were taught for community level risk assessment.

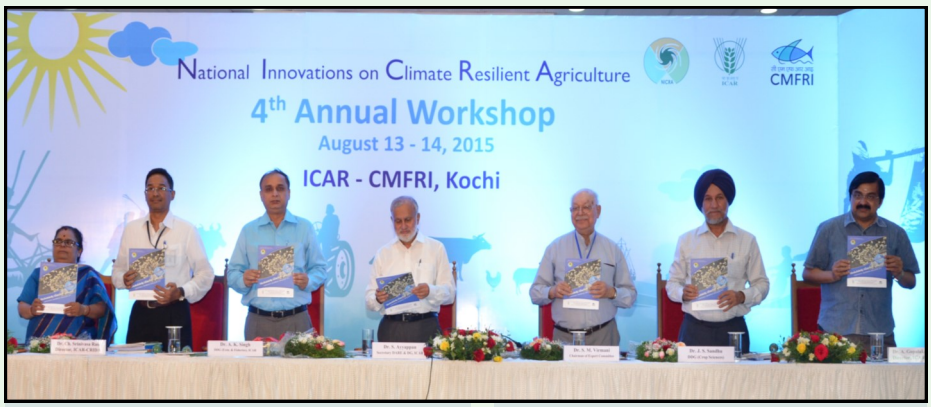
Exposure regarding policy & project formulation, funding mechanism and RUFORUM was also obtained.

NICRA Recent Publications

DG, ICAR Released KVK NICRA Book

Director General, ICAR released a hand book '***Samrambhakthwa Parisheelana Paripadi***' during NICRA review meeting on 13th August 2015.

Book was prepared as part of Entrepreunership Development Programme (EDP) On "Climate Resilient Aquaculture".



The training was organized for attracting youth and initiating Aqua-enterprises as profession.

Financial support for training programme conduct was provided through NICRA project.

- Shinoj Subramannian, P.A Vikas, F Pushparaj Anjelo Ed., 2015, **Samrambakathwa Vikasana Paripadi**. NICRA – 2015. CMFRI-NICRA Publication series 4. CMFRI, Kochi, 97 page.
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- G. Rojith and P.U. Zacharia., 2016, **Enhancing Regional Climate Resilience of Indian Fisheries Through Wetland Restoration and Scientific Fish Farming**. *International Journal of Tropical Agriculture*, Vol.33, No.4, October – December 2015, 3439-3445.
- V. Supraba , P. Dineshbabu, Sujitha Thomas, Prathibha Rohit, K. M. Rajesh and P. U. Zacharia., 2016, **Shift in diet composition of Indian mackerel *Rastrelliger kanagurta* - An analysis in relation to climate change**. Indian Journal of Fisheries., 63(2) : 42-46.

NICRA Events

NICRA 4th Annual National Workshop at ICAR-CMFRI, Kochi

Fourth Annual National Workshop of NICRA project was held at CMFRI headquarters, Kochi during August 13th –14th, 2015. Event was inaugurated by Dr. S.Ayyappan, DG, ICAR and several other prominent dignitaries were present on the occasion. Besides inaugural and plenary, 8 technical sessions were conducted.

Dr S Ayyappan, Secretary DARE & DG, ICAR

Dr. A. Gopalakrishnan, Director, CMFRI, Kochi Headquarters

Dr.P.U. Zacharia, Principal Investigator, NICRA, CMFRI, Kochi Headquarters

The workshop was attended by around 200 scientists from various partner institutes and the research progress was reviewed along with finalization of work plan for 2015-16.

ICAR scientific community

Review of Progress

Cultural Program

Event was highly fruitful with multiple sessions on Resilience, Technology Demonstration, Vulnerability assessment, Impact assessment, Adaptation and Mitigation Strategies, Modeling framework, Consolidated progress and implementation issues, etc in the context of climate change.

Dr. Srinivasa Rao, Director, CRIDA

Poster Presentations

Dr.M. Maheswari, Principal Investigator, NICRA Project, CRIDA

Awards & Recognitions

Best Performing NICRA Institution Award

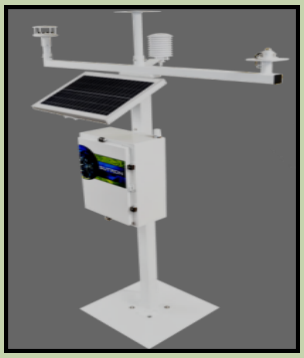
Dr.P.U.Zacharia, Principal Investigator of NICRA project & Principal Scientist, Demersal Fisheries Division, CMFRI receiving award for Best Performing NICRA Institution from Dr. S. Ayyappan, Secretary DARE & DG, ICAR at NICRA 4th Annual Workshop held during August 2015.

Best Poster Award: NICRA Tech Demo

NICRA Technology Demonstration paper entitled '*Sustainable intensification of food production from Pokkali farming system through Cage farming*' by Vikas P.A, Shinoj Subramannian, John Bose and P.U. Zacharia received best poster award from Dr. J.K. Jena, Chairman, AFSIB and Dr. A. Gopalakrishnan, Director, CMFRI at the 5th International Symposium on Cage Aquaculture in Asia (CAA5) during 25th to 28th November 2015.

NICRA Image Gallery

NICRA Procurement: 2015-16



Automatic Weather Station

Current Meter

Auto Analyser

NICRA Vulnerability Workshop at Mangalore

Way forward....

- Marine Climate Card Series
- Catch forecast
- Species vulnerability
- Coastal vulnerability & preparedness
- Mariculture for alternate livelihood
- Carbon footprint and protocols for green fishing
- Adaptation framework

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