ISCA Webinar

BOOK OF ABSTRACTS

International Symposium on Coastal Agriculture: Transforming Coastal Zone for Sustainable Food and Income Security

16th - 19th March 2021

Organized by

Indian Society of Coastal Agricultural Research (ISCAR)
Canning Town, West Bengal, India

Collaboration with

ICAR-Central Soil Salinity Research Institute, Karnal, Haryana, India

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The society would also like to put on record the painstaking efforts taken by the staff of ICAR- Central Soil Salinity Research Institute, Karnal, Haryana, India and its Regional Research Station, Canning Town, West Bengal, India in organizing the event successfully.

Organizers

Contents

SPECIAL LECTURES

3rd Dr. J. S. P. Yadav Memorial Lecture

IMPACT OF CLIMATE CHANGE ON COASTAL AND ISLAND ECOSYSTEMS

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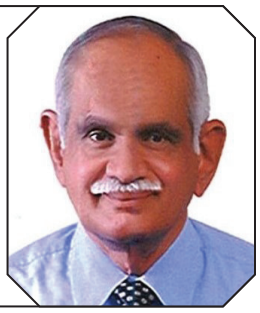

Prof. Anil Kumar Singh (b 1952), an Alumnus of the prestigious Indian Agricultural Research Institute, New Delhi, conducted his Post-Doctoral Research as DAAD Fellow at the University of Hohenheim, Stuttgart, Germany (1982-83), obtained a Diploma on 'On Farm Water Management' (1992) from University of Arizona, Tucson, USA, and worked as a Project Scientist at the International Rice Research Institute, Philippines (1993-95). He started his career as Scientist S-1 through the ARS examination held in 1976, served as Project Director, Water Technology Centre, IARI, New Delhi, 1999-2007; Acting Director IARl, New Delhi, 2005-06; DDG (NRM), ICAR, New Delhi, 2007-12; and as Vice Chancellor, RVS Agricultural University, Gwalior, 2012-17.

He has carried out outstanding basic, strategic and adaptive research in the field of Natural Resources Management with specific focus on soil-water-plant-atmospheric interactions, increasing crop production and water & nutrient use efficiency through soil and water management; crop growth simulation modeling; monitoring of hydrological parameters in watersheds; developing decision-support systems based on field studies on various aspects of water management; and integrated nutrient management studies including role of soil organic matter in sustainable crop production. He has made significant contributions in the use of Remote Sensing techniques in agriculture starting with the identification of Spectral Bands for use in IRS Satellite to monitor water stress conditions in crops. The first systematic studies on aerobic rice production system in the country were conducted under his guidance. As DDG(NRM), he was instrumental in the formulation of the District-wise Contingency Plans for tackling Extreme Weather Events which have instilled drought proofing in the country's agricultural production system. He also initiated the Mega Project of ICAR - National Initiative on Climate Resilient Agriculture (NICRA) during that period. As Vice Chancellor of the newly established Agricultural University at Gwalior, he created State of Art Infrastructure at the HQs of University, Colleges and KVKs, added new disciplines and initiated e-governance.

Prof. Singh has received several awards and fellowships in recognition of his professional contributions, including Honorary Membership of the Indian Society of Soil Science (2011); BhuRatna by the Soil Conservation Society of India (2012), ISCA Platinum Jubilee Lecture 2009; Dr. C. Subramanium Outstanding Teacher Award 2007-08 by ICAR; X Shri Hari Krishna Shastri Memorial Award – 2009 by IARI; Prof. S. K. Mukherjee Commemoration Award 2010 by ISCA; Fakhruddin Ali Ahmed Award 2016 by ICAR and several other prestigious awards & invited memorial lectures. Currently, he is the Vice President of the National Academy of Agricultural Sciences, New Delhi.

Prof. Singh has more than 400 publications in the form of research papers, books/bulletins, seminar/symposia proceedings, popular articles, manuals, policy papers and technical reports on various aspects of soil-water-nutrient-plant relationships, remote sensing applications and use of modern tools in water management.

Abstract: Global warming is impacting day to day existence of the human race in several direct and indirect ways some of which are felt immediately while others in medium and long term. Most of the time, the global warming is talked about in terms of GHG emissions resulting in temperature rise, changes in rainfall pattern and intensity, as well as increase in extreme weather events like droughts, floods, cyclones and the like. According to the Global Climate Risk Index (CRI) 2021, India was the seventh most adversely impacted nation globally by climate change in 2019. However, CRI does not consider Sea Level Rise (SLR) as it is a slowly occurring phenomenon but its impact on the coastal ecosystems will be huge as world over the coastal regions are more densely populated than the main lands. According to UNEP, India is one of the 27 countries that will suffer most due to SLR. Island ecosystems particularly small islands, are going to be severely affected and may result disappearance of many. Sea level rise is caused by thermal expansion of water, melting of glaciers, ice sheets melting and land water storage changes. Historically, glacial melt and thermal expansion were considered as the major drivers for SLR but now the contributions from melting of ice sheets and changes in land water storage have increased. One recent publication has added another factor "marine ice-cliff instability" (MICI) related to glaciers contributing to SLR. The impact on SLR is highly variable with some countries being more adversely impacted like Australia, compared to others like parts of US and West Coast of Mexico. It has been reported that the global SLR was between 21-24 cm since 1980 but one third of that increase occurred in the last two and a half decades. SLR was around 1.4 mm year^{-1} during the twentieth century but increased to 3.6 mm year^{-1} during the period 2006-2015. In some ocean basins, SLR has been recorded between 15-20 cm since the start of satellite record in 1993. Initial estimates had pegged SLR to be about 30 cm by 2100 compared to 2000, but recent studies have indicated a rise will be of a much higher magnitude than the model predictions and may exceed even 1 metre.

India has a coastline which is more than 7500 km which includes the Andaman and Nicobar Islands and Lakshadweep islands. SLR will inundate more than 57000 km^2 area directly affecting nearly 7.1 million coastal population. India has the second largest population (63 million) in the world located in the Low Elevation Coastal Zone spread over 82,000 km^2. The impact will not only be felt by millions inhabiting the coastal areas and small-island communities but also croplands, biodiversity, salinization of fresh water bodies, ground water quality and many other ecosystems like salt marshes seagrass beds, rocky shores, kelp forests coral & oyster reefs in addition to mangrove forests. Earlier estimates were that by 2050, 5 million of the Indian population would be affected annually by coastal flooding out of a globally affected population of 79 million but revised estimates have pegged this figure for the Indian population at 36 million out of a total of 300 million. There is a wide variability on the SLR trends across India e.g., it was more than 4 mm year^{-1} at Diamond Harbour near Kolkata between 1948 to 2013 but slightly over 1 mm only during the same period at Vishakapatnam. With 520 cyclones between 1891 and 2018, the east coast has been more vulnerable than the west coast with 126. It is the infrastructure of ports that gets damaged due to these events.

As an illustration of the impact of climate change, one can examine the case of Sundarbans, which are the largest contiguous mangrove ecosystem in the world spread over 9630 km^2. Climate change is expected to result in shrinkage of wetland areas and the decaying organic matter will become a source of carbon. Satellite imagery research has indicated that 1 m SLR will inundate about 1000 km^2 in that region. Four islands in that region have already disappeared in the last 2 decades. Coastal flooding and shoreline disintegration can be reduced by mangroves and coral reefs. A study across 52 sites found that natural habitats were 2-5 times more effective than engineering structures. In this paper, in addition to the current status, results will be presented highlighting the management strategies available to minimize the adverse impacts through conventional, innovative and ecosystem-based adaptation options as they only can serve as effective measures for protection and hold the key to sustainable integrated coastal management and its development.

Plenum Lecture 1

HOW CAN eHALOPH, A DATABASE OF SALT-TOLERANT PLANTS; HELP YOUR RESEARCH?

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Professor Timothy John Flowers graduated from King's College London in 1964 and completed his PhD at the University of Nottingham before undertaking postdoctoral research at the University of Illinois. He returned to the University Sussex in the UK in 1968, where he began research on the cellular basis of salt tolerance in halophytes, a topic that has interested him throughout his career. Along with Dr Tony Yeo he conducted extensive research into the salt tolerance of the halophyte Suaeda maritima and then, with support from the UK government, on rice. The work on rice led to collaborations in Pakistan and CSSRI in India. After completion of a term as the Dean of the School of Biological Sciences he again took up his interest in halophytes, working on development and revision of the database eHALOPH. Tim is the co-author of two books, co-editor of three other books; author or co-author of 42 reviews, editor of six special issues of journals and author or co-author of 190 peer-reviewed papers.

Abstract: A list of halophytes, plants able to grow in the presence of dissolved salts, was constructed "for anyone growing or planning to grow halophytes" and published in 1989 by James Aronson. This list, based on plants being able to grow in approximately 80 mM NaCl, included important traits such as plant type, life form, maximum salinity tolerated, photosynthetic pathway and economic uses. The, database, while an amazing resource, was limited in its value as a printed list and so was converted to a searchable database, now available as eHALOPH (http://www.sussex.ac.uk/affiliates/halophytes/). The original dataset has been supplemented with information on antioxidants, secondary metabolites, compatible solutes and habitat, and whether or not there have been publications on ecotypes, germination, the presence or absence of salt glands, molecular data, microbial interactions and mycorrhizal status. Over the last five years the original data has been checked against information in the Web of Science and additional species added from the list of Menzel and Lieth. The database eHALOPH can be used in the analysis of traits associated with tolerance and for informing choice of species that might be used for saline agriculture, bioremediation or ecological restoration and rehabilitation of degraded wetlands or other areas.

References:

Aronson, J. A. (1989). Salt-tolerant plants of the world. Tucson: University of Arizona.

Menzel, U. and Lieth, H. (2003). HALOPHYTE Database Vers. 2.0 update. In: Lieth, H., Mochtchenko, M., eds. Cash Crop Halophytes. Dordrecht: Kluwer.

Santos, J., Al-Azzawi, M., Aronson. J. and Flowers, T.J. (2016). eHALOPH a database of salt-tolerant plants: helping put halophytes to work. *Plant & Cell Physiology*, **57**: e10.

Plenum Lecture 2

THE FUTURE OF FISH AGRI-FOOD SYSTEMS

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Dr. Michael Phillips is Director of the CGIAR Research Program on Fish Agri-Food Systems. Recognized as a global leader in aquaculture and agri-food system research, Michael joined WorldFish in 2008 where he has since developed a wide portfolio of research on aquaculture and fisheries. Previously, he served as Program Manager at the Network of Aquaculture Centers in Asia-Pacific (NACA) where he managed the organizations' aquaculture research and development programs. Michael holds a Ph.D. in Aquaculture and Fish Behavior from the University of Stirling and a B.S. in Biological Sciences from University of Lancaster. In his current role, he leads the CGIAR's global program on fish agri-food system, that aims to enhance the sustainability, productivity and resilience of fish agri-food systems globally, to reduce poverty, enhance food and nutrition security, and improve natural resource systems.

Abstract: A fish agri-food system is an interconnected and interdependent system involving components of fish production, through to processing, marketing and consumption. The CGIAR Research Program on Fish Agri-Food Systems (FISH), a five-year program from 2017-2021, has the objective of enhancing the sustainability, productivity and resilience of fish agri-food systems with an overall goal of reducing poverty, enhancing food and nutrition security, and improving natural resource systems. The presentation will present new findings from the research program and highlight some key challenges and opportunities for fisheries and aquaculture to positively contribute to global development goals, with reference to specific examples from Africa, Asia and the Pacific.

Plenum Lecture 3

IMPROVING FOOD AND LIVELIHOOD SECURITY OF COASTAL COMMUNITIES THROUGH FISHERIES AND AQUACULTURE

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Dr Vijay Gupta Modadugu has been involved in fisheries research, development and management for over 50 years through implementation of programs in over 20 countries in Asia, Pacific and Africa. Focus of his work has been on improving livelihoods of rural farmers and landless in developing countries through low-cost, sustainable aquaculture practices he has developed, that has benefitted hundreds of thousands of farmers. His special focus has been on empowering rural women through involvement in aquaculture. As Research Coordinator of International Network on Genetics in Aquaculture, he has been responsible for initiation of germplasm improvement programs in 12 countries that has resulted in fast growing strains of fish that are contributing to increased production. In recognition of his contribution to food and nutritional security in developing countries, he has been bestowed with many awards and prizes, most prominent among them being the World Food Prize considered as Nobel Prize in Food and Agriculture and Sunhak Peace Prize, considered as alternative to Nobel Peace Prize. He has been consultant/advisor to a number of international organisations.

Abstract: The unique coastal ecosystem provides immense opportunities for food and livelihood security, economic development and environmental protection. At the same time, there are a number of challenges to be addressed to optimize sustainable benefits from the system and improve the livelihoods of millions who depend on these resources. Fish productions from the coastal ecosystem (fresh, brackish and marine) have been contributing albeit at a low level due to a number of constraints that needs to be addressed. These include natural disasters, destruction/over exploitation of some of the natural resources, lack of knowledge/technologies/information on farming systems suitable to the coastal ecosystem, insufficient/inefficient extension system for conveying technological information to the farming/fishing communities, market access and marketing, lack of real time need based information and in some cases lack of appropriate policies, etc. While in recent years some progress has been made in addressing the above issues, there is urgent need to look from the perspective of not only increasing production, but also looking at the need for improving the livelihoods of poor coastal population who depend on these resources without any alternate source of income and food. The presentation will provide details as to how these constraints/challenges are being addressed or need to be addressed.

Plenum Lecture 4

AGRICULTURAL SYSTEMS TRANSFORMATION FOR FOOD AND INCOME SECURITY IN COASTAL ZONES

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Dr. Abdelbagi M. Ismail: Principal Scientist with over 30 years of research for development, focusing on crop improvement to enhance adaptation to unfavorable environments and to increase resilience to climate change, especially for areas affected by floods, drought, salt stress, nutrient deficiencies and toxicities. Contributed to advancing understanding of mechanisms associated with tolerance of several abiotic stresses in crops, and also to the development and deployment of stress-tolerant rice varieties and proper system-based crop and resource management packages; with notable impacts in Asia and Sub-Saharan Africa. Led several regional programs and projects on breeding and delivery of high-yielding, climate smart varieties and technologies, through building and coordinating large networks of research and development partners. Served in several leadership roles including Deputy Director General for Research (Interim) and Head, Genetics and Biotechnology Division. Currently assuming the role of Regional Representative of IRRI in Africa. Holds a PhD in Botany, University of California, Riverside. Authored/co-authored over 265 peer reviewed articles, chapters and books. Recipient of several merit and leadership awards and member of several editorial boards and science societies; Fellow (Foreign), National Academy of Agricultural Sciences, India.

Abstract: Coastal zones are extremely dynamic and fragile, with wide variation in soils, water and land uses, and with significant long-term and seasonal changes. Natural disturbances are common in these areas and are further aggravated by climate change adversities; making them highly unstable. Livelihood sources in coastal tropical zones are quite diverse and are dominated by agriculture and aquaculture activities. Competition among resource users usually leads to environmental and social challenges, mostly needing to be addressed at regional levels. Most coastal areas are inhabited by dense populations with prevalence of poverty and food insecurity, attributed to low and unstable agriculture productivity caused by several factors, including persistence of salinity during the dry season and floods in the wet season, together with acidity, high organic matter, and nutritional toxicities or deficiencies throughout the year. Excessive rainfall during the monsoon season causes long-term partial floods or even complete submergence, making rice farming the preferred agricultural activity. Despite these challenges, coastal areas hold considerable potential for food production in the tropics, yet they remain mostly underused. Major investments in infrastructure to control floods and salt intrusion demonstrated impacts on livelihoods in some areas, but this entails proper planning and policies for monitoring and adjustments, and large capital investments not within reach of smallholder farmers. Our understanding of the challenges and opportunities in these areas is evolving, and numerous relevant technologies are becoming available to exploit their potential for food security and for other livelihood options. Noticeable progress was made in developing short maturing, high yielding rice varieties that can tolerate salinity and floods or both, and are showing remarkable impacts. These varieties provided opportunities for designing better management strategies and presented assurance for farmers to invest in inputs and

good crop husbandry, besides options for improving cropping intensity and diversity to enhance their nutritional outcomes and household income. More efforts, however, are needed to fully exploit the potential of these areas for future food and nutrition security through large-scale adoption of validated technologies, human and infrastructure development and access to input and output markets, together with concomitant access to information via digital tools. Improving and sustaining productivity of rice-based agri-food systems in these areas, while assuring quality through proper harvest and postharvest processing and handling and value addition will significantly improve the food security and livelihood of smallholder farmers living off these areas, and would subsequently contribute to global food and nutrition security.

Plenum Lecture 5

IMPACT OF SOIL CARBON DYNAMICS ON THE ENVIRONMENT AND MANAGEMENT OF IMPROVED SOIL HEALTH IN THE COASTAL ECOSYSTEMS

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Prof. Rattan Lal, Ph.D. from the Ohio State University, is a Distinguished University Professor of Soil Science and Director of the Carbon Management and Sequestration Center at The Ohio State University. He is an Adjunct Professor at the University Iceland; IARI, New Delhi, India, and holds a Chair in Soil Science and Goodwill Ambassador position s with the Inter-American Institute of Cooperation in Agriculture, San Jose, Costa Rica. He was President of the Soil Science Society of America (2006-2008), and the International Union of Soil Sciences (2017-2018). He researches soil carbon sequestration for food and climate security, carbon footprint, eco-intensification, conservation agriculture, soil restoration, soil health, and soils of the tropics. He has authored about 1000 journal articles, mentored 360 researchers, h-index of 156 and 110,347 citations. He is laureate of the 2018 GCHERA World Agriculture Prize, 2018 Glinka World Soil Prize, 2019 Japan Prize, 2019 U.S. Awasthi IFFCO Award, the 2020 World Food Prize, and 2020 Arrell Food Prize.

Abstract: The global coastline is about 440,000 km long (Ouillon, 2018). Coastal ecosystems include intertidal and subtidal areas on and above the continental shelf to a depth of 200 m and immediately adjacent lands (Burke *et al*., 2001). Thus, coastal ecosystems comprise coral reef, mangroves, tidal wetlands, seagrass beds, barrier islands, estuaries, peatland swamps, etc. (Burke *et al*., 2001). Both the coastline and the associated ecosystems are under pressure by anthropogenic activities. Thus, numerous ecosystem services (ESs) provisioned by coastal ecosystems are being jeopardized. Some key ESs provided by coastal ecosystems include the following: water quality, biodiversity, food production and marine fisheries, shoreline stabilization, mining of sand and minerals, tourism and recreation.

Agricultural activities in the watersheds with drastic impacts on coastal ecosystems are : eutrophication of coastal

waters by riverine fluxes of sediments (Hedges and Keil, 1995; Beusen *et al*., 2005) and the attendant plant nutrients (e.g., N, P, K) leading to anoxia (Selman *et al*., 2008) through inputs of fertilizers, herbicides, pesticides, and heavy metals (Nobi *et al*., 2010); wetland drainage; and deforestation and adoption of plow-based agriculture. Based on the data from 124 global rivers, Beusen *et al*. (2005) estimated total suspended sediment load of 19 Gt y^{-1} (with a range of 11-27 Gt y^{-1}). Associated particulate organic carbon (POC), particulate nitrogen (PN) and particulate phosphorus (PO) were estimated at 197 Mt y^{-1}, 30 Mt y^{-1} and 9 Mt y^{-1}, respectively (Beusen *et al*., 2005). Anoxia or hypoxia is a problem in 415 areas around the world (Selman *et al*., 2008), and can strongly impact the quality of coral reef (Altieri *et al*., 2017). Transport of organic carbon into oceans via coastal ecosystems have a strong impact on the global C cycle (Smith and Hollibaugh, 1993; Lal, 2003). Urbanization and intensification of agriculture lead to an increase in water runoff and coastal salinity, and drastic changes in nutrient stoichiometry and biogeochemistry. Coastal areas also receive sediment-borne soil carbon (Hedges and Keil, 1995), and contribute to ~25% of the global ocean primary production. Agricultural pollution threatens about 25% of the global coral reef areas (Altieri *et al*., 2017), and the threat is being exacerbated by intensification of agricultural activities.

A prudent strategy of sustainable management of coastal ecosystems involves reducing land-based pollution by adoption of conservation-effective measures include conservation agriculture (Lal, 2015), regenerative agriculture (Lal, 2020), agroforestry, and complex farming systems which create a positive soil/ecosystem, carbon budget (Lal, 2004). These measures would reduce runoff and soil erosion, minimize non-point source pollution, and decrease fluxes of plant nutrients and other pollutants. Restoration of the soil health of agroecosystems through sequestration of soil organic carbon (SOC) and soil inorganic carbon (SIC) is a prudent strategy to protect and restore coastal ecosystems (Lal, 2016). Similarly, protection and restoration of wetlands, afforestation of steep lands, and setting aside agriculturally marginal lands can reduce transport of sediments, plant nutrients, and other pollutants into the coastal ecosystems.

Risks of soil degradation, by accelerated erosion (wind, water) and other processes (e.g., depletion of SOC, decline of soil structure, salinization), may be aggravated by climate change. Therefore, adoption of restorative land use at the watershed/landscape scale and of recommended soil management practices (e.g., conservation agriculture) are important to protect coastal ecosystems. Sustainable management of soil health through SOC sequestration and upscaling of landscape/watershed management options are critical to reducing land-based pollution of coastal ecosystems.

Selected References

Altieri, A.H., Harrison, S.B., Seemann, J., Collin, R., Diaz, R.J. and Knowlton, N. (2017). Tropical Dead Zones and Mass Mortalities on Coral Reefs. *Proceedings of the National Academy of Sciences of the United States of America* **114**, no. 14 (April): 3660–3665.

Beusen, A.H.W., Dekkers, A.L.M., Bouwman, A.F., Ludwig, W. and Harrison, J. (2005). Estimation of Global River Transport of Sediments and Associated Particulate C, N, and P. *Global Biogeochemical Cycles* **19**, no. 4 (December 1). https://doi.org/10.1029/2005GB002453.

Burke, L., Kura, Y., Kassem, K., Revenga, C., Spalding, M. and McAllister, D. (2001). *Coastal Ecosystems: Pilot Analysis of Global Ecosystems*. Washington, D.C.: World Resources Institute. http://pdf.wri.org/page_coastal.pdf.

Hedges, J.I., and Keil, R.G. (1995). Sedimentary Organic Matter Preservation: An Assessment and Speculative Synthesis. *Marine Chemistry* **49** (2): 81–115. http://www.sciencedirect.com/science/article/pii/030442039500008F.

Kroon, F.J., Schaffelke, B. and Bartley, R. (2014). Informing Policy to Protect Coastal Coral Reefs: Insight from a Global Review of Reducing Agricultural Pollution to Coastal Ecosystems. *Marine Pollution Bulletin* **85**, no. 1: 33–41. http://www.sciencedirect.com/science/article/pii/S0025326X14003646.

Lal, R. (2003). Soil Erosion and the Global Carbon Budget. *Environment International* **29**, no. 4: 437–450. http://www.sciencedirect.com/science/article/pii/S0160412002001927.

Lal, R. (2004). Soil Carbon Sequestration Impacts on Global Climate Change and Food Security. *Science* **304**, no. 5677 (June 11): 1623–1627. https://science.sciencemag.org/content/304/5677/1623.

Lal, R. (2015). A System Approach to Conservation Agriculture. *Journal of Soil and Water Conservation* **70**, no. 4 (July 1): 82A-88A.

Lal, R. (2016). Soil health and carbon management. *Food and Energy Security* **5**(4):212-222.

Lal, R. (2020). Regenerative agriculture. *Journal of Soil and Water Conservation* **75**: doi:10.2489/jswc.2020.0620A

Nobi, E.P., Dilipan, E., Thangaradjou, T., Sivakumar, K. and Kannan, L. (2010). Geochemical and Geo-Statistical Assessment of Heavy Metal Concentration in the Sediments of Different Coastal Ecosystems of Andaman Islands, India. *Estuarine, Coastal and Shelf Science* **87**, no. 2: 253–264. http://www.sciencedirect.com/science/article/pii/S027277141000003X.

Ouillon, S. (2018). Why and How Do We Study Sediment Transport? Focus on Coastal Zones and Ongoing Methods. *Water (Switzerland)* **10**, no. 4 (December 30): 390. http://www.mdpi.com/2073-4441/10/4/390.

Selman, M., Sugg, Z., Greenhalgh, S. and Diaz, R. (2008). *Eutrophication and Hypoxia in Coastal Areas*. Washington, D.C.: World Resources Institute. https://www.wri.org/publication/eutrophication-and-hypoxia-coastal-areas.

Smith, S.V. and Hollibaugh. J.T. (1993). Coastal Metabolism and the Oceanic Organic Carbon Balance. *Reviews of Geophysics* **31**, no. 1 (February 1): 75–89. https://doi.org/10.1029/92RG02584.

Plenum Lecture 6

NATURAL ECOSYSTEMS, BIODIVERSITY AND CLIMATE CHANGE

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Prof. Ravindranath has focused his research, advocacy and publications on various dimensions of Climate Change -Mitigation Assessment, Greenhouse Gas Emissions Inventory in Land Use Sectors, Impact of Climate Change and Vulnerability Assessment in Forest and Agro-ecosystems, Adaptation and Climate Resilience, Forest Ecology, CDM and REDD+ Projects. He has also worked on Bioenergy, Biofuels and Biomass Production, Environmental / Ecosystem Services, and Citizen Science. He is an author for several IPCC (Intergovernmental Panel on Climate Change) Assessment Reports on Climate Change – WMO and UNEP focusing on mitigation in forest sector. He is an author for IPBES (Inter-Governmental Platform on Bio-diversity and Eco-system Services)-Reports. He is the Scientific Advisory Panel Member for Global Environmental Outlook (GEO 6). He was the Science Technology Advisory Panel (STAP) member of GEF (Global Environmental Facility) for Climate Change Focal Area during 2008 – 2012. He is a UNFCCC expert reviewer for GHG (Greenhouse Gas) inventory reports. He is member of Science Policy Initiative Expert committee of UNCCD. He was a member of Scientific Advisory Panel (SAP) of UNEP, Global Environmental Outlook -6. He has published 8 books (from Oxford and Cambridge Uni. Press, Kluwer, and Springer Publishers) out of which 4 are on Climate Change. He has published over 150 peer reviewed

research papers out of which about 60 are on Climate Change. He has worked for or advised many State governments on "Assessment of Climate Change Projections, Impacts and Vulnerability". He is an expert for several World Bank, UN and other bilateral projects related to climate change. He was on the Editorial Board of several top International journals such as; Environmental Research Letters, Biomass and Bioenergy, MITI journal, etc. A study conducted by Stanford University recognized Prof. Ravindranath as one among the 2% of the world's most-cited researchers.

Abstract: Forests, wetlands, mangroves, grasslands, oceans and the associated biodiversity and ecosystem services are under threat due to various land use policies, demand for land for agriculture and infrastructure, over or non-sustainable extraction of forest products, fishes, etc. over grazing, human induced forest fire, pollution, invasion of alien species, etc. Now on top all these pressures climate change is already impacting all the natural ecosystems and biodiversity of forests, wetlands and grasslands. According to IPBES-2020; "An average of around 25 per cent of species in assessed animal and plant groups are threatened, suggesting that around 1 million species already face extinction, many within decades, unless action is taken to reduce the intensity of drivers of biodiversity loss. Without such action, there will be a further acceleration in the global rate of species extinction". According to IPCC-2014, many terrestrial, marine and freshwater species have shifted their geographic ranges, seasonal activities, migration patterns, abundances, and species interactions in response to ongoing climate change. Thus, climate change is already happening and impacting natural ecosystems and biodiversity.

Climate change is projected to impact all terrestrial and aquatic ecosystems and biodiversity. Climate change is projected to become an important direct driver of changes in these ecosystems. The projected impacts of climate change are likely to become more pronounced in the coming decades. Most scenarios of future project adverse climate change effects on biodiversity and ecosystem services, which may worsen, in some cases exponentially, with incremental global warming. Even at moderate levels of warming of 1.5°C to 2°C, the majority of terrestrial species ranges are projected to shrink dramatically. Changes in ranges can adversely affect the capacity of terrestrial protected areas to conserve species, greatly increase local species turnover and substantially increase the risk of global extinctions. Climate change will further exacerbate the adverse impacts of other socio-economic stresses such as land use change, forest fire, pollution, degradation, etc.

Thus, a two-pronged strategy is required, firstly to reduce human pressure of land use change and non-sustainable extraction of natural ecosystems and secondly, address climate change and loss of biodiversity. At the global level there are multiple multilateral environmental conventions aimed to address natural ecosystems, land degradation, climate change and biodiversity namely; UN Framework Convention on Climate Change, Convention on Biodiversity and UN convention to Combat Desertification. In addition, UN SDGs have also been agreed. Under UNFCCC Paris Agreement aims to address climate change and under CBD Aichi targets aim to address biodiversity loss. There are adequate international agreements, policies, strategies and institutional arrangements. However, there are many barriers at national and local level in operationalizing the goals and targets of international agreements and even the national level environmental goals namely; inadequate finance, lack of institutions, lack of technical capacity, inadequate participation and involvement of citizens and local communities, lack of monitoring and accountability and even inadequate research. Despite global level agreements on environment and national desire to conserve environment and biodiversity and address climate change, environmental degradation, loss of natural ecosystems, ecosystem services and biodiversity and climate change are projected continue adversely impacting human health, well-being and prosperity.

Plenum Lecture 7

WATER MANAGEMENT STRATEGIES TO MITIGATE SALTWATER INTRUSION WITH SPECIAL REFERENCE TO COASTAL SAURASHTRA

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Dr. Anupma Sharma completed her PhD in Hydrology from the Department of Hydrology, IIT Roorkee (formerly, University of Roorkee) in 1997, and, subsequently, joined the National Institute of Hydrology (NIH), Roorkee, in 1998, as Scientist-B in the Groundwater Hydrology Division, where she is continuing till date, presently as Scientist-F. She has handled major projects on coastal regions both on the east and west coast of India under the World Bank assisted Hydrology Project Phase-I and Phase-II and supervised a project under UNESCO Asian GWADI program. Presently she is the Principal Investigator of several prestigious research projects sponsored by various agencies such as DST-NERC-EPSRC project under the Newton-Bhabha Fund as part of international collaboration between India and UK Governments, National Mission for Clean Ganga, and National Hydrology Project. She has published more than 40 research papers in various International and National journals and conferences, besides supervising MTech and PhD Thesis. She has also been continuously serving as member of various committees constituted by the Ministry of Jal Shakti and Central Govt. Agencies. During her research assignments, she has travelled different countries namely, Denmark, China, Syria, Nepal, Sri Lanka, and United Kingdom. Her areas of interest include groundwater flow and contaminant transport modeling, coastal hydrology and salt water intrusion, managed aquifer recharge, integrated water resources management, environmental flows, and impact of climate change on water resources.

Abstract: Coastal land salinity problems are attributed to the phenomenon of saltwater intrusion. Intrusion may occur through surface water bodies connected to the sea, such as estuaries and rivers, up to several kilometers inland from the river mouth which affects the agricultural, industrial and drinking water supply of adjoining coastal lands. At many locations, sea water entering through the creeks during high tides may submerge large areas of cultivable land that renders the fertile land progressively saline making it unfit for crop cultivation. Saltwater intrusion in coastal regions may have serious repercussions when the intrusion occurs into the freshwater aquifer systems. The extent of subsurface saltwater intrusion may vary widely from place to place. Variations in hydrogeologic settings, spatial distribution of saline water, and history of groundwater withdrawals and freshwater drainage may lead to different pathways of saltwater intrusion into coastal aquifers. Suitable water management strategies are needed to prevent saltwater intrusion to ensure a sustainable development and socio-economic growth of the coastal regions. The peninsula of Saurashtra in Gujarat, India, provides a wide variety of coastal features due to its varied physiography, geomorphology and coastal processes. On account of proximity of the area to the Arabian Sea, almost the entire groundwater system along the coast of Saurashtra has been affected by salinization. The paper discusses the complex dynamics and hydrogeology of the semi-arid coastal region in Minsar river basin with limestone and Deccan trap formations, occurrence of coastal land salinity arising from saltwater intrusion, its impact on crop yield and environment, and various water management techniques taken up in the region during the past two decades to mitigate the adverse impacts of saltwater intrusion.

Plenum Lecture 8

WATER RESOURCE POTENTIAL AND USES ALONG THE COASTAL ZONE: ROLE OF COASTAL RESERVOIR

T. G. SITHARAM
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Prof. Dr. T. G. Sitharam has taken over as the Director, Indian Institute of Technology, Guwahati, Assam on July 01, 2019 and was holding additional position of Chairman, BOG of IITG till August 28, 2020. He was a Senior Professor, Department of Civil Engineering, Indian Institute of Science, Bangalore, India (he is on deputation from IISc from July 01, 2019). He was formerly a Chair professor in the area of Energy and Mechanical Sciences at Indian Institute of Science (IISc), a premier research and education Institute in India. He was former founder Chairman of a Centre for Infrastructure, Sustainable Transport and Urban Planning (CiSTUP) at IISc, Bengaluru. Presently, he is the Honorary Professorial Fellow at University of Wollongong, Wollongong, Australia from 2019 to 2022 and Distinguished professor at Hankou University International Innovation Centre, China. Presently, He is the Chairman, Research Council, CSIR-Central Building Research Institute (CBRI), Roorkee. He is the Chairman, Executive Council of Visvesvaraya Industrial & Technological Museum Bangalore India. He is Governing Council member of National Council for Science Museums (NCSM), Govt of India and EC member of AICTE, Govt of India, New Delhi. He is the founder President of International Association for Coastal Reservoir Research (IACRR), registered in NSW, Australia. He has delivered talks on Sustainability of water resources management, underground drains and coastal reservoirs. He is the Chairman of the International Scientific Committee of the First IACRR Congress on Coastal Reservoirs and sustainable water management. He is the President, Indian Society for Earthquake Technology (ISET), Roorkee. He is presently the Chairman, AICTE South western zonal committee, Regional office at Bengaluru. Formerly, he was a visiting professor at Dalhousie University, Canada; Yamaguchi University, Japan; Indian School of Mines (IIT-ISM), Dhanbad; and William Mong fellow at University of Hongkong, Hongkong. He was the vice president of Indian Society for Earthquake Technology (ISET) and Vice President of Indian Society of Earthquake Science (ISES).

He obtained his bachelor's in civil engineering from Mysore University, India, master's in civil engineering from Indian Institute of Science, India (1986) and Ph.D. in Civil Engineering from University of Waterloo, Waterloo, Ontario, Canada (1991). Further, he served as a Research Scientist (for his post-doctoral work) at centre for earth sciences and engineering in the Department of Petroleum Engineering, University of Texas at Austin, Texas, USA until 1994. During this time, he has lead research on sand production, wellbore stability and hydraulic fracturing in petroleum wells supported by many oil companies. Earlier to that, He served as a lecturer for six months in 1991 at University of Waterloo, Ontario, Canada and he taught Geotechnical engineering. Over the last 35 years, he has carried out research and development extensively in the area of geotechnical and infrastructure engineering, and has developed innovative technologies in the area of fracturing and geotechnical applications, leading to about 500 technical papers, 12 books with an H-index of 38 and I-10 index 101with >4375 citations. He has 5 patents, more than 120 consulting projects and 2 start-up companies to his credit. He is responsible for designing, restoration and

expansion of several earth dams for raw water ponds, tailing ponds, ash ponds and red mud ponds across India. He has guided 30 Ph.D. students at IISc and 30 Masters Students and trained several postdoctoral and several thousand industry professionals and teachers through continuing education workshops. Presently he has another 9 Ph D students at IISc, Bangalore. He is the chief editor of international journal of Geotechnical Earthquake Engineering, (IJGEE), PA, USA. He is the Editor-in-chief, Springer Transactions in Civil and Environmental Engg series, Book Series, Singapore. He is also fellow of many societies and actively engaged in socially relevant projects.

He has received many awards and credits. In 2015, he is a recipient of IGS Kuckleman Award for his life time contributions in Geotechnical Engineering. In 2014, he is a recipient of Prof. Gopal Ranjan research award from IIT Roorkee for his excellent contributions to Geotechnical Engineering in the country. This was given to Prof. Sitharam for his pioneering work in Geotechnical engineering. Amulya and Vimala Reddy Lecture Award at Indian Institute of Science, Bangalore in the field of Sustainable Development for the year 2014 was conferred on Prof. Sitharam. Earlier, he is recipient of Sir C.V. Raman State Award for Young Scientists, Government of Karnataka, in the year 2002 in recognition and appreciation of exceptional contributions to Engineering Sciences. He was also the recipient of 1998 S.P. Research award (SAARC) from SP research foundation, USA for his contributions to geotechnical Engineering in SAARC countries. He has also received many best paper awards for his papers published in conferences and journals. He is the fellow of Institution of Civil engineers, UK and many other societies.

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Smart water network to store river flood water in sea-based reservoirs and a method of interlinking these reservoirs (Sarovar MalaTM), Thallak Gundurao Sitharam, India Copyright Registration number L-72417/2018 dated 16.01.2018.

Patent:

Smart water network to store river flood water in sea-based reservoirs and a method of interlinking these reservoirs (Sarovar MalaTM) - TEMP/E-1/44294/2016-CHE - 2016, India

Sustainable Water Resources Management: Water scarcity to Security - An IITACB Webinar; https://www.youtube.com/watch?v=_fT5oE6HOeE, May 10, 2020.

Abstract: The Global Risk Perception Survey conducted by the World Economic Forum reports that the highest level of societal impact over the next 10 years will be from water crises. Water stress has caused countries around the world to consider ways to mitigate the impact of increased population and climate change. More than 50% of the world's population live within 200 km of the coast, and 75% of the megacities are situated by the sea. Big pressure on land, water supply, and other infrastructure appears in these coastal cities and zones. Based on the overall sustainable development of Coastal areas and conservation of the Coastal Environment, the Government of India has approved the new Coastal Regulation Zone Notification in 2018. Procedures have been streamlined and simplified for CRZ clearances. This will add to creating additional opportunities for affordable housing, boosting tourism with new livelihood and jobs, more activities, more infrastructure, and more opportunities along the coastal zone. A National Perspective Plan (NPP) for the comprehensive development of India's 7,500 km coastline, 14,500 km of potentially navigable waterways, and the maritime sector was prepared - The Sagarmala Programme along with the connect to highway networks will reduce the logistics cost and increase the domestic trade with minimal infrastructure investment along the coastline. As the coastal economy has become so important for the countries and as the majority of the future population live in coastal cities, a big question is how to manage the coastal zone in terms of water resources and their potential uses. To construct the coastal economic corridor and achieve

higher economic growth, the water shortage problem or water scarcity must be first solved. Among the coastal infrastructures, coastal reservoirs have shown to provide sufficient water, which nourishes the coastal prosperity. India has a coastline of 7516.6 km- 5422.6 km of mainland coastline and 1197 km of Indian islands. Indian coastline touches nine states and two union territories. We propose a simple and easy "river-linking project" in the lower end of rivers, i.e., "Sarovar Mala" for a coastal economic corridor linking coastal reservoirs at the mouth of rivers (where a river joins the ocean) in peninsular India; an alternative to "river-linking project" in the upper region's of rivers. These freshwater reservoirs (Sarovar) are the most important infrastructure to sustain all other developments in the coastal zone. Sarovar mala provides good connectivity for non-perennial rivers and will provide a storage plan for freshwater from the excess river floodwaters and one can develop the floodwater agriculture, Industrial clusters, and hinterland up to a radius of 100 km resulting in Sarovar's becoming the drivers of economic activity in coastal areas. This presentation discusses the Indian coastal economic corridor and compares it with China in its coastal areas. A multi-purpose coastal reservoir can effectively mitigate water scarcity and provides sufficient freshwater supply for flood water agriculture and environmental protection for the coastal zones. Some case studies of the existing coastal reservoirs will be presented along with the advantages and disadvantages of coastal reservoirs.

Plenum Lecture 9

COASTAL AGRICULTURE UNDER FUTURE CLIMATE CHANGE: CAN DEVELOPING COUNTRIES ADAPT?

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Dr. M. Monirul Qader Mirza has extensively researched hydrological and climate extremes, natural hazards and their management, climate change, and water resources an associated vulnerability, impact and adaptation. He received his PhD from the International Global Change Institute (IGCI), University of Waikato, Hamilton, New Zealand on climate change and flood modeling in Bangladesh in 1998. He contributed as a Coordinating Lead Author (CLA) to the Special Regional Report (1997), the Third Assessment Report (TAR), and the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC) of the United Nations, Millennium Ecosystem Assessment (2006) and Global Agriculture Assessment (IAASTD)-2009. In 2008, he received special awards from the Governments of Canada and Bangladesh for his contributions to the IPCC. He is an Adjunct Professor at the Department of Environmental Sciences, The University of Toronto Scarborough. He is a member of the American Society of Civil Engineers (ASCE) and Professional Engineers, Ontario, Canada.

Abstract: It is a profoundly challenging task to live in any low-lying coastal areas of developing countries. Presently approximately 40 per cent of the developing countries population lives in the coastal areas. The coastal people and their economies are at constant threats of natural hazards. Life and livelihoods of the coastal population have been predominantly by and large dependent on agriculture. Heavy rainfall from cyclonic storms and high tidal flows destroys crops. Salinity intrusion reduces agricultural productivity. Waterlogging due to unplanned infrastructure development has proven to be destructive to coastal agriculture. Commercial aquaculture especially shrimp destroys

soil quality mostly permanently. In addition to rising temperature and changing precipitation patterns, increasing episodes of cyclonic storms, salinity intrusion, waterlogging and sea-level rise could significantly impact coastal agriculture in the future. Adaptation challenges of coastal regions are different from the other parts of any country due to differential risks. Historical accounts show that despite adaptation investments in the coastal regions, key economic sectors especially agriculture have remained vulnerable. Options for adapting to future climate change challenges and limitations are explored for coastal agriculture in the developing countries.

Plenum Lecture 10

BUILDING THE COASTAL RESILIENCE IN ASIA AND THE PACIFIC: OPPORTUNITIES AND CHALLENGES

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Dr. Sanjay K Srivastava, Ph. D (IARI, New Delhi), is presently Chief of Disaster Risk Reduction at UN Economic and Social Commission for Asia and the Pacific (ESCAP). He was the Regional Adviser of Disaster Risk Reduction of ESCAP from 2009-2014. Prior to the UN positions, He was the Deputy Project Director of Disaster Management Support Programme at Indian Space Research Organisation (ISRO); Scientist/Engineer at ISRO HQ Bangalore since 1991. Sanjay has been a lead author of ESCAP's flagship publication – Asia-Pacific Disaster Report.

Abstract: Asia-Pacific Disaster Report 2019 captures a comprehensive picture of the complexity of disaster risk for the first time. Annualized economic losses more than quadruple to USD$675 billion when slow onset disasters are added to the region's riskscape. Coastal ecosystems are increasingly at the risk with their exposure to tropical cyclone, storm surges, flooding and erosion. As sea levels continue to rise, perennial flooding will likely to spread and more land will be permanently lost to the ocean. It is from the rising sea levels where the heightened coastal flooding now poses a serious threat to damaging infrastructure, ruining crops and even displacing many coastal communities from their homes. Recent research by Nature Communications, based on sea level projections for 2050, reports that the land currently home to 300 million people will fall below the elevation of an average annual coastal flood. By 2100, land now home to 200 million people could sit permanently below the high tide line.

The presentation will highlight how emerging technologies can reduce the impact of new climate reality on costal ecosystems. The substantial reductions in mortalities and economic losses due to tropical cyclones were attributed to big data applications that enabled impact-based forecasting and risk-informed early warning. For flood forecasting, a recent innovation in climate modelling is the use of ensemble prediction systems which offers the ratio scenarios of forecasting indicating the range of possible outcomes. Machine learning can also be used to accurately predict the location and severity of floods. Further, the presentation will shed light on how the Big Data, digital identity systems, risk analytics and geospatial data reduce the barriers in information flows to include and empower the coastal community at risk. It is vital that vulnerable coastal ecosystems are protected from these risks, so that everybody can benefit from this rich new source of information and knowledge.

Plenum Lecture 11

COASTAL ECOSYSTEMS –EXPLORE VALUE CHAINS, PROCESSING AND EXPORTS FOR POVERTY ALLEVIATION

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Dr. P. K. Joshi superannuated as the Senior Advisor to the Director-General and the Director-South Asia, International Food Policy Research Institute, Washington DC. Prior to this he was holding the positions of the Director, ICAR-National Academy of Agricultural Research Management, and the Director of the ICAR-National Centre of Agricultural Economics and Policy Research. After his superannuation, he is serving as the Policy Adviser to the World Bank, the Food and Agriculture Organization, Harvest Plus program of CGIAR and Australian Centre for Agricultural Research (ACIAR). He has extensively worked towards transforming agriculture and market integration in India, and many south and southeast Asian countries.

Dr Joshi has received the following awards: Dr MS Randhawa Memorial Award of the National Academy of Agricultural Sciences (2009–11), Dr RC Agarwal Life Time Achievement Award of the Indian Society of Agricultural Economics (2012-13) for his outstanding contribution in social science and agricultural economics research and management; the Life Time Achievement Award of the Pantnagar Alumni Almamater Advancement Association; and the Global Leadership Award by the Indian Chambers of Food and Agriculture. He is the Fellow of the (1) National Academy of Agricultural Sciences, (2) Indian Society of Agricultural Economics, (3) Indian Society of Agricultural Engineering, and (4) International Society of Noni Research.

Dr Joshi was President-elect of Indian Society of Agricultural Economics (2014); Conference President of Indian Society of Agricultural Marketing (2014), Conference President of Agricultural Economics Research Association-India (2015), and Secretary-General of 4th World Congress on Conservation Agriculture (2009). He is presently the President of the Agricultural Economics Research Association; and the Secretary of the National Academy of Agricultural Sciences.

Dr Joshi has also served as the chairman of the SAARC Agricultural Centre's governing board in Dhaka, Bangladesh (2006–08); chairman of the UN-CAPSA governing board in Bogor (2007); member of the BRICS-Agriculture group; and member of the intergovernmental panel on the World Bank's International Assessment of Agricultural Science and Technology for Development (2007–08). He served as a member of the International Steering Committee for the Climate Change, Agriculture, and Food Security Challenge Program, led by the ESSP Science Community and the CGIAR (2009–11). He was also a member of the core group of the Indian government's "Right to Food" National Human Rights Commission.

Plenum Lecture: Globally, poverty and hunger are still twin challenges despite concerted efforts made to overcome these. Roughly, 750 million people are in extreme poverty and struggling for their food and nutritional security.

About half of the world's population still lives below $2.50 a day. To overcome these problems, the global leaders renewed the efforts to end poverty and protect the planet and ensure prosperity for all as a part of new Sustainable Development Goals (SDGs). During past few years, poverty was declining but Covid 19 pandemic has further pushed back 150 million poor to the poverty trap. The largest concentration of poor is in South Asia and Sub-Sahara Africa. South Asia houses roughly 350 million poor, of which 70% live in India.

Agriculture can play key role in reducing poverty and improving food and nutritional security of poor. Among other ecoregions, coastal ecosystem offers enormous opportunities to improve the livelihood of poor. More than 600 million people live in coastal areas that are less than 10 meters above sea level. Nearly 2.4 billion people live within 100 km of the coast. Rice and fish are the main staple food commodities in most parts of the coastal areas. Poultry, meat and fruits & vegetables are gaining importance in coastal food system. Seaweed farming is opening-up new prospects for increasing income and employment opportunities for the poor living along the coastal areas. Ecotourism, a non-farm activity, has huge potential for overall development and prosperity of the region. Innovations in value chains, processing and exports are necessary conditions to harness the emerging opportunities. However, rise in temperature, sea water intrusion, soil salinity and climate change are obstructing the economic prosperity in coastal areas. Market-oriented policies and institutions along with improved technologies, will transform coastal areas to achieve higher economic growth and improve livelihood opportunities. A need-based architect of effective policies and institutions is needed to harnessing opportunities and overcoming challenges in coastal eco-system.

Theme I:

Systems approach for coastal zone development: agriculture, horticulture & plantation crops and their tolerance to biotic & abiotic stresses

SESSION I:

Agricultural crop improvement including biotechnological approaches, genetic resource management, abiotic stress tolerance

T1S1I01

GENETIC AND EPIGENETIC NOVELTIES IN PLANT BREEDING: CREATING ADAPTIVE TRAITS AND IDEOTYPES FOR MARGINAL ENVIRONMENTS

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Prof. Benildo G. De Los Reyes: Prior to joining the Tech faculty, De los Reyes was a tenured faculty member at the University of Maine's School of Biology and Ecology, and Department of Molecular and Biomedical Sciences, moving through the ranks of assistant professor, associate professor and professor of molecular genetics from 2004 to 2012. He also served as the school's associate director until his departure in December 2015 to join the faculty of Plant and Soil Science at Texas Tech. Earlier he worked as a postdoctoral research associate at Michigan State University's Department of Crop and Soil Sciences, a graduate research associate at Oklahoma State University's Department of Plant and Soil Sciences, and a graduate research assistant at Pennsylvania State University's Department of Horticulture. De Los Reyes is investigating the mechanisms built upon the power of regulon restructuring, regulatory RNAs, and DNA methylation to understand the intricate processes by which novel gene expression patterns mediate transgression from parental phenotypes. The transformative knowledge uncovered by his current research on rice is being translated to other major crops of economic importance to the state of Texas including cotton and sorghum.

Abstract: What would be the genetic blueprint of the new generation of crops with minimal penalty to productivity potentials under marginal environments? Such a profound question pushes even further the frontier of biological complexity that modern plant breeding needs to conquer, beyond the achievements of the Green Revolution. Genomics-enabled plant breeding must recognize that such level of complexity cannot be addressed by a reductionist approach. Real physiological gains similar to what have been optimized by natural selection involve complex synergies with inevitable biological trade-offs. Evolutionary biology supports a theory that the novelties of rare wide-hybrids and recombinants, which are also observed among transgressive populations created by plant breeding, contribute to adaptive speciation. The true potential of this classic phenomenon as vehicle to create the stress-adaptive novelties for the 21st century remains underexploited, perhaps because it is over-shadowed by the more recent reductionist approaches to genetic manipulation. In this presentation, the author will discuss recent findings on a transgressive population of rice for salinity tolerance, to make a case that stress-adaptive developmental and physiological novelties involve intricate molecular synergies and network rewiring created through the modification of the epigenomic landscape. Modern views on the molecular underpinnings of transgressive phenotypes with potential applications to coastal crop breeding will be presented holistically in context of the Omnigenic Theory, and current understanding of gene regulation by DNA methylation and chromatin remodelling.

T1S1I02

CHALLENGES AND OPPORTUNITIES IN DESIGNING SALT TOLERANT RICE

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Prof. Prasanta K. Subudhi working on the following topics: (a) application of classical and molecular breeding for crop improvement, (b) genomics of complex traits (abiotic stress tolerance, seed dormancy, seed shattering, and flowering response to photoperiod) in rice. He has high experience in both basic and applied research on salt tolerance for rice improvement; specifically, the pros and cons of different breeding methods, QTL mapping, and next generation sequencing in elucidating the molecular basis of salt tolerance and development of salt tolerant rice varieties.

Abstract: Rice is a major food crop for more than half of the world's population. Since rice is highly sensitive to salinity at both seedling and reproductive stages, development of salt tolerant varieties is necessary to continue rice farming in salt affected areas. There is abundant natural genetic variation in the world rice germplasm for use in breeding programs, but the progress has been slow due to complex genetics and multiple mechanisms associated with salt tolerance. Numerous studies reported identification and utilization of quantitative trait loci (QTLs) for salt tolerance to accelerate the breeding efforts. We report here the progress made at the Louisiana State University Agricultural Center towards the development of rice varieties with enhanced salt tolerance. Several mapping populations were developed from crosses involving known salt tolerant donors and cultivars adapted to the southern rice growing regions of the USA. Evaluation of these populations was done for salinity tolerance at both seedling and reproductive stages in greenhouse experiments. Besides mapping of QTLs for salt tolerance attributes in multiple mapping populations, several QTLs were validated using introgression lines. Using several exotic salt tolerant donors, we successfully developed salt tolerant breeding lines, which are now being evaluated for agronomic traits including yield in replicated field trials. Since the level of salt tolerance needs further improvement, we are now pyramiding the superior alleles of the QTLs/genes from multiple donors. To accomplish this goal, we are making crosses between salt tolerant introgression lines carrying the salt tolerant QTLs to introgress multiple QTLs to several high yielding US varieties. Several mini-multi-parent advanced generation inter-cross populations were also developed to accumulate superior alleles from multiple donors. Our preliminary evaluation indicated that salt tolerance of some selected breeding lines is better than the donor lines. While advancing these populations, plants with desirable agronomic traits are selected for multiplication and salinity screening. The advanced breeding lines with enhanced salt tolerance and the genomic resources developed in this project will accelerate development of climate resilient rice varieties and elucidation of the molecular basis of complex salt tolerance mechanisms operating in rice.

T1S1I03

ANAEROBIC GERMINATION TOLERANCE IN RICE: THE UNDERLYING GENETICS AND BREEDING EFFORTS

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Dr. Endang Septiningsih had received her Ph.D. in Plant Breeding from Cornell University. From 2005 to 2015, she worked at the International Rice Research Institute (IRRI) in the Philippines, where she was a Senior Scientist-Molecular Geneticist before joining Texas A&M University as a faculty member in 2015. Her current position is Associate Professor at the Department of Soil and Crop Sciences, Texas A&M University. Her current research focus is plant genetics and genomics, with an emphasis on rice and legumes. This covers various traits, including environmental stresses, grain quality, yield and key agronomic traits that are important to Texas and the rest of the world. Research activities include QTL mapping, genome-wide association studies (GWAS), whole genome expression profiling, gene cloning and genome editing. Local, national and international research collaborations are being pursued to accelerate progress for crop improvement and broaden the research impacts.

Abstract: Most rice production in the US and Latin America is direct-seeded, and addressing constraints in the direct-seeded rice (DSR) ecosystem is key to providing robust crop establishment leading to higher yields. Likewise, DSR is being rapidly adopted across many rainfed and irrigated ecosystems worldwide primarily due to labor and water shortages leading to an increased cost of production for transplanted rice. One of the key traits to improve crop establishment during DSR production is tolerance to flooding during germination, or anaerobic germination (AG). AG tolerance is important to prevent poor crop emergence and establishment due to unleveled fields, frequent rainfall and poor drainage and also as a mechanism for weed control, a major issue for direct seeded rice. A number of QTLs from bi-parental mapping and genome-wide association studies (GWAS) have been identified. The underlying gene from one of the QTLs, *AG1*, had been cloned, which is the *OsTPP7* gene; while some others have been fine mapped and the potential candidate genes are under investigation. It is pivotal to introgress this trait along with some other relevant traits to high-yielding rice cultivars to increase their resilience under flooding stress conditions, including the coastal ecosystems.

T1S1I04

WILD HALOPHYTIC RICE, *P. COARCTATA* AS A RESOURCE FOR RICE CULTIVATION IN SALINE SOIL

ZEBA I. SERAJ*, M. UMMEHABIBA, DOLA KARMOKER, ANIK KUMAR SAHA and M. RAKIBUL ISLAM
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Dr. Seraj has been teaching Biochemistry and Molecular Biology for more than 30 years. Her Plant Biotechnology Laboratory in collaboration with both national and international institutes, like BRRI, IRRI and ICGEB has produced saline tolerant rice using DNA-marker-assisted selection as well as genetic transformation. Using modern sequencing technologies, she helped discover multiple salt tolerance loci of a traditional rice and to introgress these into commercial rice. She is also studying a local halophytic rice called Uridhan or *Porteresia coarctata* as a resource for making sensitive rice more tolerant of salinity stress. She has published more than 70 peer-reviewed research articles in reputed journals and 5 book chapters. Seven scientists have already received PhD under her supervision and 4 more are currently engaged in PhD work under her supervision. She has received the Dean's Award for best research in 2013 for producing salt tolerant transgenic helicase rice lines. She has received the Annanya award for 2016 for research. She has given a Tedx talk on her work on climate change. She has been featured in NHK TV for her work on salt tolerant rice 2019 and in GCP, 'Partner and Product Highlights 2006.

Abstract: *Porteresia coarctata* is the only known halophyte which sets rice-like grains. It can complete its life-cycle in seawater which has an ion conductivity of ~40 dS m^{-1}. One of the known mechanisms for the halophytic character of *P. coarctata* is the excretion of salt through abaxial and adaxial salt glands in its leaves. It can effectively de-salinate a 200 mM hydroponic solution at the rate of 2.4 mM per day without any self-detrimental effects and the rate of desalinization was found to gradually increase up to 400 mM salt solution. We are trying to determine how it distributes the Na^+ in its leaves, roots and rhizomes, since we have observed an increase in its tillering as well as rhizome growth even under 100 mM salt. This work is in progress. We are also looking for endophytes associated with the roots of *P. coarctata* which may confer beneficial effects, not only to the halophyte but to rice as well. Two endophytic bacteria, of the *Staphylococcus* and *Micrococcus* sp. were found to promote survivability scores, root width, lateral root growth as well as enhanced chlorophyll content under salt stress. We are studying the Ca^{2+}ATPase gene of *P. coarctata*, since it expression continues to increase from 100-400 mM salt in both its leaves and roots. In addition, we cloned the ASR, vacuolar H^+ ATPase (c subunit) and metallothionein genes from *P. coarctata* and inserted these into sensitive rice by *in planta* transformation technology. The genes were able to confer enhanced tolerance to sensitive rice.

T1S1I05

BIOTECHNOLOGICAL APPROACHES TO DEVELOP SALT-TOLERANT RICE FOR THE COASTAL REGIONS

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Abstract: Tremendous advances have been made in understanding the genetic control of salinity tolerance, which has provided molecular tools for developing salt-tolerant rice for the coastal regions. A large number of quantitative trait loci (QTLs) for both seedling and reproductive stage salinity tolerance have been identified using efficient single nucleotide polymorphism (SNP) genotyping methods. These QTLs provide useful targets for marker assisted backcrossing of large-effect loci to increase tolerance in breeding lines. At the same time, new biotechnology tools are now available using CRISPR/Cas9 for precise gene editing, which can enable validation of candidate genes through gene knockouts, as well as providing a means for allele replacement as a fast-track method for testing natural allelic variation. This talk will review the current status of molecular breeding tools and explore future directions that promise the greatest impact in accelerating progress for developing salt-tolerant rice, including the use of gene editing for rapid pyramiding of beneficial alleles at breeding-relevant genetic loci.

T1S1I06

WORRIES OF SALINITY INTRUSION IN THE MEKONG RIVER DELTA, VIETNAM: WHAT INNOVATIVE SOLUTIONS CAN WE OFFER THROUGH BREEDING FOR SALT TOLERANT RICE?

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Dr. Glenn B. Gregorio obtained his Ph.D. in Genetics, M.Sc. in Plant Breeding, and BS Agriculture at the University of the Philippines Los Baños (UPLB). Born and educated at Central Mindanao university, Musuan, Bukidnon for this Elementary and High School. His career was developed at the International Rice Research Institute (IRRI) as researcher; then he served as Post-Doctoral Fellow and assumed various research positions like International Research Fellow, Scientist, Senior Scientist, and Deputy Division Head of IRRI's Plant Breeding Genetics and Biotechnology Division. At IRRI, he worked on Rice Breeding for tolerance to saline-prone and problem soils, and as Coordinator for varietal development pipeline-cross cutting R&D. He had a three-year stint as crop breeding manager for corn at East-West Seed Company. He is a professor of the Institute of Crop Science, College of Agriculture and Food science at UPLB and currently the Director of Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA). His numerous awards include the following: Ten Outstanding Youth Scientists of the Philippines (TOYS 1980); Outstanding Young Scientist (OYS 2004) in the field of Genetics; Crop Science Society of the Philippines Achievement Award for Crop Science Research (2004); Honorary Foreign Scientist of the Rural Development Administration (RDA) Award of Korea (2002-2005); The Outstanding Young Men (TOYM 2004) Philippines; Ho Chi Minh Medal award for "Having Great Contribution to the cause of Agriculture and Rural Development of Vietnam" (2012); Crop Science Achievement Award in Research Management (2014). Dr. Gregorio was also conferred the rank of Academician as member of NAST-Philippines in 2018.

Abstract: Overall, salinization, as exacerbated by several climate change-related hazards, has been significantly affecting rice production in the Mekong River Delta (MRD), a major rice production region in Vietnam. What can farmers do to effectively respond to salinization and ensure farm production is maximized? There is a solution—massive promotion of Good Agricultural Practices including the use of tolerant rice varieties in cultivating rice in coastal saline environment among farmers up to a level that has achieved significant and wider strategic adoption. Most farmers in MRD are generally aware of the negative impacts of salinization in coastal areas to rice productivity and profitability. Farmers are implementing adaptation practices by improving the yield through application of fertilizers and switching from local rice varieties with long growth duration to high yield varieties with shorter growth duration. Recently, many new varieties were released for commercial production that have tolerance to salinity and flash flooding, along with the adjustments on the cropping calendar to avoid the drought-salinity intrusion cycles that led to an increased rice production during autumn and winter seasons. Major components necessary for a competitive rice sectors are already in place in Vietnam, but these has to be furthered strengthened to ensure institutional flexibility to respond to climate change-induced salinity and other hazards. Among a number

of relevant policy interventions, the following rice varietal development-related interventions are suggested:1) Sustained promotion and support for Research and Development (R&D) geared towards the development and wider adoption of integrated rice farming technologies that ensure high productivity and resilience; 2) More research on how to effectively identify and design innovative ways to improve the efficiency of rice production complemented with actual setting up of credit and insurance systems for rice farmers; 3) Awareness-building on the adverse impacts of unsustainable practices such as extensive groundwater pumping and agro-chemical application which could also add to an improved adaptation practice; 4) Subsequent investments to further improve varieties that have tolerance to flooding, drought, heat, and salinity, and a breeding program for new varieties and continued support to traditional rice varieties (TRV); 5) An enhanced application of modern technology and science-based recommendations along with capacity development critical for improved rice seed quality, innovative cropping system, pest and disease management, infrastructure and enterprise development, and ensured efficiency at lowest risk for farmers; and 6) At the micro-level, farmers adaptation of Good Agricultural Practices giving emphasis on the use of climate change-ready varieties in growing rice to effectively respond to salinization and ensure maximized farm production.

T1S1I07

DHANI (*Oryza coarctata*): A WILD RELATIVE OF RICE IS A POTENTIAL SOURCE OF COASTAL SALINITY TOLERANCE GENES SUITABLE FOR RICE BREEDING

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Dr. Tapan Kumar Mondal is an Agricultural Scientist presently working on rice, wild species of rice and tea. His research interest is to understand the salinity tolerance mechanisms of rice and its wild species. He is pioneer to develop the microRNA based DNA markers of rice. His team leads to decode the *Oryza coarctata* genome. He is also pioneer to develop first transgenic tea and presently working on tea genome sequence. He did B.Sc. (Agri) and M.Sc. (Agri) from Assam Agricultural University, Jorhat. He has obtained Ph.D. degree from Institute of Himalayan Bioresource Technology (CSIR), Himachal Pradesh, India under the guidance of Late Prof P. S. Ahuja, Ex-DG, CSIR. After that, he served as Research Scientist, Tata Tetley Ltd, Munnar, Kerala and later as Assistant Professor at North Bengal Agricultural University, West Bengal. After that he has joined as Senior Scientist at Indian Council of Agricultural Research, Ministry of Agriculture, New Delhi and presently working as Principal Scientist at National Institute for Plant Biotechnology, IARI, Pusa New Delhi. He did his Post-Doctoral training at University of California, Riverside, USA and University of Urbana–Champaign, Illinois, USA. He is recipient of several fellowships of professional societies of India including National Academy of Science, India. He was also awarded 'Young scientist award' by Korean Society of Tea Science in 2003 and Japan Tea Science Society in 2004. His mentored farming community of Sagar island, Sundarban, West Bengal got prestigious Genome Savoir Award of PPFRA, new Delhi for conserving the salinity tolerant of rice. He has visited several countries, written two books on biotechnology, edited one book on wild species of rice of Springer publication. He has published more than 60

scientific research papers, developed 5 databases, one software, guided 7 Ph.D. students including one from Nigeria and several M.Sc. students. He is also Associated Editor of peer review journals such as Plant Molecular Biology Reporter, PLOS one, Scientific Reports.

Abstract: Wild species are excellent reservoirs of important genes, many a times that are not found in cultivated gene pool. Canonically rice plant is salt sensitive though few genotypes are salinity tolerant which have been extensively used as donor in salinity breeding program of rice. Thus, there is a need to discover alternative favourable alleles/ genes that give better salinity tolerant. *Oryza coarctata* is a wild species that can grow up to maximum EC value of 40 ECe (electrical conductivity) dS m^{-1}, against the EC value of 12 which is believed to be the height level of tolerance for rice. It is mainly found in the coastal region of South Asian countries. Unfortunately, the conventional crossing of this plant is not very successful with rice. Thus, to find out the cause of low breeding success as well as salinity tolerant mechanisms, we did cytogenetic, genomics, transcriptomics and metabolomics study of this species. While decoding the nuclear genome along with transcriptomic studies gave several novel salt tolerant genes, metabolomics study indicated key compounds that might be responsible for its salinity tolerance. A details account of our research finding of this species will be delivered in my talk.

T1S1I08

SODIUM TRANSPORTER *HKT1;5* FUNCTION THE HALOPHYTIC WILD RICE *Oryza coarctata*

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Dr. Gayatri Venkataraman is a Principal Scientist in the Biotechnology Program Area at the M.S. Swaminathan Research Foundation, Chennai. She is an expert in the area of plant abiotic stress tolerance, especially in relation to mangrove species and associates. Her research focuses on ion transporter function in relation to salinity tolerance and their transcriptional and post-transcriptional regulation. Other areas of work interest include salinity tolerance in halophytes, ion transporter diversity and wild rice biology. She is a member of the National Academy of Sciences, India.

Abstract: Climate change and sea level rise is increasingly affecting coastal regions of India. Intrusion of sea water into agricultural lands in coastal regions is increasing soil salinity [increasing soil sodium ion (Na^+) content)], affecting agricultural productivity. In the genus Oryza, of twenty-two rice species recognized, *Oryza coarctata* (= *Porteresia coarctata*) is the only species of wild rice that is known to be naturally salt tolerant. It occurs as a mangrove associate in the coastal regions of India and Bangladesh in constantly fluctuating salinity. *O. coarcata* has evolved numerous mechanisms to deal with salinity. Salt glands on the leaf surface secrete Na^+, maintaining a low leaf Na^+/K^+ ratio even under high salinity. Aerenchymatous roots develop from extensively branching rhizomatous pseudo-taproots, anchoring it firmly to the soil even under inundated conditions.

Salinity negatively affects crop growth, due to both osmotic and cytotoxic effects of elevated cellular Na^+. As a result, there is imbalance in K^+ homoeostasis (Na^+ competes with K^+ in cellular processes), an ion critical to plant growth and development, inhibition of cell expansion, reduced photosynthetic activity, enhanced leaf senescence and reductions in assimilate allocation to reproductive structures. Na^+, K^+ ion transporters are crucial to conferring salinity tolerance and include either plasma membrane-based transporters (HKT/SOS1) or endomembrane/vacuolar transporters (NHXs).

HKT transporters can be categorized into two types. Of these, Type I transporters that control Na^+ uniport and are major determinants for salinity tolerance in most cereal crops. Among cereal crops, rice is the most sensitive to salinity at seedling and reproductive stages. Tolerance to salinity in rice is associated with the *Saltol/SKC1* loci that contain the *HKT1*;5 gene (*OsHKT1*;5). *HKT1;5* is a plasma membrane transporter that retrieves Na^+ from root xylem vessels, loading it into adjacent parenchyma cells, reducing xylem sap Na+, and thus, minimizing shoot Na^+ transpirational flux, improving shoot K^+/Na^+ ratio. The presentation will share recently published comparative data on *O. coarctata HKT1;5* transport characteristics in relation to cultivated rice *HKT1;5* and provide an ecophysiological rationale for the same.

T1S1I09

PROTEIN *L ISOASPARTYL METHYLTRANSFERASE (PIMT)*: A KEY ENZYME FOR PLANT SURVIVAL UNDER ABIOTIC STRESS

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Abstract: Protein *l-isoaspartyl methyltransferase (PIMT)* is a widely distributed protein repairing enzyme which repairs isoaspartate (isoAsp) mediated protein damage in a cell. In our study, we have shown that isoAsp accumulation in proteins increases upon seed aging, and in plants under environmental stresses, which negatively influences seed

vigor, viability and plant growth and survival during abiotic stresses. We also demonstrated that PIMT activity is essential to restrict such deleterious isoAsp in proteins during seed aging and in plant growth and survival particularly under stressful environments. Our molecular genetics and biochemical analyses on *PIMT* overexpression and RNAi mutant analyses revealed that *PIMT* plays a key role in preserving seed vigor and viability for prolonged period of times, and in plant growth and survivability under abiotic stress conditions. Subsequent biochemical and MS/MS analyses revealed that *PIMT* activity is important to repair isoAsp-mediated damage of antioxidative enzymes to maintain ROS homeostasis during aging and stressful environments. Collectively, our results suggest that besides in seed, the *PIMT*-mediated protein repair system is an integral part of the stress tolerance mechanism in plants, in which *PIMTs* protect antioxidant enzymes that maintain proper ROS homeostasis against isoAsp-mediated damage in stressful environments. In conclusion, *PIMT* plays a key role in improving seed vigor, longevity and plant growth and survival under stressful environments, and can be utilized to develop a climate resilient crop.

T1S1I010

GENETIC ENGINEERING AND GENOME EDITING FOR ABIOTIC STRESS TOLERANCE OF RICE

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Abstract: Rice is the major staple food crop of India. Rice productivity is adversely affected abiotic stresses such as drought, salinity, heat and cold stresses. Tolerance to these abiotic stresses is regulated by ABA-dependent and –independent pathways in plants. Hence genes for ABA-dependent pathways and ABA-independent pathway were analysed in rice for their ability to confer tolerance to various stresses. In ABA-dependent pathway, rice ABA receptor genes were analysed by using transgenic approach in rice. Transgenic rice cv. Pusa Sugandh 2 overexpressing ABA receptor *OsPYL6* either from constitutive and stress inducible promoter conferred enhanced drought tolerance at both

vegetative and reproductive stress through enhanced expression of various stress responsive genes. *PATRD29A::PYL6* transgenics also exhibited about 25% lesser whole plant transpiration as compared with WT plants under drought stress. However, *PYL6* overexpression significantly reduced grain yield under non-stress conditions. Stress-inducible overexpression ABA receptor *OsPYL10* significantly enhanced higher survival rate of transgenic rice cv. MTU1010 under cold stress and tolerance to drought stress (-80 kPa SMP). In ABA-independent pathway, *AtICE1* overexpression conferred enhanced tolerance to cold, salt and drought stresses to the rice transgenic MTU1010. *ICE1* transgenic rice plants produced significantly higher grain yield as compared with WT plants under control conditions as well as stress conditions. CRISPR-Cas technology helps development of elite cultivars with desirable alleles by precision gene editing. Hence, a study was carried out to create mutant alleles of *DROUGHT AND SALT TOLERANCE (DST)* gene by using CRISPR-Cas9 gene editing in indica rice cv. MTU1010. A transgene-free homozygous dst mutant with 366 bp deletion ($dst^{\Delta 184–305}$) was identified which has a deletion of amino acid residues from 184 to 305 in frame. The $dst^{\Delta 184–305}$ mutant enhanced leaf water retention under dehydration stress, reduced stomatal density and enhanced tolerance to salt stress. Thus, appropriate regulation of ABA-dependent and –independent genes by using genetic engineering and genome editing offers solution to development of stress tolerant rice varieties.

T1S1ORAL01

Evaluation Different Salt Tolerant Paddy Varieties in Sodic Soil and Farmers Preference for Adoption in Tiruchirappalli District in Tamil Nadu

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Salt-affected soils, those on which plant growth is limited by an excess of salts. Rice is suitable for rehabilitating saline and alkaline soils because of its ability to grow under flooding and its high potential for genetic improvement. But, modern high yielding varieties required considerable investment to ameliorate these soils to ensure reasonable yields and this investment is beyond the capabilities of the resource-limited small holder farmers living off these salt affected areas. Hence, this study was conducted on assess the performance of different salt tolerant rice varieties at farm field level to improve the yield potential of rice for the improvement of salt affected areas of Tiruchirappalli district. The present experiment was conducted in sodic soil during rabi season at Manikandam block of Tiruchirappalli district, Tamil Nadu during 2015-16 & 2016-17. The soil of the experimental farm is clay loam in texture with low in Organic carbon content (0.3 per cent), pH value of 9.2, EC is 1.9 dS m^{-1}, ESP is 39 and the fertility level falls under low in N (150 kg ha^{-1}) and P (5.0 kg ha^{-1}) and medium in available K (212.5 kg ha^{-1}). Half of required gypsum @ 755 kg ha^{-1} was used for reclamation, daincha as a green manure crop was raised and incorporated in soil @50% flowering stage at before planting. Uniform cultural practices were applied to all the varieties up to maturity. Proper plant protection measures were taken according to the incidence of pest and diseases. Five paddy varieties viz., Paddy BPT 5204 (farmers practice), Paddy TRY 3 (released by TNAU), Gangavathi Sona (05-01) (Released by, ARS, Gangavathi, Karnataka) and CSR 36 (released by CSSRI, Karnal) were studied under investigation. Among the varieties, more paddy yield was recorded from Paddy TRY 3 36 (69.6 q ha^{-1}), which was followed by CSR 36 (55.8 q ha^{-1}), Gangavathi sona 05-01 (48.7 q ha^{-1}), BPT 5204 (45.5 q ha^{-1}) and CO 49 (43.6 q ha^{-1}), respectively. Net return was recorded maximum of (Rs. 77,900) from Gangavathi sona 05-01 followed by Paddy TRY 3(Rs. 65,470) and least in BPT 5204 (Rs. 47075). It was observed from the performance of different varieties that the Paddy TRY 3 yielded highest straw yield of 97. 9 q ha^{-1}, which was followed by CSR 36 (81.2 q ha^{-1}). It was concluded that Paddy TRY 3 (69.6 q ha^{-1}), recorded more yield and performed better under

sodic soil. Whereas, Gangavathi sona (05-01) registered more net income of Rs.77,900 in sodic soil due to nature of grain and market preference.

T1S1ORAL02

Response of Landraces and Wild Relatives of Rice from Goa and Karnataka Coast for Induced Salt Stress at the Seedling Stage

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Salt stress is the second most widespread problem affecting the rice crop worldwide after the drought. Identification of novel salinity tolerant sources from the germplasm pool would help in widening the genetic base and thereby reducing the genetic erosion. Traditional rice landraces and wild relatives from the coastal and interior parts of Goa and Karnataka are unique in terms of their phenotype, response to salinity and water stagnation, and yield attributes. The explorations were conducted from2013 to 2018 coinciding with the harvesting during *kharif* season. A total of 160 genotypes comprising mostly landraces, few wild relatives, and cultivated varieties were screened for induced salt stress at the seedling stage in the micro plots. The experiment was carried out during the rabi season of 2020-21 in four microplots in an augmented design accommodating 43 genotypes in each of the tanks and three check varieties (FL478 and Pokkali as tolerant checks and IR29 as a sensitive check) was repeated in all the four tanks. A single row was maintained for each genotype with 16 seedlings per row at spacing of 15 cm between the rows and 10 cm between the hills. Germinated seeds were sown directly in the micro plots of size 8m length, 1.8 m width, and 1.2 m depth. After the emergence of the second leaf, salt-water was introduced in the tank and the electrical conductivity (EC) of the irrigation water was raised slowly till it attained the final EC of 12 dS m^{-1} on the 14th day. Later salinity level was maintained at EC~12 dS m^{-1} till the sensitive check variety (IR29) showed a highly sensitive (HS) reaction (SES score 9). Scoring was done as per the IRRI standard evaluation scoring method. Among the genotypes screened, eight genotypes showed tolerant (T) reaction to salt stress, 20 genotypes were moderately tolerant (MT) and the remaining 132 genotypes showed sensitive (S) to a highly sensitive (HS) reaction. Tolerant genotypes from the study are Goa Dhan 2, Goa Dhan 4, *CST 7 1,* Korgut, Kaveri Gidda, GWR 016, Dodgi, and KS 04. The observations were recorded for seedling vigor, shoot length, root length, fresh shoot and root weight, and dry root and shoot weight. From this study, we identified eight genotypes showing tolerance reaction to salt stress at the seedling stage. These genotypes could be utilized as donors alternate to frequently used FL478 and Pokkali in the development of new high-yielding salinity tolerant varieties.

T1S1ORAL03

Submergence Tolerant Red Rice Variety Sahyadri Panchamukhi for Low Land Situation of Coastal Karnataka

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Rainfed Rice cultivation in lowland ecosystems of coastal Karnataka is largely dominated by the traditional varieties. They are characterized by tall plant types prone to lodging, poor responsive to fertilizer inputs, and generally low yielding. Yearly, more than 500 ha area is being affected by flood, because of incessant rain in the region and hence, farmers are unable to get high returns. To overcome the lodging and yield constraints, intensive efforts were made in AICRIP on Rice, at Zonal Agricultural and Horticultural Research Station, Brahmavar and the outcome of the efforts led to the identification of the red rice variety named Sahyadri Panchamukhi (IET 27670). It is a pure line selection from IRGA-318-11-6-9-2B (IRLON- Module 2, INGER, IRRI, Philippines). Field experiments for the past three years, this variety recorded16% increased yield over local check red rice MO 4. In AICRP trial, IVT-IM of *kharif* 2018 at Brahmavar centre the IET No.27670 exhibited the significant higher yield (5975 kg ha^{-1}) with 30%, 60% and 16% increase yield over the National check, Zonal check and local check respectively. In AICRP trial, IVT-IM of kharif 2018 with 64 entries over 32 locations, IET27670 was exhibited significant higher Grain yield in Kota (7739kg ha^{-1}), Pattambi, Kerala (7709 kg ha^{-1}), Patna (7030 kg ha^{-1}) and Katlagere (7000 kg ha^{-1}) and was superior to Ratna, Sabour Shree, Sweta, Rajendra Sweta, JGL 1798 and MO 4 the local check(IIRR, 2018). AICRIP screening nurseries trials *Kharif*-2018 incidence of pest (18 location) and disease (34 location) also evaluated and IET27670 showed the tolerance reaction to NSN-2 Leaf Blast, Neck Blast, Brown spot, Sheath blight, Sheath rot and BLB and similarly for pest like Stem borer damage, leaf folder damage, BPH+WBPH and gallmidge. Evaluation of physio-chemical characteristics and cooking, organoleptic study of the entry IET No.27670 were made along with check at the Central Rice Research Institute, Cuttack and AICRP on Rice (FAN), Bangalore respectively. The tests revealed that the red kernelled medium bold variety required less water uptake (175 ml per 100g) and become more bulk density after cooking compared to check MO4. Besides having less Leached out solids (0.36 per 10 g), soft texture, good appearance, little aroma and Tasty too and the physical characteristics of this entry is hulling% is 77 and milling% is 67.0. The Farmers accepted the variety because of its medium bold red kernel with medium duration, semi tall, non-lodging, submergence tolerant and higher grain yield with tolerance to gall midge, blast and major insect pests. The variety is also tastier with mild aroma, lesser cooking time and lesser water requirement for cooking and is suitable for parboiling and higher zinc content (20.0 ppm) compared to MO 4 (15 ppm). It is recommended and accepted for the release in Zone 10 of Coastal Karnataka for lowland situation in Kharif season by Annual technical meeting and ZREP work shop held at UAHS, Shivamogga. Similarly, in the 38th state seed sub- committee in 2019 it was for the release in the name Sahyadri Panchamukhi in Zone 10 of Coastal Karnataka for lowland situation in Kharif season. The National Bureau of plant Genetic Resources had given National Identity number IC 630611 for this red rice variety.

T1S1ORAL04

Evaluation of Rice Genotypes for Tolerance to Seedling Stage Salinity Under Hydroponics

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Rice is continuously being challenged by varying agro-climatic and soil conditions and important among them is soil salinity considerably impacting plant growth and yield. Area under salinity in India itself accounts for 6.25 m ha and is continuously increasing because of anthropogenic activities, sea water inundation, excess ground water usage and excessive use of chemicals and fertilizer. It has been speculated that by the end of year 2050 India will be home to 16 m ha of saline soil encroached by sea (sea level rise) and increasing inland salinity. This has posed a challenging task in front for breeders to improve rice with better adaptability to saline soils and continuously improving yield and grain qualities. In the present study thirty two (32) rice genotypes were evaluated for their tolerance to seedling stage salinity tolerance under hydroponics. Seeds were placed on floating tray in hydroponics without nutrient solution for four days for germination. Later, Yoshida nutrient solution was added as per protocol of IRRI and seedlings were grown for ten days. Salinity treatment was given on 10 days old seedlings (14th day after seeds were placed on tray) and salinity was maintained at EC of 8-10 dSm^{-1} by adding table salt as per requirement. Traits such as SPAD chlorophyll reading of third leaf from top was taken on 10th day after induction of salinity. Morphological observation on root length, shoot length was taken on 14th day after salinity induction. Standard Evaluation Scoring (SES) on a scale of 0-9 was performed on 14th day after salinity induction as per IRRI manual. Based on overall observation, Agami, Nona Bokra, Pokkali, FL478, PNL1, Bulk 212, CSR46, BMZ24 and BRRIDhan78 were moderately tolerant to tolerant for seedling stage salinity. Genotypes such as IR29, VSR156, Pusa44, IR64 and Sadri were susceptible for seedling stage salinity tolerance. These results assume significance in breeding for tolerance to coastal salinity in rice.

T1S1ORAL05

DNA Barcoding of Rice (*Oryza sativa* L.) Varieties Developed by Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli

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DNA barcoding is a new advanced step to DNA fingerprinting which makes use of short sequences from a standardized region of a genome to provide quick and reliable identification of species among all forms of life. DNA barcoding is reported in animals based on mitochondrial gene CO1 and that in plants has been reported in the

plastidal genome regions. Reports have suggested that candidate loci belonging to chloroplast genome and nuclear genome have studied by DNA barcoding to discriminate plant at inter and intraspecies level. DNA barcodes derived from the chloroplast genome can be used to identify varieties and in the conservation of breeding resources. The variations in the barcoding loci have been used to construct the barcodes for the varieties under study. The present study was conducted with an objective to characterize and add a molecular tag i.e. the DNA barcode for the 16 varieties developed by Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli. The present study involved 10 barcoding loci primers, evolutionary analysis and phylogenetic relationship study was done using MEGA software. CLUSTAL Omega online tool detected the conserved region in the varieties. Data analysis results showed that parsimony informative sites estimated with maximum 161 sites recorded in psbA-trnH, followed by 159 sites trnK and 33 rbcL, 21 in matK and number of variable sites reported highest in psbA-trnH 568, trnK 457 and matK1M-matK3RIM 285.While nucleotide diversity (per site pi) reported maximum in trnK 0.1455.

T1S1ORAL06

SSR Marker Analysis for the Identification of the Elite Rice Variety Lavanya with its Parent VTL-3 and DNA Fingerprinting

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Indigenous rice varieties of Kerala possess several adaptable features like resistance to various abiotic and biotic stresses. Farmers however, experience heavy crop loss due to tall stature of majority of these varieties, as they are prone to lodging Mutagenesis has proved to be a very effective tool for improving specific characters of existing rice varieties. Several researchers have reported successful uses of induced mutations to improve characters like plant height, maturity period and grain characteristics. A tall high yielding rice variety VTL-3 which is popularly cultivated in the Pokkali ecosystem was developed by Rice Research Station, Vyttila which is tolerant to salinity stress. Farmers however, experienced about 40 – 50% yield loss due to the lodging nature of VTL-3 rice variety. Hence, this variety was subjected to mutagenesis by gamma irradiation to generate semi- tall mutant lines. Gamma irradiation with 40 KR doze was effective in inducing semi dwarfism in Pokkali rice genotype VTL-3. The selected seven mutant lines were screened with SSR markers linked to Saltol QTL along with parental variety VTL-3 and check varieties to confirm whether the Saltol region is unaffected in the mutant lines. Culture 51.5 selected after comparative yield trials of the mutant lines and screening with Saltol markers, which was later released as Lavanya, was further screened with 48 SSR markers to generate DNA fingerprinting of the selected mutant line and the parental variety. Molecular profiles were generated with 14 SRR markers linked to Saltol QTL out of which only three markers showed variations in the banding pattern with respect to their parent. All the other markers exhibited the same banding pattern as VTL-3. This confirms that the Saltol QTL is retained in the mutant lines and induced mutagenesis of VTL-3 to generate semi- tall lines did not affect the salinity tolerance trait. The selected mutant line of VTL-3 (Lavanya) along with its parent VTL-3 and check varieties were screened with a total of 48 SSR markers covering all the 12 chromosomes of rice. A total of 55 bands were detected across the varieties used. Eight markers were found to be polymorphic between Lavanya and its parent, VTL-3. The number of allele per locus ranged from 1 to 3 with an average of 1.14 and the size of PCR products ranged from 110 to 300 bp with Polymorphic Information Content (PIC) from 0 to 0.5. Therefore, these eight markers can be effectively used to distinguish mutant elite rice variety Lavanya from the parent variety.

T1S1ORAL07

A GIS-Based Diversity Assessment of Indian Sunhemp (*Crotalaria juncea* L.) Accessions for Enhanced Biomass and Fibre Yield

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Sunhemp (*Crotalaria juncea* L.) is an annually renewable multipurpose nonwood fiber crop. It is one of the oldest fibre species from the Indian subcontinent being grown since 600.Traditionally the fibre is used for cot stringing, unsized twine, fishing nets, matting, sacking, marine cordage, coarse canvas, bags and ropes. Apart from the conventional applications, sunhemp has been evolved as an annually renewable non-food substrate for lingo cellulosic biofuel production. The crop can be easily grown during fallow periods between major cash crops with minimum inputs, which helps in sustainable use of limited land and water resources and solves the problem of "food vs. fuel" debate for biofuel production. The fibre is rich in cellulose, containing 75.6% cellulose, 10.05% hemicellulose, 10.32% lignin, with high crystallinity (80.17%) and degree of polymerization (650). One kg of sunhemp fibres contain 756 g of cellulose, yields 595 g of glucose and 203 g of hydroxymethyl furfural (furanic biofuel precursor), further fermentation of glucose produces 75.6% bioethanol. Biofuels produced from non-food lignocellulosic feed stocks like sunhemp have the potential to replace a significant percentage of fossil fuels. In order to cash such enormous industrial applications, there is a need to improve the biomass and fibre yielding potentiality of sunhemp by redesign the breeding programs by including newer and diverse germplasm lines. In this endeavour, the present investigation was undertaken to understand the existing variability of Indian sunhemp accessions for enhanced biomass and fibre yielding potentiality and to identify the genotypes for population improvement program. An experiment was designed to evaluate 42 germplasm accessions assembled from ten different states of India. Phenotypic evaluation revealed significant genetic variability among the genotypes for biomass and fibre yield leading to identification of several promising accessions. DIVA-GIS approach identified eastern Rajasthan, western Jharkhand and border area between Bihar and Jharkhand as sites of highest sunhemp diversity. Further, grid map for specific traits viz., green biomass yield and fibre yield was generated and locations with highest phenotypic value for the trait was identified. Sunhemp accessions with high green biomass yield were found mainly in eastern and southern districts of Rajasthan (Pali, Alwar, Dausa and Sawai Madhopur) and parts of northern Orissa region. Whereas, only accessions from eastern and southern districts of Rajasthan were turned out to be high fibre yielders, which means these accessions has got good fibre recovery percentage. Cluster analysis and PCA grouped the 42 sunhemp accessions into three clusters. Cluster II and III are highly divergent harboring contrasting phenotypes. Inter-mating of these genotypes is expected to generate high population variability. Hence, it suggests use of these germplasm in population improvement program to break the yield barrier in sunnhemp.

T1S1POS01

Agro-Morphological, Yield and Grain Quality Analysis of *Sub1* Introgressed Lines of Jyothi

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Plant breeders are always faced with the challenges of improving crop varieties and making them tolerant to various abiotic stresses. Most of the popular high yielding rice varieties of Kerala are sensitive to submergence. In the current study, Marker Assisted Backcross Breeding (MABB) was used to introgress *Sub1* QTL from submergence tolerant *Swarna-Sub1* into the genetic background of Jyothi, the most popular high yielding rice variety of Kerala to produce submergence tolerant rice variety. The BC_3F_2 seeds from *Sub1* introgressed progenies were subjected to necessary field trials for seed collection as well as to evaluate the agronomic traits and yield. Newly developed *Sub1* introgressedJyothi along with both donor and recurrent parents were planted with three replications following Randomised Block Design (RBD). Observations on days to 50% flowering, days to maturity, plant height, panicle length, number of productive tillers per plant, number of filled grains per panicle, 100 grain weight and grain yield per plant and total yield were recorded and statistically analysed. The results suggested that developed lines were found to be more or less similar to recurrent parental characters in terms of certain agronomic traits. Some plants showing better performance than the recurrent parent based on the measured traits were also identified. All the progenies had significantly better yield than the recurrent parent. Progenies 32-57-8-4, 45-65-1-4, 12-6-2-8, 32-57-8-1, 32-57-9-3, 32-57-8-8, 32-57-18-4, 45-65-1-10, 32-57-18-1and 32-57-9-5 produced a yield in the range of 8.08 – 8.42 t ha^{-1}. Grain quality of a new variety is the most important parameter which determines the acceptability of the variety. Hence breeders have always considered grain quality mandatory next to grain yield for developing a cultivar. In the current study, grain dimension, kernel colour and cooking and eating quality parameters of the *Sub1* lines of Jyothi developed through MABC programme were analysed along with the parental lines to identify high yielding superior quality grains of introgressed lines. Length/breadth ratio of all the screened *Sub1* introgressed lines ranged from 2.7 - 3.2. The introgressed lines were found to have low and intermediate amylose content. Few lines exhibited an alkali value of 5 with intermediate gelatinization temperature whereas majority of the progenies exhibited lower alkali value with higher gelatinization temperature. According to gel consistency measurement, all the introgressed lines except for two of the progenies were found to have softer gel consistency. With respect to grain colour, all the developed lines were found to have red grains similar to the recurrent parent Jyothi. Among the 20 BC_3F_2 progenies screened, nineteen progenies had protein content values on par with the recurrent parent ranging from 7.63 - 9.31%. A total of six progenies were selected after field evaluation of the 20 *Sub1* introgressed BC_3F_2 lines of Jyothi for agro- morphological traits. Therefore, these selected lines with improved yield and preferred grain quality can be subjected to further proceedings necessary for release of a new variety.

T1S1POS02

Field Evaluation of Agro- Morphological Characters in *Sub1* Introgressed BC_3 Lines Developed Through MABB

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Rice (*Oryza sativa* L.) is the major staple food crop of Asia. Submergence is the third important abiotic stress affecting rice crop in coastal ecosystems of Kerala due to heavy showers of South-West monsoon. The most possible solution to overcome this problem is to introgress submergence tolerant gene into high yielding rice varieties. Hence, the study was undertaken to introgress submergence tolerant gene into the rice variety Jaya through Marker Assisted Backcross Breeding. The national yield check rice variety Jaya is used as recurrent parent and Swarna *Sub1* as donor parent. Recurrent parent and donor parent crossed to raise F_1 seeds and these F_1 plants were backcrossed with recurrent parent to raise BC_1F_1 generation. In the same way, BC_2F_1 and BC_3F_1 generations were raised. The selection of tolerant plants in each generation was done using the selected polymorphic foreground, recombinant and background markers. The selected introgressed BC_3F_1 plants were selfed to raise BC_3F_2 generation which were subjected to background screening to select the best introgressed line with maximum background recovery. The BC_3F_2 progenies were evaluated in the field during '*kharif*' 2017 in replicated comparative yield trial in randomized block design to assess their field performance along with the recurrent parent and the donor parent. Apart from yield, other yield attributes were observed and statistically analysed. Polymorphism assay using 625 Simple Sequence Repeat markers could select three foreground, five recombinant and 76 background polymorphic markers. The genotypic selection of heterozygous plants was made in F_1, BC_1F_1, BC_2F_1 and BC_3F_1 generations and in selfed progenies homozygous plants were selected using the selected foreground and recombinant markers. The segment size of introgressed donor Sub1 region into the selected twenty BC_3F_2 progenies was estimated to be 3.1-5.1 Mb. The percentage recovery of the recurrent parent genome in the best BC_3F_2 progeny was 95.3 %. Five superior BC_3F_2 lines viz. BC_3F_2-3-2-6-8, BC_3F_2-5-21-5-2, BC_3F_2-3-5-4-6, BC_3F_2-3-5-4-2 and BC_3F_2-3-5-4-7 were selected for further evaluation to prove the confirmity of superior performance. Correlation analysis of fourteen morphological characters of twenty BC_3F_2 lines was done to find the correlation coefficient among the variables. The parameters 50% flowering duration, crop duration, total grain number per panicle and filled grain number per panicle were significantly correlated with grain yield whereas grain length and 1000 grain weight had inverse relationship with grain yield. This inverse relationship might be due to the very small grain size of Swarna Sub1 which recorded the maximum grain yield due to the extra-long duration of 25 days compared to Jaya. The best performing 1 or 2 lines from the selected lines can be released as a new variety after assessing the repeatability of performance in two more comparative yield trials and based on the performance of these selected lines in farm trial.

T1S1POS03

Chemical Priming for Improving Salinity Tolerance in Rice

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Rice cultivation in coastal regions of Kerala is affected by soil salinity. Though certain traditional varieties like Pokkali are tolerant to salinity, the most customer rated varieties like Jyothi and Uma are sensitive to salinity stress. Breeding for salinity tolerance is an alternative but a time consuming and laborious work can well be substituted by the use of certain chemicals. Initiating a mild stress at germination can help the plant to cope with salinity at later stages. Exploiting this clue of how seed germination and after growth are linked, an experiment was conducted at Rice Research Station, Vyttila to assess the effect of chemicals as seed primers for improving the salinity tolerance level of rice varieties under salinity stress. The study consisted of two parts viz., screening of rice varieties for salinity tolerance and effect of seed priming to improve salinity tolerance. The First experiment was a laboratory study to screen three rice varieties namely Jyothi, Uma and Vytilla-10 at five salinity levels *i.e.*, non-saline, 3 dS m^{-1}, 6 dS m^{-1}, 9 dS m^{-1} and 12 dS m^{-1}. Based on the results it was concluded that at 16 DAS variety Jyothi was found susceptible at 6 dS m^{-1} whereas variety Uma was moderately tolerant and variety Vytilla-10 was highly tolerant. At 21 DAS, varieties Uma and Vytilla-10 were found to be susceptible at salinity levels of 6 and 9 dS m^{-1} respectively. In continuation with the experiment, seeds of these varieties were primed with three priming chemicals namely beta amino butyric acid (BABA) at1 Mm L^{-1}, calcium chloride at 2% and sodium nitroprusside (SNP) at 100 µM and with water as control. The germinated seedlings of Jyothi and Uma were raised at salinity levels of 6 dS m^{-1} and 9 dS m^{-1}, while seedlings of Vytilla-10 was raised at salinity levels of 9 dS m^{-1} and 12 dS m^{-1}. The efficacy of each priming chemical was analysed based on germination percentage, growth parameters and visual salt injury symptoms. Priming seeds with 2% calcium chloride was found to influence both the growth parameters and salinity tolerance of seedlings.

T1S1POS04

Effect of Potassium and Coastal Saline Water on Yield, Nutrient Accumulation and Uptake by Rice

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A pot culture experiment was conducted to assess the interaction effects of salinity and potassium nutrition on rice during 2018. A pot experiment was conducted in CRD with three replications and twelve treatments consist

of four levels of diluted coastal saline water (0, 2, 4 and 8 dS m^{-1}) and three doses of potassium (60, 120 and 180 kg ha^{-1}). The crop received a common dose of N @ 120 kg ha^{-1} (in splits) and P @ 60 kg ha^{-1}. The crop received saline water irrigation up-to saturation point at 30, 45, 60 and 80 DAP (days after planting). The study indicated that the cumulative application of saline water @ 4 and 8 dS m^{-1} decreased the grain yield and straw yield, yield components, potassium content and uptake by rice whereas, sodium content and uptake increased significantly at higher level of salinity (4 and 8 dS m^{-1}). The adverse effect of Na was reduced with application of potassium. The grain and straw yield, yield component, potassium content and uptake by rice was increased with increasing the dose of potassium. The sodium content and uptake by rice was reduced significantly with higher dose of potassium (180 kg ha^{-1}) application. Based on the present study, split application of potassium @ 180 kg ha^{-1} is recommended for rice in saline soil. The K^+/Na^+ ratio in soil and plant can be considered as a best indicator in evaluating crop performance in saline soil.

T1S1POS05

Genomic and Transcriptomic Approaches to Accelerate Salinity Stress Tolerance in Jute (*Corchorus spp.*)

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Salinity or salt stress is a major factor restricting the expansion of jute in saline environments that might reduce competition with food crops for arable land. Because salt stress affects a cascade of different pathways in metabolism and physiology, understanding the response at a molecular level is critical for targeted genetic modification or breeding efforts in plants. In recent years, both at national and international levels, genomics and transcriptomics have been exploited to identify stress-tolerant genes that are regulated by salinity stress. The application of digital gene expression tag profiling (DGE), using next-generation sequencing (NGS) strategy to transcriptomics study, allows in-depth characterization of transcriptional events responsive to stress treatments. For the mining of novel alleles of stress tolerance in jute and allied fibres, genome-wide analyses were performed to identify Aquaporins (AQPs), multifunctional stress protein family genes, in both Tossa and White jute. Jute genomes have been recently sequenced, and the first detailed genome-wide analysis of the AQP gene family in jute provides valuable information through functional analysis about their role in abiotic stress response. In the case of *Corchorus olitorius*, 39 AQP genes were identified, including nine NOD26-like intrinsic proteins (NIPs), eight tonoplast intrinsic proteins (TIPs), 12 plasma membrane intrinsic proteins (PIPs), and eight small basic intrinsic proteins (SIPs), based on sequence homology and phylogenetic relationship with *Theobroma cacao, Gossypium raimondii* and *Arabidopsis thaliana*. Similarly, in *C. capsularis*, 35 AQP genes were identified, which included 11 PIPs, 10 NIPs, eight TIPS, and three SIPS. Analysis of the gene structure of Major Intrinsic Protein (MIP) genes revealed that the distribution of introns and exons in the AQP genes is highly variable. NIP genes contained four introns each, whereas PIPs contain either two or three introns. Variations were also observed among different subfamilies in terms of gene size, CDS size, and average intron lengths. The expression profile of *Corchorus* AQP genes revealed their role in salt stress responses. qPCR analyses showed that distinct differential expression among genotypes and within tissues. PIP genes providing salt tolerance could be potentially targeted to impart salinity tolerance in jute. This presentation will offer an update on the progress made and the challenges ahead in developing designer jute cultivars with broad-spectrum salt tolerance by harnessing the advances of genomics and molecular breeding.

T1S1POS06

Development of Ionome (Salt-Omic) for the Varietal Improvement and Food Security of Coastal Population of India

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Global agricultural productivity of economically important crops are regulated by soil salinity, one of the major abiotic constraints faced by the farmers. The genomic, transcriptomics and metabolomic salt profiling of coastal crops could provide an insight into the mechanisms by which the differential performance is regulated in contrasting varieties of a single crop. The economically important varieties of rice, maize, mung-bean, potato, tomato, cotton and sunflower are susceptible to salinity stress. Plant can tolerate salinity stress by processes including salt exclusion or inclusion. The most predominant form of salt stress involving NaCl causes nutrient and metabolic imbalance affecting major physiological response. Increased salt stress leads to ion toxicity affecting water retention capacity of the plant. In this study an attempt is taken to identify Ionome (Salt-Omic) for legume grown in coastal region emphasizing mung-bean (*Vigna radiata*). The most relevant metabolic pathways, gene markers, proteins/ aminoacids, secondary metabolite such as polyamines suitable for biotechnological improvement of coastal saline legumes were identified. Functional genomic studies with meta-analysis of data available at public domain were accessed and utilized for Ionome construction of legumes. Metabolic marker analysis identified some common compound equally responsive in saline and high temperature stress.In the salt genome analysis segment, the appropriate genes in legumes were identified and categorized. The genes were classified into ion transport genes, senescence associated genes, molecular chaperones, dehydration genes. In transcriptome in addition to protein coding sequences, micro RNAs and endogenous small interfering RNAs were proved crucial in varietal response in legumes. The metabolome construction included distinct signatory compounds. This repository will be vast resource for initiation of salinity studies in mung-bean and other members of Leguminosae family. The bioinformatics tools like DEG, GEO, DAVID, PANTHER, KEGG were found useful for identifying different salt-responsive biomolecules. The study was able to differentiate between salt tolerant and resistant gene-sets and could help in formation of Ionome for the improvement of coastal legume crops. This repository could assist molecular plant breeders in their research and with gradual up-gradation may aid in the development of bio-tools similar to CODIS, AMBAB or RiceMetaSys.

T1S1POS07

Genotypic Variability in Physiological Traits of Black gram under Salinity Stress

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The Blackgram (*Vigna mungo* L.) is one of the salt sensitive legumes cultivated in arid and semi-arid conditions of

India. Towards changing the scenario, now it is also cultivating in rice fallows of coastal areas where salt problems are becoming severe. A laboratory experiment was conducted in completely randomized design replicated five times with fifty blackgram genotypes at Division of Basic Sciences, ICAR-Indian Institute of Pulses of Research, Kanpur. The experiments were conducted both in paper roll (14.5 dS m^{-1}) and pot culture (7.5 dS m^{-1}) at two different concentrations through NaCl induced salinity stress. A significant variation was observed among the genotypes for germination percentage, radicle survival percentage, seedling survival, SPAD chlorophyll meter readings, dry biomass and yield. The relative values of these traits revealed that genotypes STY 2801, SPS 29, PANT U30 and KC 153 performed better while genotypes UG 378, PLU 158, PLU 99-10, and PANT U 40 performed poorly under salinity conditions. Under salinity stress, relative percent reduction in dry root biomass recorded more as compare to total dry biomass of seedlings. Ion uptake and total soluble sugar were estimated in selected contrasting genotypes in soil culture under salinity stress. Tolerant genotypes (SPS 29 and Pant U 30) showed higher accumulation of sodium ion concentration in shoot tissues as compared to sensitive genotypes (PANT U 40and PLU 158) under saline condition. The identified blackgram genotypes will pave the way to breed for tolerant varieties to enhance the crop production under salinity stress condition.

T1S1POS08

Screening of Segregating Mapping Population of Tossa Jute (*Corchorus olitorius*) for Stem Rot Resistance

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Stem rot of jute caused by *M. phaseolina* is one of the most important diseases of jute as it reduces fibre production, as well as, fibre quality. Attack at early stage leads to the death of the plant resulting total crop failure, while infection at the latter stage damage the quality of the bast fibre. Although fungicide application is an effective measure of controlling this disease, host resistance is much more preferable for the resource poor jute farming community as the pathogen can survive on several alternate hosts making it almost impossible to eradicate by chemical measures. But unfortunately, neither any stem rot resistant jute verity is available till date, nor there exists any report of genomic regions involved in resistance to jute stem rot. Keep in this view, involving two moderate resistance (RS-6; resistant & red stem and OIN-154; resistant & ovate leaf) and two susceptible parents (OIJ-172; Green stem and OIN-456; Lanceolate leaf) to *Macrophomina phaseolina* for developing mapping populations. In between we made all possible cross combinations during kharif-2018 and subsequently raised F_1, s in next season. Then, in kharif-2020 we found that only mapping population OIJ-172 × RS-6 {χ^2 cal value = 1.11} and OIN-456 × OIN-154 {χ^2 cal value = 0.01} were segregated in 3:1 ratio of resistance to susceptible as per the Mendel law of inheritance. This mapping population were screened for resistance against stem rot disease caused by the infection of necrotrophic fungus *Macrophomina phaseolina* using stem inoculation method in the kharif-2020 at ICAR-CRIJAF, Barrackpore. Progress of infection was measured as length of infected stem portion (i.e., lesion length in cm) after 7 days, 14 days and 21 days of inoculation. None of the lines were found to be immune (no disease) or highly resistant (lesion length <2.0 cm). Although, in population OIJ-172 × RS-6 ten plants were exhibited moderately resistant symptoms while in case of mapping population OIN-456 × OIN-154 five plants exhibited moderately resistant symptoms and remaining were showed moderate to highly susceptible symptoms.

T1S1POS09

Rice Grain Quality Characteristics of Improved Varieties of Karjat Centre under B.S.K.K.V. Dapoli University

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Rice (*Oryza sativa* L.) is one of the most important food crops as it is consumed by more than half of the world's population (Khush, 2005). Visual characteristics of rice grains are important search attributes that affect consumers' purchasing decisions and hence are used as some of the first selection criteria in varietal improvement programs (Tomlins *et al*., 2007). The quality of rice grain includes in four major group, first grain appearance consist of length, breadth, grain type and chalkiness, second milling quality it includes hulling and milling percentage, third cooking and biochemical quality characteristics it consist of water uptake, volume expansion ratio, alkali spreading value, gel consistency and amylose content and last fourth nutritional quality includes crude protein content. The objective of this experiment is to evaluate the improved rice varieties of Karjat centre for their quality parameters. The data pertaining to the grain quality parameters revealed that Trombay Karjat Kolam variety showed highest milling and head rice recovery percentage i.e. 73.71 and 67.98 respectively with absent of grain chalkiness to all varieties. The Water Uptake ranged from 260 to 330 ml per100gm of rice, was observed highest in Karjat-6 (330 ml/100gm). The Volume Expansion Ratio (VER) ranged between 2.83 to 6.0 which was observed highest in varieties Karjat-6, Karjat-8 and TrombayKarjat Kolam (6.00). The Elongation Ratio ranged from 1.67 to 1.85 was observed highest in Karjat-9 (1.85). The Alkali Spreading Value of different cultures ranged from 4.0 to 6.0. The highest spreading value indicates the Karjat-7 variety. Among the 10 improved varieties released by Karjat centre the Amylose content was found intermediate (20-25%) to varieties Karjat-3, Karjat-4, Karjat-5, Karjat-6, Karjat-8, Karjat-9, TrombayKarjat Kolam, Karjat-184 i.e 22.75, 23.19, 24.29, 22.81, 23.64, 23.52, 23.09 and 24.56% respectively. The varieties Karjat-2 and Karjat-7 showed high amylose content i.e. 25.01 and 25.45. All rice varieties exhibited medium to soft Gel Consistency. The gel consistency is important parameter for defining the softness of starch granules when particularly amylose is high. The Gelatinization Temperature showed the time required for cooking. Among ten varieties seven are showed High-Intermediate Gelatinization Temperature, two varieties are showed Intermediate(70-74OC) Gelatinization Temperature and one variety indicate Low (55-69oC) Gelatinization Temperature. In improved varieties Karjat-6 variety found highest for protein content (8.33%). Overall, it is concluded that on the basis of milling and nutritional quality TrombayKarjat Kolam and Karjat-6 showed superior performance as compare with other varieties.

Theme I:

Systems approach for coastal zone development: agriculture, horticulture & plantation crops and their tolerance to biotic & abiotic stresses

SESSION II:

Agricultural crop management and cropping system intensification

T1S2I01

CROPPING INTENSIFICATION IN THE SALT AFFECTED COASTAL ZONES OF THE GANGES DELTA

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Dr. Mohammed Mainuddin is working as Principal Research Scientist with the Water Security Program of CSIRO Land and Water based in Canberra, Australia. He has over 30 years of research experience in integrated water resources management and modelling for river basins, coastal water and salinity management, irrigation systems performance analysis, agricultural productivity and food security analysis, socio-economic and livelihood issues related to water use, and impact of climate change on water availability, agricultural productivity and food security. He has worked on several major river basins in Asia, Australia, Africa, and South America and has experience of working in Australia, Bangladesh, The Netherlands, Thailand, Pakistan and Sri Lanka as a resident. Non-resident assignments included India, Laos, Cambodia, and Vietnam. He is currently leading projects in Bangladesh and India dealing with cropping system intensification in the coastal zone, sustainable groundwater management for food security and, improving agricultural productivity.

Abstract: The contiguous coastal zone of the Ganges delta in Bangladesh and West Bengal, India is of great significance for food security, biodiversity conservation, fisheries production and climate change adaptation and mitigation. Due to its low elevation, the delta is highly vulnerable to inundation from rising sea levels. These areas are disadvantaged by poverty, food insecurity, environmental vulnerability and limited livelihood opportunities. The governments of Bangladesh and West Bengal have targeted the coastal zone as the region most in need of poverty alleviation and improvement in food security. CSIRO of Australia along with several Australian, Bangladeshi and Indian organizations has been leading the research project 'Cropping system intensification in the salt-affected coastal zones of Bangladesh and West Bengal, India' since 2015 funded by the Australian Centre for International Agricultural Research (ACIAR) and Krishi Gobeshona Foundation (KGF) of Bangladesh. The project aimed to sustainably increase cropping intensity and productivity in the coastal zones of the Ganges delta particularly in the dry (Rabi) season through integrated soil, water and crop management. The activities of the project were carried out in 3 selected polders: Amtali, Barguna and Dacope, Khulna in Bangladesh and Gosaba Island in West Bengal. The activities included understanding of the surface water and groundwater resources, groundwater recharge/discharge mechanisms, salt and water dynamics and their trends in three selected polders, and crop production responses to various improved crop water management strategies. These were done through detailed salt and water balance calculations, surface water, groundwater and salinity interaction modelling at the polder level. Apart from the polder level modelling, extensive field experiments and demonstration were conducted in the fields within the polders in every cropping season (*Kharif*-I, *Kharif*-II, and *Rabi*) over the last 5 years. These experiments were on improvement of the productivity of main *Kharif*-II rainfed rice, introduction and finding suitable varieties of *Kharif*-I (Aus) and Boro rice, introduction of new crops, varietal screening, early establishment using different techniques such as zero tillage, relay cropping, dibbling, mulching, etc., management of different Rabi season crops and use

of different types of irrigation and drainage. The results of these experiments and underpinning model assessments have demonstrated strategies that are likely to increase productivity, cropping intensity and profitability. Significant achievements of the project will be presented in this paper.

T1S2I02

COASTAL AGRICULTURAL DEVELOPMENT IN BANGLADESH: SOIL FERTILITY AND LAND PRODUCTIVITY

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Abstract: Coastal areas cover about 30% of total agricultural lands in Bangladesh. Out of 2.85 million ha, 0.83 million ha are affected by salinity of variable intensities. In last 40 years, salinity has increased by 26%, but in recent decade it has increased by 3.5% indicating that salinity increasing rate is faster than earlier decades. Rise in sea water level, reduction in upstream flows, tidal surge, unplanned shrimp culture, etc are responsible for increased salinity. Such increased salinity is destroying soil fertility and health and finally cause reduced land productivity. Coastal pollution from inlands and transboundary sources are another dimension of soil and water quality degradation. As global surface temperature is increasing, mineralization loss of carbon is also magnifying that need to be reversed through management practices. Besides, salt composition varied greatly in coastal Bangladesh and so does soil reclamation would be different for crop production. So, generation of futuristic scenarios of land suitability based on salinity, fertility and soil health can help in delineating future agriculture for the coastal Bangladesh. As fresh water resources are becoming scarce, tuning up of fertilizer doses for brackish water agriculture need to be developed. Steps for soil health improvements by adopting different management practices are more than imperative for sustainable crop production in coastal Bangladesh.

T1S2I03

THE BENEFITS AND RISKS OF EARLY SOWING OF RABI SEASON CROPS IN THE COASTAL ZONE OF THE GANGES DELTA

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Prof. Richard Bell has held academic positions at Murdoch University, Perth, Australia since 1990 and has been Professor of Land Management since 2007. Most of his research has been on plant and crop nutrition and on management of problem soils, generally in the context of cropping and farming systems. Internationally, he has led collaborative research in Bangladesh, Cambodia, China, Thailand and Vietnam (principally supported by the Australian Centre for International Agricultural Research) and developed research partnerships with Brazil, India, and Turkey. He has supervised 65 PhD and Masters students. He has published over 200 peer reviewed articles in journals and edited 15 books.

Abstract: Early maturing rice varieties in the Ganges coastal zone can out yield current farmer's varieties, and when introduced to cropping systems open the opportunity for cropping system intensification by facilitating early sowing of Rabi season crop provided drainage of excess water can be effectively managed. In order to optimize early sowing of Rabi season crops, time of sowing experiments were conducted in Dacope, Khulna, Bangladesh for at least two years with wheat, maize, sunflower, mustard, grass pea, lentil and spinach. Early sown Rabi season crops out yielded those sown after the natural recession of the flood waters. Wheat produced a maximum yield of 4.2-4.4 t ha^{-1} when sown between 25 November and 1 December. Delay in sowing decreased wheat yield. Similar benefits with early planting (late November to mid December) were found in experiments for yield of sunflower, maize, lentil, and grass pea. For wheat and sunflower, early sowing delays flowering which lengthens the vegetative growth period: the longer vegetative growth together with higher level of soil water and lower soil salinity appear to explain why the early sown crops have higher yield potential in the coastal zone. Crop modelling with APSIM showed that for simulations over the period 1995-2018, the optimum period for establishment was 15-30 November. Earlier sowing than 15 November, apart from being more difficult to manage due to excess standing water and heavy rainfall risk, exposes crops to greater winter chilling which decreased yield potential. Delayed sowing after 15 November increased the risk of salinity damage to crops. APSIM modelling suggests that salinity had minimal effects on crops sown on 15 November, but thereafter the longer the delay in sowing the increased the probability of low yield due to salinity. However, heavy late monsoon rainfall in early December depressed wheat yield from over 4 t ha^{-1} (which was highly profitable) to about 1 t ha-1 which was not profitable). Maize yields were depressed from 8-9 t ha^{-1} to 4-5 t ha^{-1}. In other cases, where standing water remained in fields for several days severe crop damage occurred. By contrast, when surface water was drained immediately in one experiment, sunflower survived and substantially recovered to produce about 2.0 t ha^{-1}. Hence there are significant risks with early sowing in the Rabi season, and further research needs to focus on risk alleviation strategies for the early-sown Rabi crops. Boro rice appears less influenced by delays after optimal sowing time (15-November) due likely to enhanced flushing of salts in comparison with Rabi crops: it may present a better option for later sowing opportunities or where the risk of waterlogging from early sowing cannot be managed.

T1S2I04

FARMING SYSTEM INTENSIFICATION FOR THE COASTAL ECOSYSTEMS

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Abstract: The population of the world is expected to grow from 7.79 billion currently to 9.75 billion by 2050. Similarly, the population of India is increased from 1.35 billion currently to 1.6 billion by 2050. Population in urban areas will also increase from the present 31% to around 51% by 2050. As a result of this whole dynamics, the country will require to produce an estimated 377 million tonnes of food grains by 2050 up from the current level of about 291.95 million tonnes. While striving to achieve the projected production with more intensive agriculture, there could be a severe strain on land and water resources. Besides, it may result in major environmental problems such as degradation of soils from overuse of chemical fertilizers, indiscriminate use of pesticides causing health hazards, the decline in crop diversity, overexploitation and deterioration of groundwater quality, waterlogging, and soil salinity. Since there is little scope to expand the net sown area to achieve the targeted food production of 377 million tonnes by 2050, it would require increasing the cropping intensity in the main land and coastal areas. The coastal agro-ecosystem in India occupies a sizable area. Agriculture and allied activities are the major livelihood of the people but the productivity is usually low as it is hindered by a cluster of problems. Coastal agricultural practices are less stable than upland agriculture because they need to cope with frequent changes in salinity, tidal processes, water stresses and waterlogging. Coastal eco-systems are greatly impacted by location-specific land use To address these problems, research organizations located western and eastern coastal regions developed a number of technologies such as land shaping, on-farm water harvesting structures to improve drainage and facilitate double cropping, aquaculture, integrated nutrient management, improved Dorouvu technology to skim freshwater floating on the saline water, reclamation of abandoned aqua ponds, reducing the influence of brackish groundwater table at shallow depth for soil salinity build-up during dry months, diversification and multiple crop cultivation round the year on mono-cropped coastal land beside developing rice varieties for deep and medium surface water stagnation during monsoon season.

T1S2I05

CROPPING SYSTEM CHARACTERIZATION OF COASTAL SEASONAL WATERLOGGED AREAS USING GEO-SPATIAL TECHNOLOGY

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Dr. Gouranga Kar is presently the Director of ICAR-Central Research Institute for Jute and Allied Fibres (ICAR-CRIJAF), Barrackpore. Earlier he served as Principal Scientist, ICAR-Indian Institute of Water Management, Bhubaneswar. He has been trained under Norman Borlaug Fellowship Programme, Michigan State University, USA (2008) and Fulbright-Nehru Post-doc Programme, Michigan State University, USA, 2011-12. He has done pioneering effort in quantification of water footprint in India on farm scale and also handled 35 National/ International projects like IWMP, FPARP, DST, NICRA, TIFAC, UNDP and Fulbright scheme related to water and watershed management, crop growth modelling, climate change research, mitigation and adaptation, land use and cropping system using RS and GIS. He has published more than 200 research papers, review paper and book chapters of immense academic as well as practical importance. For outstanding work in the field of natural resource management, Dr. Kar has received many prestigious awards like ISCA young scientist award, 2001; ICAR Vasant Rao Naik Award 2004; IARI Sukumar Bosu Memorial Award; ASWC Dr. K. G. Tejwani Award 2006 ; ISSS Golden Jubilee Commemoration Young Scientist Award 2007 ; ICAR Hari Om Ashram Trust Award 2007-08; USDA Norman Borlaug International Agricultural Science and Technology Fellowship Award 2008 ; NAAS Associateship 2008 ; DWM Proficiency Award 2008 & 2011; R.C. Patro Memorial Award 2009 ; Bharat Jyoti Award 2011 ; NAAS Recognition Award 2012; Fulbright Senior Research Fellowship (USA) 2011-12; Rajdhani Samman Award 2015; Ekamrashee Award 2016; IARI Hooker Award, 2018; ICAR-Swami Sahajananda Saraswati Award 2019; Rajbhasa Gaurav Puraskar 2019. He holds important editorial board member positions of several scientific journals of national and international repute in agricultural and allied sciences. He is also fellow of different scientific Societies like National Academy of Agricultural Sciences (FNAAS), Indian Society of Soil Science (FISSS), Indian Association of Soil and Water Conservationists (FIASWC), Association of Agro-meteorologists (FAAM), and West Bengal Academy of Science and Technology (FWAST). For his outstanding work in the field of natural resource management, ICAR also offered him National Fellowship.

Abstract: India has more than 7,500 km long coastline and a significant amount of population living around low-lying flood prone coastal regions. Coastal regions are the hub of economic activities such as fisheries, agriculture, tourism, energy, etc. and are under direct threat of climate change. The coastal zone of India suffers from multiple weather hazards like flood, drought, cyclone etc. Further, the saucer shaped land forms, high rainfall (average 1500 mm) due to southwest monsoon (June-September), poor drainage condition make these coastal regions susceptible to waterlogging and flood prone and area remains submerged for about 3-4 months (July-October) under water depths varying from 0.5-2.0 m in low lying areas and 0.10-0.50 m in high land areas. Indian coast is highly vulnerable to the risks associated to rising sea levels due to global warming. Flooding is just one of the challenges in the coastal areas are already facing and that more areas will face in the future as sea level will rise due to climate change/global

warming. It is therefore, urgently needed to develop appropriate sustainable water and crop management strategies to enhance the productivity for the resource rich coastal waterlogged ecosystem. Sustainability should be the hallmark of the technology development which must be agronomically suitable and socio-economically viable for the region. Water harvesting, pond-based farming system, crop diversification can provide an opportunity to increase farm income of coastal areas. In this study, based on surface waterlogging depth in rainy season, soil type and digital elevation model (DEM), pond centric farming/ land modification-based farming (waterlogging tolerant rice, fish inside pond, un-dyke vegetable, un-dyke agroforestry, aquatic crops, poultry) etc. were developed for waterlogging depth of 0.75-2.0 m at Satyabadi block, Puri, Odisha, India during 2006-20018. At 0-0.75 m surface waterlogging depth, dugwell based drip fertigation with crop diversification, vegetable-vegetable/rice-vegetable cropping system were developed at representative coastal area (Gudpada, Cuttack) during 2014-2018. After assessing the impact, the integrated pond-based farming with poultry, fish, vegetables, on-dyke agroforestry system was found to be a viable option in the area, specially where surface waterlogging depth exceeded 0.5 m. On an average, the region receives 1500 mm annual rainfall and 75-80% of which occurs during rainy (June-Sept) season. During winter season (December-January), only 44.0-54.9 mm rainfall occurs but erratic. Coefficient of variation (%) of monthly rainfall was less during southwest monsoon season but rainfall is highly erratic and variable during summer and winter seasons. Therefore, carry-over flood water /residual soil moisture need to be effectively utilized to grow second crops along with some supplementary irrigation. The above proven technologies were then up-scaled throughout the coastal districts of Odisha using remote sensing and GIS after developing Composite Land Development Unit (CLDU) by overlaying digital elevation model (DEM), slope, land use and soil map of the coastal districts of Odisha. Though many earlier workers used remote sensing and GIS technology as for achieving sustainable land use and land cover plan but these studies were mainly confined to watershed/basin under rainfed situation. In this study, depth and duration of flood and surface waterlogging depth were used to up-scale proven crop and water management technologies. A set of decision rules were applied on CLUDs to generate action plan map, showing location specific recommendations on sustainable water and crop management strategies in the entire coastal belt of Odisha. The technological options included growing of waterlogging tolerant rice varieties, rice-based cropping system, introduction of aquatic crops, the integrated pond management with poultry, fish and vegetables, on-dyke agroforestry etc. where water depth varied from 0.5-2.0 m. In highland areas with 0.10-0.50 m waterlogging depth, dugwell based drip fertigation, vegetable-based farming, crop diversification with low water requiring crops etc. were implemented. After assessing the impact, the integrated pond management with poultry, fish, vegetables, on-dyke agroforestry system was found to be a viable option in the low-lying areas with net income ranging from Rs. 60,000 to Rs. 95,000 and income from drip-fertigation was about 1,60,000-2,30,000 per ha from low-lying areas. These proven technologies were then up-scaled throughout the eleven coastal districts of Odisha using remote sensing and GIS though geostatistics based interpretation technique.

T1S2ORAL01

Optimization of Nitrogen Rate for Wheat Grown under Zero Tillage in Coastal Saline Soils

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The cropping system is improving from single crop to double crop in the saline soil of southwestern (SW) coastal Bangladesh. As an emerging cropping pattern judicious nutrient management is essential for sustainable and profitable crop cultivation. The field experiments were conducted in two repeated years with a view to optimize the nitrogen (N) rate for wheat under zero tillage in wet and saline soils. Grain yield of wheat substantially improved

from 0.67-4.14 t ha-1 with the increase of N from rates from 0 to 140 kg ha^{-1} afterwards declined. We concluded that N @ 140 kg ha-1 would be optimum for recommendation under zero till wheat in the coastal saline soil of SW Bangladesh.

T1S2ORAL02

Exploring Nutrient Prescription Techniques for Sustaining Rice Productivity in Coastal Ecosystem

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Law of minimum states that "The yield of any crop is proportional to the amount of the most limiting nutrient, whichever nutrient it may be". From this, it is clear that adequate and balanced supply of nutrients is one of the most important aspects for a successful crop production. Starting from the first phase of soil analysis correlation work carried out at IARI, many concepts and approaches of fertilizer recommendation have been evolved at different periods and situations by researchers. After analyzing the merits and demerits of important fertilizer recommendation methods and their adoption in different situations, the present investigation was programmed to evaluate various fertilizer recommendation methods for sustaining the rice productivity in Sanyasikuppam soil series of Puducherry U.T. The experiment consisted of three replications and fourteen treatments viz., farmer's practice, Blanket, STL, IARI and STCR methods of fertilizer recommendation through inorganic and organic combinations, and also through solely inorganic in RBD. The results revealed that, plant height, leaf area index, number of tillers, productive tillers, dry matter production, root biomass, grain and straw yield, and gross and net returns were higher in the treatment combination of STCR method through inorganic and organic, for targeted yield of 8 t ha^{-1}. The B:C ratio was the highest in the targeted yield of 8 t ha^{-1} through inorganic alone. From this study, it is concluded that STCR method of fertilizer recommendations inveterated their supremacy on the higher productivity of rice and profitability to farmers.

T1S2ORAL03

Evaluation of *Zymo grainrich* on the Growth, Physiology and Yield of Rice

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Organic farming system in India is not new and is being followed from ancient time. It is a method of farming system which primarily aimed at cultivating the land and raising crops in such a way to keep the soil alive and in good health by use of organic wastes (crop, animal and farm wastes, aquatic wastes) and other biological materials along with beneficial microbes (bio-fertilizers) to supply nutrients to crops in a sustainable way with an eco-friendly pollution free environment. FAO suggested that "Organic agriculture is a unique production management system which promotes and enhances agro-ecosystem health including biodiversity, biological cycles and soil biological activity which is accomplished by using on-farm agronomic, biological and mechanical methods and exclusion of all synthetic off-farm inputs. A biotechnology formulation of M/s UAL (P) Ltd., Chennai "*Zymo grainrich*" is a biological preparation that can be used instead of synthetic fertilizer for which field evaluation was undertaken during rabi 2019-20 with rice as the test crop under both normal and SRI method of planting. The treatments include

T_1 - Recommended Fertilizer Dose (RFD), T_2 - *Zymo grainrich* @2.25 kg per ac, T_3 - *Zymo grainrich* @2.25 kg per ac with 50% RFD, T_4 – *Zymo grainrich* @2.25 kg per ac with RFD of only DAP and T_5 - *Zymo grainrich* @1.125 kg per ac with RFD of only DAP. Most of the growth parameters like plant height, number of tillers, Leaf Area Index (LAI), Shoot and Root Dry Matter Production (DMP), Chlorophylla, band total chlorophyll content in the leaves etc. even though was much favoured by the RFD fertilizer treatments at the early growth stages of the crop due to its immediate availability, the Zymo grainrich treatments remained statistically on paranda like in response to that of the RFD treatments in the later growth stages due to the stable, persistent and constant action of the product in the root rhizosphere region. The productive tillershill-1 produced by the SRI method of rice cultivation was substantially higher than the normal method of planting. On a statistical point of view, the RFD treatment and *Zymo grainrich* application @ 2.25 kg ac-1 had registered significantly similar, statistically equal and highest grain yield under both normal and SRI method of planting. Similarly, none of the soil properties viz. pH, EC, Organic Carbon, available N, P and K significantly varied between nutrient treatments in the post-harvests oil, however, the pH was greatly stabilized to neutral reaction in the *Zymo grainrich* application treatments while slight acidification reaction resulted in the RFD treatments when compared to the initials oil properties.

T1S2ORAL04

Effect of Planting Time, Levels and Time of Nitrogen Application on Growth and Yield of Sweet Potato (*Ipomea batatas* L.)

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A field experiment was conducted during Kharif season of 2017 at AICRP on Tuber Crops, Central Experiment Station, Wakawali, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri (M.S.). The soil of experimental plot was sandy clay loam in texture and acidic in reaction having pH 5.30. It was medium in available nitrogen (360.5 kg ha^{-1}) and medium in available phosphorus (16.21 kg ha^{-1}) and potassium (238.5 kg ha^{-1}) with high in organic carbon. The experiment was laid in split plot design with three replications. The main plot treatments comprised of three planting times (D_1-24th MW, D_2-26th MW and D_3-28th MW), sub plot treatments comprised of three nitrogen levels (N_1-100kg N ha^{-1}, N_2-75kg N ha^{-1}, N_3-50kg N ha^{-1}) and sub-sub plot treatment comprised of time of application (T_1- Full basal dressing, T_2-50% basal + 50% top dressing at 30 DAP). The results of the present investigation revealed that the growth attributes viz. vine length, number of subsidiary vines plant-1, number of leaves plant-1, number of nodes per main vine, chlorophyll content in leaves and dry weight matter are significantly superior in 24th MW planting time than rest of the planting times. Similarly, the number of tubers (3.86), tuber diameter (3.90 cm), tuber weight (61.18 g $plant^{-1}$) and tuber yield (19.72 t ha^{-1}) are significantly superior in 24th MW planting time than rest of the planting times. The increase in tuber yield in treatment of 24th MW planting was to the tune of 6.74, and 7.96 per cent than 26th MW and 28th MW planting, respectively. The fertilizer level N_1 i.e. 100 kg N ha^{-1} was significantly superior in vine length, number of subsidiary vines $plant^{-1}$, number of leaves plant-1, number of nodes per main vine, chlorophyll content in leaves and dry weight matter as compared to the rest of the nitrogen levels. Similar trend was observed as regards to yield the yield attributes i.e. number of tubers $plant^{-1}$ (3.92), tuber diameter (4.08 cm), tuber weight (63.77 g $plant^{-1}$) and tuber yield (21.55 t ha^{-1}). The increase in tuber yield in treatment N_1 was to the tune of 9.1 and 25.2 per cent than the treatments D_2 and D_3, respectively. Under time of application of nitrogen, the treatment T_2 (Nitrogen application as 50% basal + 50% top dressing at 30 DAP) found significantly superior in different growth attributes like number of subsidiary vines, dry weight matter and chlorophyll content in leaves than the treatment T_1 (Full basal dressing). Similarly, the treatment T_2 recorded

significantly superior values of yield attributes than the treatment T_1. The treatment combination $D_1N_1T_2$ recorded highest net profit of Rs 249912.50 ha^{-1} with B:C ratio (1.81). From the above results, it can be inferred that, planting of sweet potato in 24th MW with 100 kg N ha^{-1} in two splits (50% basal +50% top dressing at 30 DAP) was found better in recording significantly highest growth and yield parameters with high monetary returns and maximum B:C ratio.

T1S2ORAL05

Upgraded Mechanical Weeder and Novel Herbicide for Efficient Jute Weed Management in Southern Bengal Condition

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It is generally accepted that herbicidal method of weed management in jute is cheap, but it has several limitations such as- shift of weed flora, developing resistance to applied herbicides, detrimental effect on soil microbes, chance of pesticide residue in the fibre and adding pollution load to the environment & human habitat. There are still scope and need of more research and development on weed management in jute encompassing especially upgraded mechanical means separately or in combination and in complementary approach with novel herbicidal method. Therefore, field experiment was conducted in the southern Bengal condition to find out an effective, easy, economical and less environment affecting weed management strategy (in combination of methods) for the small & marginal jute farmers as well as for commercial jute cultivators. From the results of the field experiment, it was recorded that two times manual weeding (7 and 21 DAS) produced the lowest weed dry matter at 42 DAS (35.57 g m^{-2}) and 60 DAS (25.07 g m^{-2}) in tossa jute. However, at 42 DAS, among the herbicidal and mechanical weed management methods, the lowest weed dry matter was noted either with ipfencarbazone @120 g ha^{-1} (PE) + CRIJAF nail weeder at 21 DAS (57.2 g m^{-2}) or with ipfencarbazone @120 g ha^{-1} (PE) + CRIJAF single wheel jute weeder at 21 DAS (57.87 g m^{-2}). The highest tossa jute (cv. JRO 204) plant height (PH) at harvest (120 DAS) was recoded with two manual weeding treatments (335.6 cm). Among the herbicidal and mechanical weed management treatments, it was observed that, ipfencarbazone @120 g ha^{-1} (PE) + CRIJAF nail weeder at 21 DAS produced the tallest jute pants (327.5 cm) closely followed by the plant height (PH) obtained with ipfencarbazone @120 g ha-1 (PE) + CRIJAF single wheel jute weeder at 21 DAS (318.7 cm) and with CRIJAF nail weeder at 7 DAS + CRIJAF single wheel jute weeder at 21 DAS (318.0 cm). Like PH, similar trends were observed in case of jute basal diameter (BD) at harvest. The highest jute fibre yield was obtained with two manual weeding (31.37 q ha^{-1}). Among the herbicidal and mechanical weed management methods considered, application of ipfencarbazone @120 g ha^{-1} (PE) + CRIJAF nail weeder at 21 DAS produced higher fibre yield (29.07 q ha^{-1}) closely followed by and at par fibre yield recorded with ipfencarbazone @120 g ha^{-1} (PE) + CRIJAF single wheel jute weeder at 21 DAS (28.72 q ha^{-1}). In both the efficacious combination treatments, the fibre yield reduction, due to competition from surviving weeds, was only 7.33 and 8.45%, respectively, as compared to the fibre yield obtained in manual weeding treatment.

T1S2ORAL06

Intensification of Rice (*Oryza sativa* L.) - Based Cropping System for Enhancing Land Productivity and Profitability under Coastal Region

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Coastal agriculture in eastern India is mostly dominant with rice-based production system. Based on the local agro-ecological condition, market and domestic needs of the people, rice-rice, rice-oilseeds, rice-pulses are major cropping systems practiced in costal ecosystems of eastern India. Lively hood of the most of the farmers of the region largely depends on sustainability of the rice production systems. To improve the productivity and profitability of the existing rice-based cropping systems on sustainable basis there is a need to exploit the possibility of crop diversification and ecological intensification with minimum impact on environment. Thus, to find out the suitable intensified rice-based cropping system for coastal ecologies of eastern India effect of crop diversification and intensification in rice-based cropping sequences was studied at ICAR-National Rice Research Institute, Cuttack (20.5° N, 86° E and 23.5 m above mean sea-level) located in the 'East and south-eastern coastal plain agro-climatic zone' of Odisha during 2018 and 2019. The experiment was laid in randomized block design and replicated thrice. The treatments consist of T_1: Rice - rice, T_2: Rice - groundnut, T_3: Rice – blackgram, T_4: Rice - blackgram + toria, T_5: Rice - maize, T_6: Rice - maize + blackgram, T_7: Rice – maize + cowpea. Rice variety 'CR Dhan -310 was grown during *kharif* season in both of the years. After the harvest of rice crop winter crops were grown with recommended package of practices. Yield and yield attributes were recorded at harvest of the respective crops. The data were analyzed statistically in Ms-Excel for RBD as per the standard procedures, following the "Analysis of Variance" (ANOVA). The differences in the treatment means were tested by using least significant difference (LSD) at 5% level of probability. Results of the experiment reveal that rice-maize cropping sequence recorded higher rice equivalent yield (10.92 t ha^{-1}) and it was at par with the rice-rice and rice-groundnut cropping sequence. Intensification of rice-maize cropping sequence with inclusion of blackgram or cowpea as an inter-crop in maize registered 10.9 and 20.5% increase in rice equivalent yield respectively as compared to rice-maize system. Rice – maize + cowpea recorded highest rice equivalent yield (13.16 t ha^{-1}), net return (Rs.132480), B: C ratio (2.27) and land productivity (57.2 kg REY day^{-1} ha^{-1}). Thus, rice-maize + cowpea/blackgram cropping system could be recommended as an alternative to the conventional rice-rice sequence to enhance the land productivity and profitability under coastal eco regions of eastern India.

T1S2ORAL07

Influence of Rainfall Variability and Waterlogging on Coastal Cropping Intensity in Bangladesh

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Coastal areas of Bangladesh are exposed to many natural hazards that hamper agricultural productivity. Rainfall

variability and waterlogging along with heavy texture of soils are major obstacles for crop intensification, although recent research results showed promising evidence of productivity improvement with early maturing rice cultivars. Farmers have chosen BRRI dhan87 for shallow water depth areas and BRRI dhan76 for deeper water environments and achieved a yield gain of 1.0-1.5 t ha^{-1} over local varieties. These varieties can be harvested 15-30 days earlier than local varieties and thus open the window for the early establishment of rabi crops. Farmers started to grow watermelon, sweet gourd, sunflower, maize and boro rice based on the water resources and land suitability but failed in many instances because of rainfall variability in the dry season. To address such issue, we have analyzed about 40 years (1981-2018) rainfall data of dry season obtained from six weather stations located in the coastal zones of Bangladesh. In dry season, the frequency of heavy rainfall (>10 mm) and very heavy rainfall (>20 mm) occurred in 42-43% and 18-23% cases, respectively, which created waterlogged conditions and hampered successful cultivation of non-rice crops in heavy textured coastal soils during the dry season. The return periods of heavy rainfall and very heavy rainfall in November to December were every 1.3-1.4 years and 1.5-2.5 years, respectively, resulting in delayed establishment of rabi crops. While considering later part of the rabi season, the return periods for heavy and very heavy rainfall in March to April were every 1.3-1.5 and 1.6-2.1 years, respectively that damaged non-rice crops at the ripening stage. We have found such types of rainfall patterns in three years out of four cropping seasons during 2015-16 to 2019-20. So, risk management and intensification of cropping intensity could be done by growing boro rice when suitable irrigation water sources are available and by encouraging farmers for growing pre-monsoon rice in coastal areas of Bangladesh.

T1S2ORAL08

Effect of Organic, Inorganic and Integrated Nutrient Management Practices and Various Cropping Systems on Yield, Economics and Soil Fertility in North Konkan Coastal Zone of Maharashtra

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Field experiments was conducted to evaluate theeffect of organic, inorganic and integrated nutrient management practices and various cropping systems on yield, economics and soil fertility in north Konkan coastal zone of Maharashtra during 2018-2019 under Network Project on Organic Farming, Model Agronomic Experiment Farm, Karjat, Dist. Raigad, Maharashtra. There were three nutrient management treatments viz. organic, inorganic and integrated and four rice based cropping systems viz. Rice-Brinjal, Rice-Chickpea, Rice-Field bean and Rice-Onion (White). The experiment was conducted in a Split plot design with six production system and four cropping system with three replications. Nutrient management treatments were allotted to main plots while cropping systems were assigned to sub plots. The Results revealed that the application of 100 per cent organic package (1/4 FYM+1/4 Glyricidia + 1/4 Rice Straw + 1/4Neem cake to *Kharif* rice and 1/3 FYM +1/3 Neem cake + 1/3 Vermicompost to Rabi crops) produced maximum and significantly higher total rice equivalent yield (REY) of 331.53 q ha^{-1}, higher gross returns (Rs. 5,37,073 ha^{-1}) and net returns (Rs. 3,34,753 ha^{-1}) as compared to other production systems. However, the B: C ratios were significantly higher under 100% inorganic package (2.63). The maximum and significantly higher REY (522.96 q ha^{-1}), gross returns (Rs. 8,47,190 ha^{-1}), net returns (Rs. 5,72,749 ha^{-1}) and B: C ratio (3.10) were observed under Rice-Brinjal system as compared to other cropping systems studied. Rice-Brinjal system grown with 100 per cent organic package produced maximum and significantly higher REY (622.40 q ha^{-1}),

net returns (Rs. 6,86422 ha^{-1}) of the system as compared to rest of the treatment combinations. However, B:C ratios were significantly higher under 100% inorganic package (3.80). The effect of different treatments on availability of soil nutrients was also studied after harvest of Rabi crops. The results showed that application of 100 % organic package recorded maximum and significantly higher organic carbon (1.54 %), available N (272.12 kg ha^{-1}), P (12.11 kg ha^{-1}) and K (317.24 kg ha^{-1}) in soil as compared to 100 % inorganic package and Farmer's Practice. Further, Rice- Field bean system remained at par with Rice- Chickpea system and both the systems recorded significantly higher available N and P and K of soil over Rice- Brinjal and White onion systems.

T1S2POS01

Supplemental Use of Non-Saline Irrigation with Saline Irrigation during the Dry Season Can Triple Sunflower Fresh Water Productivity in the Ganges Delta

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Rising global sea level and increasing global populations mean that in many coastal regions freshwater will be increasingly unavailable for agricultural crop production. Increasing fresh water productivity (FWP) may therefore be the only way to sustain agricultural crop productivity over the coming century; this entails the decreased use of freshwater and the increased use of brackish or saline water. Two field experiments were conducted in a coastal saline area of Bangladesh with sunflower during the Rabi season to increase FWP (crop yield per unit of freshwater use, a new term for sustainable use of natural resources). Our system of labelling treatments reflects the fact that *Rabi* crops in southern Bangladesh generally require 3-4 irrigations per season. We use sequences of numerical suffixes behind the letter T to indicate the ECw of the irrigation water used at each time of irrigation; thus T2/10/- indicates a sequence of three times of irrigation in which the first irrigation was with water of EC_w 2 dSm^{-1}, the second irrigation was with water of ECw 10 dSm^{-1} and the third irrigation was missed. Our work was also conducted with two times of sowing, a late sowing date (SD_2) or an early and late time of sowing (SD_1 and SD_2 respectively). In 2018, we applied irrigation water at EC_w values between 2 (fresh) and 10 dSm^{-1} with one late time of sowing (15 December = SD_2); the seven irrigation treatments were $T_{2/2/-}$, $T_{2/-/10}$, $T_{2/10/-}$, $T_{2/2/5}$, $T_{2/2/10}$, $T_{2/10/10}$ and$T_{6/10/10}$. In 2019, there were eight irrigation treatments, four with an early time of sowing ($T_{-/-/-/-\_SD1}$, $T_{-/2/2/3}\_SD_1$, $T_{-/2/2/10}\_SD_1$ and $T_{2/2/10/-}\_SD_1$) and four with a late time of sowing ($T_{-/-/-/-}\_SD_2$, $T_{2/2/2/3}\_SD_2$, $T_{2/2/3/2}\_SD_2$ and $T_{2/10/10/10}\_SD_2$); the times of sowing were 30 November (SD_1) and 15 December (SD_2). One fresh irrigation at the initial growth stages with two to three saline irrigations increased FWP for sunflower 3-12 fold in terms of seed and oil yield compared with the use of two to four fresh irrigations. Early sowing decreased the need to use fresh water for the first irrigation, which also increased FWP. This saved freshwater was replaced by the saline water in the later growth stages. We conclude that the early planting of moderately salt tolerant Rabi crops have the potential to increase FWP many-fold. The risks of long-term salinization in these soils may not be high because the soils generally receive more than 1200 mm of rainfall in the Kharif season, which would leach the salt.

T1S2POS02

Effect of Boron and Zinc Application on Yield of Cowpea (*Vigna unguiculata* L.) and Soil Properties in Alfisol of Konkan

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Cowpea is grown as a sole crop in this region, mostly during late *Kharif* or *Rabi* or summer season after rice. Cowpea is highly responsive to fertilizer application. Boron (B) and Zinc (Zn) are the essential plant micronutrients and their importance for crop productivity is similar to that of major nutrients. In fact, both these elements are thought to be found deficient in soils of Konkan region. Keeping this in view, the present experiment was designed to study the effect of different levels of boron (1.0, 1.5 and 2.0 kg ha^{-1}) and zinc (2.5, 5.0 and 7.5 kg ha^{-1}) either alone or in combinations along with recommended dose of fertilizers i.e. 25:60:40 N:P205:K20 kg ha^{-1} + Rhizobium and PSB @ 25 g kg^{-1} seed on growth, yield cowpea (*Vigna ungiculata* L.), changes in physico-chemical properties and nutrient availability in Alfisols of Konkan. The experiment was undertaken at Research and Education Farm, Department of Agricultural Botany, College of Agriculture, Dapoli, Dr. B.S. Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri during Rabi, 2019-20, laid out in Randomized Block Design comprising eleven treatments and three replications. The yield of cowpea and available nutrient status of soil indicated graded increase in parameters with increments in doses of boron (1.0, 1.5 and 2.0 kg ha^{-1}) and zinc (2.5, 5.0 and 7.5 kg ha^{-1}) alone as well as in combinations, suggesting the mutual synergism between Zn and B, where application of recommended dose of fertilizers i.e. 25:60:40 N:P205:K20 kg ha^{-1} + *Rhizobium* and PSB @ 25 g kg^{-1} seed + Boron @ 2.0 kg ha^{-1} + Zinc 7.5 kg ha^{-1} resulted in significantly highest values of yield of cowpea as well as available nitrogen, available phosphorus, available potassium, available B, DTPA extractable micronutrients (Fe, Mn, Cu and Zn) and found to be beneficial in lateritic soils of Konkan from the view point of enhancing the production and productivity of cowpea.

T1S2POS03

Development of Technology for Enhancing the Productivity and Profitability of Organic *Kharif* Rice and *Rabi* Chickpea Cropping System in Konkan Coastal Region of Maharashtra

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In India, the rice-based cropping system is a major food production system with rice as the first food crop. The cereal-based cropping system is low-yielding and highly nutrient exhaustive resulting in the declining of soil fertility. Diversification of rice-based cropping systems with inclusion of pulses/legumes is known to improve soil organic matter through biological nitrogen fixation, root exudates, leaf shedding and higher below ground biomass.

The strategy for higher yields in the cropping system should be formulated using the combined application of organics and inorganic fertilizers coupled with the inclusion of crops in summer fallows for sustainable yields and preservation of soil health. Which will be helpful for improving the productivity of rice-based systems, eradicate the hunger and poverty, facilitate economic development and food security. The objective of this experiment is to evaluate the direct and indirect effect of organic manures and inorganic fertilizer for enhancing the productivity, profitability and its influence on nutrient use efficiency of rice crop. The research trial was conducted at Agronomy farm of Regional Agriculture Research Station, Karjat in *Kharif* 2019 and *Rabi* 2019-20 seasons. The experiment was conducted by using 5 treatments and 4 Replication with Randomized Block Design. The Karjat-3 rice variety was used for *Kharif* season and Digvijay chickpea variety used for Rabi season. Among treatmentsT_1- 100% RDF through inorganic fertilizers, T_2 - 100% RDN through organic manure (Equivalent of Nitrogen), T_3 - INM (75% through inorganic and 25% through organic sources equivalent of N), T_4 -Control (No fertilizer application) and T_5 -Farmers' practice (location specific). The results revealed that the treatment T_1 recorded significantly highest plant height, number of tillers m^{-2}, number of effective tillers m-2, filled grains $panicle^{-1}$, grain yield q ha^{-1}, straw yield q ha^{-1}, total dry matter production q ha^{-1} and REY of Kharif rice over rest of treatments except treatment T_3 which was at par. Test weight of rice was found to be non-significant. In case of Rabi Chickpea treatment T_1 recorded significantly highest plant height, number of branches $plant^{-1}$, number of pods $plant^{-1}$, test (1000 grain) weight, grain yield q ha^{-1}, stover yield q ha^{-1}, total dry matter production q ha^{-1} and REY of *Rabi* chickpea over rest of treatments which were tried in the experiment except the treatment T_3-INM (75% through inorganic and 25% through organic sources equivalent of N) which was at par. It is concluded that treatment T_1-100% RDF through inorganic fertilizers to *Kharif* rice followed by *Rabi* chickpea recorded significantly highest REY of the system. The net returns and B:C Ratio of the system was recorded higher by the same treatment over rest of the treatments.

T1S2POS04

Timing of Nitrogen Application Influence the Seed Yield of Sunflower Grown in the Coastal Soils of Southwestern Bangladesh

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Agricultural land use and cropping intensity in coastal region of southwestern (SW) Bangladesh is lower compare to that of country average. The cropping system in this area has been started to increase from single transplanted (T) aman to double crops by cultivating winter crops. Sunflower is well fitting in the wet soil of SW coastal Bangladesh under zero tillage. As new crops are adding, new nutrient requirement should be investigated. Sunflower response to nitrogen was found highly significant and seed yield increased with the increase rate of N and 150 kg N ha^{-1} was found optimum in this region. But when and how much N need to apply for better utilization by crop is essential to ensure profitable and sustainable N management. Therefore, the current study was conducted in the farmer's field at Pankhali, Dacope, Khulna with a view to investigate the appropriate timing of N application for better N utilization, growth and yield of sunflower. The experiment consisted of eight treatments varying the application time and amount keeping the same N rate (150 kg N ha^{-1}) [viz. F_1= 100% basal and no top dressed, F_2= 50% basal and 50% top dressed (20 DAE), F_3= 50% basal and 50% top dressed (20 & 40 DAE), F_4= 25% basal and 75% top dressed (20 & 40 DAE), F5= 25% basal and 75% top dressed (15 DAE, 30 DAE & 45 DAE), F_6= No basal and 100% top dressed (20 DAE, 40 DAE), F_7= No basal and 100% top dressed (10 DAE, 30 DAE & 45 DAE) and F_8= No basal and 100% top dressed (5 DAE, 20 DAE). 35 DAE & 45 DAE). The experiment was arranged in a randomized

complete block design with three replications. Seeds were sown by dibbling in wet soil (~45% moisture content) maintaining a spacing of 70 cm and 40 cm between line to line and seed to seed respectively. Seed was dibbled (~6-7 cm depth) and fertilizer was placed in the hole at both side of the seed. Timing of nitrogen had significant influence on growth and yield of sunflower. Basal application of N was very much essential for initial and subsequent growth but excess amount had no significant influence (50% basal) on growth and yield even harmful (100% basal) to seedlings. The highest seed yield (3.72 t ha^{-1}) was obtained from 25% basal and 75% top dressed with three splits (15, 30 & 45 DAE) which was statistically similar to 25% basal and 75% top dressed with two splits (20 & 40 DAE). The maximum net return (BDT 71459 ha^{-1}) was calculated from 25% basal and 75% top dressed (20 & 40 DAE). It can be concluded that 25% basal and 75% top dressed (20 & 40 DAE) would be suitable timing of N application for better yield and profitable N management for sunflower cultivation in wet saline soil of SW coastal Bangladesh.

T1S2POS05

Effect of Different Methods of Land Configuration on Yields and Nutrients Uptake by Wheat (*Triticum aestivum* L.) Under Partially Reclaimed Coastal Salt Affected Soil of South Gujarat

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The field experiment was carried out at Coastal soil salinity research station, Navsari Agricultural University, Danti during rabi seasons of 2016-17 and 2017-18 to study the effect of different levels of land configuration on yield and nutrient uptake of wheat under partially reclaimed coastal salt affected soil of South Gujarat. The land configuration methods comprises; flat bed (L_1), broad bed furrow (L_2), and ridge-furrow (L_3) as a main plot treatments. Pooled of two years revealed that yield attributes like effective tillers, spike length, spikelets $spike^{-1}$ grains $spike^{-1}$ etc., and yields of wheat crop significantly influenced due to the nutrients uptake i.e. nitrogen, phosphorus and potassium after harvest of crop. Among the land configuration methods; Broad bed furrow treatment (L_2) significantly influenced the yields and nutrient uptake by wheat crop.The broad bed furrow treatment recorded significantly higher grain yield of wheat (3893 kg ha^{-1}) which was 14.77% higher than the flat bed method. The ridge and furrow treatment registered significantly higher straw yield which was 5274 kg ha^{-1}, but it remained at par with broad bed furrow method. In case nutrient uptake, the broad bed furrow method recorded significantly higher total N (105.53 kg ha^{-1}) and P (15.44 kg ha^{-1}) uptake, while potassium uptake (143.87 kg ha^{-1}) was higher in ridge and furrow method but at par with broad bed furrow treatment.

T1S2POS06

Effect of Phosphorus and Biofertilizers on Growth, Yield and Quality of Groundnut (*Arachis hypogaea* L.) in Coastal Region of Maharashtra

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Field trials over two consecutive *rabi* seasons of the year 2017-18 and 2018-19 were undertaken to find out the effect

of phosphorus and biofertilizers levels on growth, yield and nutrients uptake by groundnut in Alfisols of coastal region of Maharashtra. Two kinds of biofertilizers i.e. vesicular arbuscular mycorrhizal fungi (AMF) and phosphate solubilizing bacteria (Pseudomonas) were added alone or in combination (no biofertilizer application, VAM @ 10 kg ha^{-1}, PSB @ 10 kg ha^{-1}, VAM + PSB @ 5 kg ha^{-1} and VAM + PSB @ 5 kg ha^{-1} each) and were compared to different rates of phosphorus (P) fertilizer @ 15, 30, 45 and 60 kg ha^{-1} when applied with recommended dose of nitrogen (N) and potassium (K). The factorial randomized block design was used with twenty treatment combinations which were replicated thrice. The results revealed that the application of phosphorus @ 60 kg ha^{-1} with recommended dose of N and K combined with VAM + PSB @ 10 kg ha^{-1} biofertilizers realized higher biomass and yield than lower dose of phosphorus and no biofertilizers application during the rabi season indicating the need of starter nutrients for hyphal growth and root colonization of AMF. The pod yield (35.86 q ha^{-1}), kernel yield (24.72 q ha^{-1}) and oil (50.23%) content were significantly the highest with the application of phosphorus @ 60 kg ha^{-1}. The co-inoculation of VAM + PSB @ 10 kg ha^{-1} each significantly increased the kernel yield (21.80 q ha^{-1}), test weight (63.46%), shelling percentage (68.93%) as well as oil (48.52%) and protein (28.35%) content. The application of phosphorus @ 60 kg ha^{-1} with dual inoculation of VAM + PSB @ 10 kg ha^{-1} each indicated the highest plant height and number of rachis which results in higher pod yield, kernel yield (27.06), test weight (68.33) and shelling percentage (72.70). However, the application of phosphorus @ 45 kg ha^{-1} also showed beneficial results in respect of the other treatment combinations. Therefore, a combination of 60 kg P ha^{-1} and VAM + PSB @ 10 kg ha^{-1} can increase groundnut yield from 22.89 to 35.86 q ha^{-1}. The results realized the significance of AMF in nutrient depleted soils as starter nutrients.

T1S2POS07

Management of Plant Na/K Ratio for Yield Enhancement in Coastal Saline Pokkali Rice of Kerala

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Pokkali is a special rice farming system in coastal saline soils of Kerala. Salinity, submergence and high inherent acidity are the major issues underlying this special system of rice cultivation. In saline soils, higher Na content and the resultant high ratio between Na and other cations like K, Ca and Mg within the plant become detrimental for crop. Maintaining a low ratio of Na with other cations especially with K, is considered to be an yield determining and salt tolerance criterion in crops. As no response to soil application of nutrients is observed in *Pokkali* rice, foliar nutrition of K is expected to maintain favourable nutritional balance within the plant. Hence a study was conducted with an objective to study the effect of the narrowing down of Na/K ratio in Pokkali rice by liming and foliar application of K. The experiment was conducted at Rice Research Station, Vyttila. Treatments included soil application of different levels of lime (500 and 1000 kg ha^{-1}) or dolomite (800 and 1600 kg ha^{-1}) alone and these treatments followed by foliar spray of sulphate of potash (2% foliar spray at 20 and 40 days after transplanting). These treatments were compared with foliar spray of sulphate of potash alone and a control (no amelioration, no foliar spray). The study showed that number of tillers per sq. m, number of panicles per sq. m, percentage of filled grains and grain yield were found to be higher for soil application of lime @ 1000 kg ha^{-1} followed by foliar spray of SOP at 20 and 40 days after transplanting. Sodium content in rice, Na/K ratio and Na/Ca ratio at 90 days after transplanting were negatively correlated with the grain yield. Among these ratios, higher Na/K ratio exhibited much more negative influence on the grain yield. Perusal of the data on correlation of Na/K ratio at different growth stages (20, 40 and 90 days after transplanting and harvest) with yield showed that Na/K ratio at the flowering stage is found to be the most critical one and treatments significantly influenced the plant Na/ K ratio at different stages of crop growth. So, maintaining a low Na/K ratio during the flowering stage benefitted the crop significantly. The control treatment recorded highest Na/ K ratio at all the stages. This indicated that amelioration and foliar spray of sulphate

of potash in the field had significant influence in reducing the plant Na/K ratio. Economic returns were also found to be higher on application of lime @1000 kg ha^{-1} and 2% foliar spray of sulphate of potash. Hence application of lime @1000 kg ha^{-1} and 2% foliar spray of sulphate of potash at 20 and 40 days after transplanting can be recommended for the increase in yield of *Pokkali* rice.

T1S2POS08

Interactive Effects of Salinity and Potassium on Maize

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A pot culture experiment was carried out during 2019-20 to evaluate the interactive effects of saline water irrigation and amendments on yield and nutrients accumulation by maize crop. The experiment was conducted in CRD with three replications. The treatment consists of 5 levels of saline water viz., 0, 8, 12, 16 and 20 dS m^{-1} and three levels of amendments i.e. FYM, K and FYM + K. The results indicated that cumulative application of saline water @ 8, 12, 16 dS m^{-1} decreased the shoot length (10-30%), root length (5-35%), shoot dry mass (50-65%), root weight (60-89%) and K uptake (52-69%) as compared to control. The Na content was increased by 25-107 % at same level of salinity. Application of FYM + K reduced the adverse effect of Na at all levels of salinity. The K^+/Na^+ ratio in maize plant and ECe of soil significantly correlated with several plant parameters. The K^+/Na^+ ratio in soil failed to correlate well with yield and nutrient accumulation. It is concluded that the K^+/Na^+ ratio in plant can be considered as a best indicator in evaluating crop performance in saline soils.

T1S2POS09

Effect of Saline Irrigation Water on Growth and Yield of Leafy Vegetables under Coastal Saline Soils of North Konkan Region

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The experiment was conducted three consecutive *rabi-summer* seasons of 2017-18, 2018-19 and 2019-20 in clayey saline soil having pH 6.75 at Khar Land Research Station, Panvel, Dist. Raigad (Maharashtra) to study the effect of different saline irrigation water levels on growth and yield of Palak, Dill and Spinach leafy vegetables under coastal saline soils of *North* Konkan region. The trial was laid out in FRBD design with 5 levels of saline irrigation water (pond water, 2, 4, 6 and 8 dSm^{-1}) and replicated thrice. The leafy vegetables responded significantly to saline irrigation water in relation to growth and yield. The data pertaining to soil pH and EC were collected at an interval of 15 days of entire crop growth. The three years pooled data revealed that the pond water treatment recorded significantly highest yield for Spinach, Radish and Dill as 10.09, 19.57 and 10.93 t/ha, respectively. Among the different levels of salinity water, pond water showed lowest electrical conductivity (EC) i.e. 2.46 dS m^{-1} and pH does not showed significant changes at initial to after harvest of crops. There was yield reduction with increase in salinity irrigation water. The yield reduction at irrigation water salinity of 8 dS m^{-1} for Spinach, Radish and Dill was

14.03, 16.66 and 58.38%. The results showed that Spinach is the tolerant among three crops followed by radish and dill. At irrigation water salinity of 8 dS m^{-1}, yield per ha was 15.65 t ha^{-1} for radish, 9.44 t ha^{-1} for spinach and 4.62 t ha^{-1} for dill. Thus, spinach and radish can be good choices for coastal salinity. Selection of particular crop can be done considering market prices and overall economics.

T1S2POS10

Impact of Different Tillage Systems on the Dynamics of Soil Water and Salinity in the Cultivation of Maize in a Salt-Affected Clayey Soil of the Ganges Delta

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The effects of minimum and reduced tillage have been investigated in many climatic regions for many cereal crops, but less research has been done for the mechanized establishment of non-rice dry season crops on poorly structured, wet clay soils in the salt-affected coastal zone of Bangladesh. Field experiments were conducted to identify the effects of different levels of soil disturbance on the establishment, growth and yield of maize, and soil physicochemical properties. Five tillage treatments namely: zero tillage (ZT), strip tillage (ST), bed planting (BP), single-pass shallow tillage (SPST) and double pass tillage (DP) were tested using Versatile Multi-Crops Planters (VMP) in 2017 and 2018 growing season. In both years, the emergence was faster and higher in ZT and ST treatments, but subsequent growth and development was better in BP treatment. Increased soil disturbance (BP, SPST and DP) had greater soil water content at 0-15 cm soil depth than minimum soil disturbance (ZT and ST) in both years. The substantial soil disturbance also minimized soil salinity (EC1:5) relative to less soil disturbance. Solute potential of soil solutions was more negative in ZT and SP compared to BP in both seasons. Grain yield was highest with the greatest soil disturbance (10-15 % improvement) than the minimum soil disturbance. These improvements were associated with the increased solute potential of soil solutions under intensive soil disturbance. The results suggest increased soil disturbance has potential to conserve soil water and reduce soil salinity and maintained higher solute potential, while producing the maximum yield in the saline clay- textured soil.

T1S2POS11

Optimum Sowing Date and Variety for Zero Tillage Potato Production in the Post-Rice Season in the Salinity-Affected Coastal Ganges Delta

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Zero-tillage potato is attracting increasing attention for cropping system intensification in the saline coastal zone of the Ganges Delta. With the use of rice straw mulch, zero-tillage potato appears to escape the worst effects of soil salinity, but the optimum sowing time in this environment has not been determined. An experiment was conducted at Tildanga during 2018-2019 and at Choto Chalna during 2019-2020, Dacope Upazilla, Khulna, Bangladesh during Rabi seasons after harvest of T. aman rice. Four sowing dates (15 December, 22 December, 29 December and 05 January) and three varieties (BARI Alu 8, BARI Alu 41and BARI Alu 72) with spacing of 50 cm x 20 cm were tested. The maximum potato yield (17.1 t ha^{-1}) was obtained at 15 December sowing of var. BARI Alu-41 during 2018-2019 followed by same date of var. BARI Alu-72 and during 2019-2020, the highest yield (17.3 t ha^{-1}) was observed at 15 December in var. BARI Alu-41. The lowest yield (8.5 t ha^{-1}) during 2018-19 and (6.7 t ha^{-1}) during 2019-2020 were obtained from 5th January sowing of var. BARI Alu-8. From two years results, it can be concluded that yield of potato, var. BARI Alu-41 and BARI Alu-72 was optimized at 15 December but reasonable yield could be possible upto December 22. From the experiment it was revealed that early sowing is preferable for zero-tillage potato in the salinity-affected southern coastal region of Bangladesh due to physiological maturity and tuber yield.

T1S2POS12

Coastal Agricultural Land Use: Emerging Challenges on South-East Coast at Sagar Island

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The present study focuses on the South-Eastern coastal region of Sagar Island as a case study to examine the challenges of protecting coastal ecosystems near areas of intensive agricultural production. Coastal water salinity, biodiversity is gravely impacted by regional land use. Primary activity of Sagar Island is agriculture, it is also home of fishery in this Island. The coastal zone of south-eastern part of Sagar Island is changing in its shape rapidly for the impact of several forcing parameters, both natural and anthropogenic. Hugli estuary is the hydrodynamic zones in which the processes of erosion and accretion are guided by joint effect of fluvial, tidal and varied wave actions under current sea level rise. The study is constructed primarily by river and tidal alluviums with silt and clayey sediments and longshore transport of sand size sediments. The present study shows the damages of agricultural land and decreasing crop production and documentation of the newly inundated areas of Dhablat and Shibpur villages at Sagar Island. The study has been done with the consideration of 1989-2020 satellite images and field survey of December 2016, 2017 and 2020. As a result of such above oscillations of tidal levels, some portion

of the agricultural land has been affected by the shifting of tidal zone in the south-eastern part of Sagar Island, and in many places of the upper supratidal zone are totally wave abraded by land ward advancing HTL (such as Bisalakshmipur and southern part of Dhablat and Shibpur villages are submerged under the Bay of Bengal). The agricultural land adjacent to the shore is frequently shallowed up, as a result the ecosystem of crop production gets affected unfavourably. The south-eastern part of Sagar Island was exposed by astronomic tides but at present about 8.91 km^2 areas of this part is usually inundated at the steady normal high tides of monsoon season.

T1S2POS13

Customized Nutrient Management Strategies for Acid Saline Soils (Orumundakan Tract) of Kerala

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Acid saline soils of Kerala comprises of rice growing soils of Pokkali, Kaipad and Orumundakan tracts. Soils with high acidity, salinity and nutritional constraints are the major problems faced by the farmers in these areas. Acid saline soils of Onattukara sandy plain (AEU 3) is known as Orumundakan soils. The Orumundakan tract comprises of 17 panchayaths covering an area of 2000 ha distributed in Alapuzha and Kollam districts of Kerala. Rice cultivation in this area is declining due to fertility constraints such as iron toxicity, salinity and nutritional problems and long duration of the existing salt tolerant varieties used for the cultivation. To revive the rice cultivation in this area, the soil fertility constraints have to be identified and soil based nutrient management strategies have to be developed, so that farmers can take up profitable crops. Hence the present study has been undertaken to develop a soil based nutrient management plan for the acid saline soils (Orumundakan soils) of Kerala. To characterize the fertility status of soils, 100 soil samples were collected from paddy fields of Orumundakan tract and analysed for 13 soil fertility parameters: soil reaction, electrical conductivity, organic carbon and available phosphorus, potassium, calcium, magnesium, sulphur iron, manganese, copper, zinc and boron following standard analytical procedures (Jackson, 1973). The data generated were used for assessing soil fertility and preparing customized nutrient management strategy for the region. Based on the new nutrient management plan field demonstrations were conducted using medium duration rice varieties from Pokkali and Kaipad areas. Soil fertility evaluation of the Orumundakan tract revealed that acidity, salinity and nutritional disorders are the major soil fertility constraints. pH ranged from 2.16-5.99 and electrical conductivity from1.5 dS m^{-1} to 17.5 dS m^{-1}. Wide spread deficiencies of Ca, Mg and B and toxicities of Fe and Mn were also observed. Organic carbon was low in 41.7 % samples and available P was low to medium in 56 % samples. Deficiency of K and Ca was recorded in 94 % samples and Mg and B were deficient in 100 % samples. Poor crop stand due to high acidity, poor tillering and chaffiness of grains were the major yield limiting problems in this area. Management of soil acidity is essential for successful crop production in this region. Soil test based recommendation for lime, N, P, K, Mg and foliar application of 19-19-19 (1%) at maximum tillering stage and foliar application of 13-0-45 (1%) and solubor (0.2 %) at panicle initiation stage were found to be promising in field demonstrations. Extensive soil acidity, salinity and wide spread deficiencies of potassium, calcium, magnesium and boron are the major limitations to crop production in this region. Nutritional stress during the critical growth stages can be overcome by supplementary foliar nutrition at these critical stages. A soil test based nutrient management plan encompassing soil test based lime and fertilizer recommendation including macro and micronutrients and supplementary foliar nutrition at critical growth stages of the crop will help the farmers for profitable crop production in this region.

Theme I:

Systems approach for coastal zone development: agriculture, horticulture & plantation crops and their tolerance to biotic & abiotic stresses

SESSION III:

Horticulture & plantation crops and grassland ecosystems: crop improvement including biotechnological approaches and their management

T1S3I01

UNRAVELING THE POTENTIAL OF BELOW- GROUND AND ABOVE-GROUND BIODIVERSITY FOR SUSTAINABLE MANAGEMENT OF THE HEALTH OF PLANTATION CROP SOILS IN COASTAL AGRO-ECOSYSTEM

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Dr. George V. Thomas, Formerly Director, ICAR-Central Plantation Crops Research Institute, Kasaragod, India, has 36 years of research experience on coconut, especially on bio-resources management. He was chairman, International Coconut Genetic Resources Network. Dr. Thomas has over 150 research publications and has edited 10 books. He is fellow of Confederation of Horticulture Associations of India, and several other socities. His research areas include agricultural microbiology, microbial diversity in plantation crops, biological nutrient management, soil health and microbial formulations. He also served as FAO expert team member to Sri Lanka and made technical visits to China, Philippines, Thailand and Cote de var. Dr. Thomas also served as Emeritus Scientist, Kerala State Council for Science, Technology and Environment and Director, Council for Food Research and Development, Konni, Kerala, India.

Abstract: A range of plantation crops viz., coconut, arecanut, oil palm, cashew, cocoa, coffee, rubber and spices are cultivated in the tropical coastal agro-ecosystem to meet the needs of food, oil, beverage, industrial raw materials and fiber. Predominantly grown in small and marginal holdings, the sustainability of these crops is confronted with a number of challenges related to production base deterioration such as soil erosion and pollution, nutrient deficiencies, loss of soil biodiversity, and climate change. In this context, viable and low-cost management technologies based on locally available resources that promote soil health and ecosystem functions are of vital importance to achieve sustainable production. In plantation crops, immense opportunities exist to cultivate a wide range of crops in the interspaces to enhance the above ground biodiversity which in turn, will determine below ground biodiversity that, in turn, influences the crop growth and soil health. Agricultural technologies such as cover cropping and green manuring, recycling of lignin rich crop residues, application of bio-fertilizers, cropping system approach- inter, mixed and high-density multispecies cropping and mixed farming integrating animal husbandry have been reported to be effective in enhancing plantation productivity with significant benefits to soil biology and fertility. Integrated nutrient management has been reported to provide highest yield output while organic farming practices contributed to sustainable yield with greater beneficial effects on soil biological activity and soil health. The recent developments in meta-genome analysis gave insights on the beneficial effects of multispecies cover crop mixtures on soil fertility and microbial diversity than single cover crop species. The beneficial advantages of low external input agricultural management practices to improve the microbial functional gene diversity related to nutrient cycling has also been reported. A cropping/ farming system approach with optimum utilization of natural resources with less reliance on agrochemicals and promoting higher level of below ground and above ground biodiversity and carbon sequestration will prove beneficial to achieve resilience in soil health, which can help to address the challenges in the future scenarios of climate change. The future research should focus on harnessing the potential of soil microbiome and

agriculturally important functional genes to maximize soil health and crop productivity by identifying appropriate management practices using locally available bio-resources in coastal ecosystems.

T1S3I02

BIODIVERSITY OF VEGETABLES: SUSTAINABLE FOOD AND NUTRITIONAL SECURITY IN COASTAL AREAS

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Prof. (Dr.) Pranab Hazra has illustrated professional career of more than 35 years in teaching and research in vegetable science, specializing in breeding and seed production. He became Dean, Faculty of Horticulture twice and at present, the Dean, Post Graduate studies, BCKV, Mohanpur, West Bengal. He has so far supervised 20 Doctoral level research works. He has also supervised 15 research projects sponsored by different Governmental organizations. He has so far written 12 books, 31 book chapters in 24 books, 4 technical manuals and a number of popular articles and published 190 research papers in the journal of repute. He has so far developed three non-viny, photo insensitive and high yielding vegetable cowpea variety; two tomato hybrids, one tolerant to leaf curl virus and other rich in lycopene; two high yielding brinjal variety, one tolerant to bacterial wilt and the other suitable for export; one high yielding and leaf curl virus tolerant variety of chilli; one noble breeding line "Purple tomato" rich in both lycopene and anthocyanin contents through introgression of the lycopene enhancing gene (dg) and anthocyanin fruit gene (Aft); one noble induced mutant line of bitter gourd rich in "Charantin" content having hypoglycaemic property. He has developed and characterized several mutant lines of tomato and bitter gourd for utilization in breeding programme. He was Visiting Scientist to the Institute of Genetics, Bulgarian Academy of Science, Sofia, Bulgaria and Department of Crop Science, Agricultural University of Athens, Greece. He also visited Bangladesh, Israel, Poland, Netherlands, United Arab Emirates, Spain, Malayasia and Sri Lanka under various assignments. He is the recipient of FAO Fellowship award, ERASMUS MUNDUS scholarship of European Commission and Dr. Kirti Singh Gold medal of Indian Academy of Horticultural Science. He is the Fellow of the Indian Academy of Horticultural Science and Indian Society of Vegetable Science and Member of the National Academy of Sciences, India.

Abstract: Food availability is a crucial dimension of food security in an agrarian society. It is largely realized through own food production of a specific society. Seasonality plays an important role in food security. Coastal areas are commonly defined as the interface or transition areas between land and sea, including large inland lakes. Overall, about 50-70 % of the global population live within 100 km of the coastline covering only about 4 % of earth's land, thereby drawing heavily on coastal and marine habitats for food, building sites, transportation, recreational areas, and waste disposal. Coastal agricultural practices are less stable than upland agriculture because they need to cope with frequent changes in salinity, tidal processes, water stresses and water logging. Coastal ecosystems are greatly impacted by location-specific land use. Projections of the precise magnitude, frequency and regional patterns of the impacts from climate change on coastal agriculture are uncertain. However, the implications of these impacts will

change the destiny of many generations to come and affect coastal communities in particular if no suitable action is taken. Given this growing concern, it is urgent that appropriate adaptation policies and strategies are developed and applied to mitigate the vulnerability of coastal agricultural systems to climate change. Biodiversity is the natural heritage of the planet and is one of the key factors of sustainable development, due to its importance not only for the environmental aspects of sustainability but also for the social and economic ones. The genetic diversity represented in "Farmers' varieties" remains a vital resource for global food security and economic stability. In the International Scientific Symposium, "Biodiversity and Sustainable Diets: United Against Hunger", jointly organized by FAO and Bioversity International for the first time, the concept of "biodiversity" was linked with the emerging issue of "sustainable diets" in exploring solutions for the problems of malnutrition in its various forms, while addressing the loss of biodiversity and the erosion of indigenous and traditional food cultures.

The purpose was to promote the development of new sustainable food production and consumption models. The people of coastal zones depend mainly on low productive agriculture due to constraints such as prolonged water logging after the wet season, saline soils, and scarcity of good quality irrigation water in the dry season. In the coastal areas adoption of several farming system like, floating garden, embankment cultivation, etc. need to be adopted for mixed cropping system that encompasses vegetables, fruits, plantation crops, spices, herbs, ornamental and medicinal plants as well as livestock that can serve as a supplementary source of food and income. Hence, it is urgently required to develop awareness as well as different models to utilize the available resources in scientific method for producing fresh vegetables and fruits to meet up the food and nutritional security of the farmers of the coastal areas. It is time to face the evidence of a worldwide unsustainable food system. Its complexity makes it extremely fragile to any climatic, socio-economic, political or financial crisis. Thus, we urgently need appropriate understanding and new strategies to really accommodate present and future population needs and well-being. In that context, we need sustainable diets, with low-input, local and seasonal agro-ecological food productions as well as short distance production-consumption nets for fair trade. It is necessary to locate and conserve underutilized species and types, often known as indigenous vegetables including species that are native to a particular region or introduced historically to a region from other areas. Modern mono-culture production system resulted many of those local, traditional crop species and varieties have been replaced by high-yielding crop cultivars and hybrids developed through modern breeding programmes.

Traditional crops typically do not meet modern standards for uniformity and other characteristics as they have been neglected by breeders from the private and public sectors. Landraces and crop wild relatives have hitherto been increasingly valued and exploited for genes that provide increased biotic resistance, tolerance to abiotic stress, yield and quality. However, use of agricultural biodiversity should not be restricted to exploiting valuable genes for use in breeding programmes if our aim is to create more robust and resilient production systems. Currently underutilized food sources ranging from minor grains and pulses, root and tuber crops and fruits and vegetables to non-timber forest products have the potential to make a substantial contribution to food and nutrition security, to protect against internal and external market disruptions and climate uncertainties, and lead to better ecosystem functions and services, thus enhancing sustainability. A wider use of neglected and undervalued crops and species, either intercropped with main staples in cereal-based systems or as stand-alone crops, would provide multiple options to build temporal and spatial heterogeneity into uniform cropping systems, thus enhancing resilience to biotic and abiotic stress factors and ultimately leading to a more sustainable supply of diverse and nutritious food. It is now generally accepted that climate change will have a major impact on both biotic and abiotic stresses in agricultural production systems and threaten yield and crop sustainability.

Greater diversity, which builds spatial and temporal heterogeneity into the cropping system, will enhance resilience to abiotic and biotic stresses. Underutilized traditional vegetables have the potential to contribute to food and nutritional security, income and more sustainable production systems. As source of essential vitamins, micronutrients, protein and other phyto-nutrients, traditional or indigenous vegetables have the potential to play a major role in strategies to attain nutritional security and are considered important for sustainable food production. Malnutrition hidden hunger affects more than half of the world's population, especially women and preschool children in developing countries. Even mild levels of micronutrient malnutrition may damage cognitive development, lower disease resistance in

children and increase the incidence of childbirth mortality and diminish quality of life. It calls for united efforts by all relevant sectors and at all levels. Vegetables are considered essential for well-balanced diets since they supply vitamins (C, A, B1, B6, B9, E), minerals, dietary fibre and phyto-chemicals. In the daily diet, they have been strongly associated with improvement of gastrointestinal health, good vision, and reduced risk of heart disease, stroke, chronic diseases such as diabetes, and some forms of cancer.

A high vegetable diet has been associated with lower risk of cardiovascular disease in humans. Some phyto-chemicals of vegetables are strong antioxidants and are thought to reduce the risk of chronic disease by protecting against free radical damage by modifying metabolic activation and detoxification of carcinogens or even by influencing processes that alter the course of tumour cells. Studies from different countries indicate that strategy of homestead production of vegetables and fruits is more successful than other types of agricultural interventions in improving nutritional security. Landless and marginal farmers have no or very small crop field. Usually, they are maintaining their livelihood by utilizing the homestead and selling of labour. The year round selling of labour is not evenly distributed. Potentiality of labour selling in agriculture is minimum in the rainy season and off-season when they suffer more malnutrition. Generally, home gardening refers to the cultivation of a small portion of land which may be around the household or within walking distance from the family home. Home gardens can be described as a mixed cropping system that encompasses vegetables, fruits, plantation crops, spices, herbs, ornamental and medicinal plants as well as livestock that can serve as a supplementary source of food and income. However, actual area of homestead devoted to vegetable gardening is very small.

T1S3I03

ADVANCES IN THE BANANA PRODUCTION TECHNOLOGIES FOR THE COASTAL ECOSYSTEMS

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Abstract: Banana is an important humid zone tropical fruit crop grown in tropical and subtropical world. It is cultivated in coastal areas in Columbia, USA, Brazil, Turkey, (Canaray islands) Spain, Morocco, Malaysia, India. Banana is grown at high density, under greenhouses, and under agroforestry systems. It is cultivated in all the coastal districts of India as main crop or homestead crop and also grown as companion crop in coconut/arecanut

gardens. The coastal districts contribute to 16% of total area and 15% of total production of banana and plantains in India. Banana plants grown in coastal ecosystem undergo abiotic stress due to heavy winds, salinity stress, and shade stress. Shade stress is experienced in banana due to either high density planting or natural shade due to agroforestry tree canopy or artificial shade by greenhouse. A meta-analysis of 89 published reports indicates the planting density of 1000 to 3500 plants ha-1 as ecologically and economically beneficial. The high-density impact on yield was analyzed and shown 20.7% yield increase over optimum density. Use of artificial shading for banana had shown yield improvement from 6.5% in Spain to 58.83% in Israel, and yield decreased at South Africa (-15.05) and Egypt (-45.35) conditions. Green house grown banana crop came to flowering 52 days earlier than open field cultivation. Banana as companion crop has shown significant advantage in increasing overall economic benefit of 40.41% over banana as sole crop. An experiment was conducted at Goa, India to identify the suitable variety of banana for high density areca garden. Amti variety (Mysore, AAB) was found suitable for the intercropping in areca gardens in terms of high bunch mass (15.7 t ha^{-1} in plant and first ratoon crop). Salinity stress management involve the quantification of two cations potassium (K^+) and sodium (Na^+). Rapid quantification of K+, Na+ ions in banana leaves was optimized using ion meters which were significantly correlated with standard test values by coefficients of 0.83 and 0.46 respectively. Foliar K^+ and Na^+ content of seven banana varieties screened using ion meters reveal that AAB group. Rasbali (Silk subgroup) variety recorded high potassium (5413 mg L^{-1}) content and sodium (188 mg L^{-1}) content than Amti (Mysore subgroup). The article concludes the results of meta-analysis and an experimental case study of shaded banana, salinity management using rapid quantification of two cations. The findings from the study are crucial for banana production in coastal ecosystem.

T1S3I04

PLANTING MATERIAL IN OIL PALM: PROGRESS FROM SEED TO CLONE

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Abstract: Oil palm (*Elaeis guineensis*) entered into the global vegetable oil pool with its two types of oil, viz. palm oil and palm kernel oil. In edible oil sector, palm oil plays a vital role apart from innumerable industrial uses and downstream products. Its production has increased to the tune of 75.51MT from 21.33 million ha during 2019-20. This increase in area under oil palm coupled with replanting programme had also increased the demand for quality planting materials. This also implies that highly productive varieties adapted to diverse growing conditions are to be supplied worldwide to growers. The choice of planting material is also important to ensure the production of high yield with good oil quality for economic sustainability to oil palm industry. There are three options of planting material (advanced D×P seeds, clonal/semi-clonal and O × G hybrids) are available to growers. The discovery of shell gene (dura; dominant homozygote (Sh+ Sh+) forms thick-shell dura (D), *tenera*: Heterozygote (Sh+ Sh-) forms thin-shelled tenera (T) and *pisifera* homozygote (Sh- Sh-) forms shell-less *pisifera* (P) in oil palm fruits by French Scientists has led to commercial production of Dura ×*Pisifera* (D×P) planting material in the world. Hybrid seed production is done by controlled pollination between selected Dura and Pisifera palms. World over oil palm breeding and seed production are moving towards second (or) cycle materials of dura and teneras and some of the centres are establishing new seed gardens. *The Elaeis oleifera* (HBK) is a wild oil palm and one of the promising genetic resources of *E. guineensis.* Two species of oil palm is hybridised to produce Oleifera × Guineensis (O×G) hybrids. In recent years, tissue culture technique and clonal propagation has been promoted for developing elite oil palm materials. Apart from traditional method of seed production, clonal propagation through tissue culture and semi- clonal production of selected parental palms are also popularized by the industry owing to problem of segregation un-uniformity in true seed derived palms. There is a potential application of tissue culture technique to multiply parental palms (which have been progeny-tested) to produce semi- and bi- clonal seeds. In this article, progress of global planting material production; initially through dura types, then hybrids and recently with advanced clones are discussed.

T1S3ORAL01

Performance of Tomato (*Solanum lycopersicum* L.) under Saline Soil Condition

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Tomato is one of the important fruit vegetable crops cultivated in major area in Krishnagiri district of Tamil Nadu. Occurrence of soil salinity is one of the abiotic stress that affect growth and yield of tomato crop. To study the effect of soil salinity on the growth of tomato crop a pot culture experiment was conducted at Regional Research Station, Paiyur, Krishnagiri district during 2012. The pot experiment consisted of eight treatments which includes 2 factors viz., soil salinity levels (S1=<1, S2=1-2, S3=2-3 and S4=3-4 dSm^{-1}) and variety (PKM 1 and US 618) with three replications. Soil having different EC values (< 1, 1-2, 2-3 and 3-4 dSm^{-1}) was collected from the farmers' field and utilized for conducting pot experiment. Tomato seeds of both variety (PKM 1) and hybrid (US 618) were dibbled @ 10 seeds per pot. The crop was raised and maintained up to 60 days. Observations on germination percentage and growth parameters viz., plant height and dry weight per plant were recorded. Results of the pot experiments revealed that as the salinity level of soil increases, the germination percentage and growth decrease in both the varieties of tomato. Order of decrease in germination and growth of tomato under different soil salinity is as follows S1 (0.52 dSm^{-1}) > S2 (1.58 dSm^{-1}) > S3 (2.87 dSm^{-1}) > S4 (4.05 dSm^{-1}). Growing of tomato under soil salinity level of S1 (<1 dSm^{-1}) showed better germination and growth of crop whereas in S4 (>4 dSm^{-1}) there is a reduction in germination and growth of the crop to the tune of 50 per cent. Hence, it is clear from the results that soil salinity level of < 3 dSm^{-1} is found to be best for growing both tomato variety (PKM 1) and hybrid (US 618) above which there is a reduction in growth of the crop.

T1S3ORAL02

Performance of Rose Cultivars (*Rosa× Hybrida* L.) for their Growth and Flowering under Coconut Plantation in Coastal Humid Climate of India

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A performance study was conducted to check the suitability of rose (*Rosa × hybrida* L.) as an intercrop in coconut plantation under coastal humid climate at Kasaragod district of Kerala state in India. A total of 10 Indian rose cultivars including Hybrid Tea and Floribunda groups were grown under 3 years and 52 years old coconut plantations separately. The performance of roses under two different age groups of plantations was assessed on the basis of its survival percentage, vegetative and reproductive growth, pest, and disease incidence. Amongst of all genotypes, highest plant survival 83.8% was observed in Damask rose which was followed by cultivars Rose Sherbet, Arunima and Pusa Arun with 79.1%, 73.8% and 71.9% survival rate, respectively. Superior vegetative growth was noticed in genotypes Damask rose, Pusa Arun, Ashwini, and Arunima. In almost all the cultivars flowering was noticed during both the seasons (January-February and October-November) except for Damask rose where maximum flowering was observed only during January-February months. Between both types of coconut plantation, superior growth and flowering was noticed in roses grown under young plantation (3 years) as compared to old coconut plantation (52 years). Intercropping was found to be beneficial for coconut and an increase in net yield of the palms were observed up to 22% with the addition of intercrop rose.

T1S3ORAL03

Feasibility Studies of Growing Sapota as Intercrop in Coconut Garden under Coastal Sandy Soil of West Coast Region

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A field experiment is being conducted at ICAR- CPCRI, Kasaragod under coastal sandy soil to study the feasibility of growing sapota as intercrop in coconut garden with different nutrient management practices. The nutrient management included application of green manure + biofertilizers + organic recycling + FYM @10t ha^{-1} in combination with 50 or 100 or 150% of recommended dose of fertilizer (RDF: 500: 360:760 g N:P2O5:K2O per tree). The experiment was conducted in Randomized block design with seven replications. Sapota variety DHS 2 was planted during 2013 in the inter space of 41 year old of coconut variety Kera Keralam. The application of 150% RDF along with organic nutrients resulted in higher fruit yield of 32 kg per tree (4992 kg ha^{-1}) in 2019 and 47 kg per tree (7332 kg ha^{-1}) in 2020 and the yield was significantly different from other treatments. Soil fertility status and microbial load were also higher under this treatment. Biochemical properties of fruits were also analysed. Intercropping of sapota has complimentary effect on coconut yield over mono cropping of coconut. The preliminary results indicated that sapota can be grown successfully as intercrop in coconut garden under coastal sandy soil.

T1S3POS01

Effect of Graded Levels of Nitrogen on Yield of Turmeric, Soil Properties and Nutrient Status under *Acacia mangium* Based Agroforestry System in Lateritic Soils of Konkan

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Acacia mangium is a N_2-fixing tree legume and has become a major plantation tree species in the tropical humid and sub-humid zones. It performs well on lateritic soils, i.e. soils with high amounts of iron and aluminium oxides. Moreover, under Agro-forestry system, *Acacia mangiumis* recommended for building up soil fertility and to be planted as a source of nutrients in lateritic soils of Konkan Region.Turmeric, a non-traditional crop in Konkan region of Maharashtra, is well acclimatized for lushy growth under low light intensities and the climatic and soil conditions seem to be suitable for its cultivation in this region. The successful cultivation of this crop under Acacia mangium based Agro-forestry system will not only provide an opportunity to generate income, but will also be an option to restore soil fertility and as a fuel species. Keeping this in view, the present experiment was designed to study the effect of four levels of nitrogen (100%, 80%, 60% and 40% recommended dose of N) along with 100% recommended dose of P and K on yield of turmeric Cv. Salem, physico-chemical properties and nutrient status of soil under thirteen year old plantation of *Acacia mangium* based Agroforestry system in lateritic soils of Konkan comprising five treatments replicated four times in randomized block design during *Kharif* 2019. The data revealed that application of 100% N + 100% PK (T2) recorded the highest rhizome yield to the tune of 30.44 q ha^{-1} and higher values of available macro and micro nutrients, which was found to be at par with 80% N kg ha^{-1} + 100% PK kg ha^{-1}. Thus, considering the yield of turmeric and available nutrient status, application of 80% N kg ha^{-1} + 100% PK kg ha^{-1} was found to be beneficial in lateritic soils of Konkan from the view point of saving 20% nitrogen fertilizer as well as getting higher rhizome yield and maintaining the soil fertility under *Acacia mangium* based agro-forestry system.

T1S3POS02

Potentials of Teen (*Ficus carica*) as a Fruit Crop in Coastal Bangladesh

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Teen (*Ficus carica*) is a composite fruit called ‘‘syconium’’ and the cultivated species of fig belonging to the family Moraceae. It can be grown well in a wide range of soils like heavy clay, loams, sandy loam and light sand. Under an expansive environment, fig plants may be cultivated which requires low chilling and can withstand even under some frost or drought conditions. However, it grows vigorously with abundant water. Subtropical and mild temperature climate is most favorable for its growth and development. Light rain with dry climate is necessary to produce fresh fruits and at least eight hours day light period for ripening. Almost all of these climatic conditions prevail in Bangladesh. Amateur gardeners in South-West Coastal region of Bangladesh gave a try to cultivate the teen (*Ficus carica*) collected from Middle-East countries which showed cultivation potentials of teen as a fruit crop to be grown

round the year in Bangladesh. This country is blessed with magnificent fertile land with a variety of soil type along with copious irrigation water and zestful human resources which may grant teen cultivation as a fruit crop. Fresh teen is one of the most cherished fruit as desert and has an increasing demand worldwide. It may be a relief resource for Bangladesh in nutritional and economic perspective which is rich in both nutritional and medicinal value and also comparable to our local fruits. Teen is very rich in mineral content and dried fruit contains energy (317.78 Kcal/100g), carbohydrate (73.50%), fat (0.56%), protein (4.67%), fiber (3.68%) and moisture (16.63%). Fig (*Ficus racemosa* and *Ficus hispida*) grows wild in Bangladesh those are tree type plants. Teen is an ideal shrub type plant suitable for yard garden to replace the wild tree type Fig (*Ficus sp*.) growing spontaneously in Bangladesh. In this context an attempt was taken to evaluate the cultivation potentials of the exotic fig in coastal Bangladesh. A survey work using a pretested interview questioner has been conducted there. A morpho-anatomical study along with has also been conducted at Agrotechnology Discipline, Khulna University, Bangladesh, and some data collected from secondary sources were used to measure its acceptance to the farmers as a fruit crop, to evaluate the teen cultivation potentials in this area and define its superiority over local figs. All the respondents showed willingness to eat and cultivate teen as fruit where 73% respondents are willing to cultivate it commercially. The study outcomes justify the potentials of teen cultivation in South-West Bangladesh as the farmers know about teen (67%) and willing to cultivate it.

T1S3POS03

Effect of Salinity on Seed Germination of Cashew nut (*Anacardium occidentale* L.)

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Cashew (*Anacardium occidentale* L.) is an economically important fruit crop, is grown in many countries of the world. It is very popular crop in the Indian coast of Bay of Bengal. Bangladesh is still far behind to adopt this nut tree in the Southwestern coastal area. Costal Khulna soil is affected by variable degree of salinity during dry season (mid-February to mid-July). Assessment of salt stress tolerance is a vital observation to introduce any new crop in the salt affected areas. Thus the present study aims at investigating the effect of salinity on seed germination of cashew nut. Five levels of salinity viz. 0, 5, 10, 15 and 20 ppt were used to investigate germination initiation time, last day of germination, germination duration, germination (%), mean germination time, mean germination ratio, uncertainty of germination process, synchronization index, coefficient of variation of germination time, germination index, coefficient of velocity of germination, time to 50% germination and correlation of germination parameters with salinity. Results of the experiment revealed that germination (%) was higher in 0 ppt (91±4%), followed by 5, 10, 15 ppt and no seed germination was observed in 20 ppt salinity. Germination duration, germination (%), mean germination ratio, uncertainty, germination index, coefficient of velocity of germination of cashew nut varied significantly with the increasing salinity. germination (%), mean germination ratio, uncertainty, germination index, coefficient of velocity of germination of cashew nut had significant negative correlation with salinity whereas mean germination time and time to 50% germination had positive significant correlation with salinity. In this study only one genotype had been used but experiment with other genotypes is suggested for further enrichment.

T1S3POS04

Effect of Potting Media on Survival and Growth of Cashew Grafts (*Anacardium occidentale* L.) Cv. Vengurla-4

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An investigation to study the effect of different potting media on survival and growth of cashew grafts (*Anacardium occidentale* L.) cv. Vengurla-4 was conducted at Nursery No.1, College of Horticulture, Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri during the year 2018-20 in randomized block design with eight treatments and three replications. The eight treatments consist of T_1 - Soil + FYM (3:1), T_2 - Soil + FYM + Vermicompost (1:1:1), T_3 - Soil + FYM + Cocopeat (1:1:1), T_4 - Soil + FYM + Rice husk (1:1:1), T_5 - Soil + FYM + Sand (1:1:1), T_6 - Soil + Vermicompost + Sand (1:1:1), T_7 - Soil + Vermicompost + Cocopeat (1:1:1), T_8 - Soil + Vermicompost + Rice husk (1:1:1). In the present investigation, the survival and morphological parameters such as plant height (cm), girth of scion (mm), girth of rootstock (mm), length of new sprout (cm), number of leaves, leaf area (cm2), absolute growth rate (cm/day), relative growth rate (cm/day), root length (cm) and dry weight of root (g) were observed periodically and found to be significantly influenced by the different potting medium. The potting medium of Soil + FYM + Rice husk (1:1:1) i.e. treatment T_4 recorded the highest percentage of survival (95.56 %), per cent increase in height (47.11 %), per cent increase in new sprout length (15.06 %), number of leaves (31.87), leaf area (278.79) and length of root (30.34 cm). The highest per cent increase in girth of scion (11.06 %) and per cent increase in girth of rootstock (10.87 %) was found in the treatment T_7 i.e. Soil + Vermicompost + Cocopeat (1:1:1). Further, maximum absolute growth rate (0.0813cm/day) and relative growth rate (0.0306 cm/day) was found in treatment T_8 i.e. Soil + Vermicompost + Rice husk (1:1:1) and the highest dry weight of root was seen in the treatment T_1 i.e. Soil + FYM (3:1). Moreover, economically the treatment T_4 i.e. Soil + FYM + rice husk (1:1:1) noted the highest net profit (Rs. 1022.9) for 100 grafts with B:C ratio of 1.15. Considering the highest survival percentage and growth of cashew grafts as well as the highest net profit and good B:C ratio, the potting medium containing FYM, soil and rice husk in the proportion of 1:1:1 was found to be an ideal potting medium in the nursery for rebagging of cashew grafts in large sized polybags.

T1S3POS05

Phytodiversity and Approaches to Preserve Medicinal Plants of High Value

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The Western Ghats of India is very rich in its medicinal wealth. The forests of this region are a treasure house of about 700 medicinal plants. Out of which some are used for traditional and folk medicinal practices. Many are exploited commercially for their active enzymes and commercial value. It is being observed that many useful medicinal plants have become either endangered or becoming extinct particularly in the tropical eco-system of developing countries. The traditional knowledge associated with them is also diminishing over the years. It is apprehended that the modern allopathic system of medicine will suffer a serious setback if certain medicinal plant species go totally extinct. There is an urgent need to develop efficient *ex situ* conservation strategies for these endangered species to

prevent further genetic erosion. In the present study, ten endangered medicinal plants of high medicinal strength were explored, collected and conserved for sustainable utilization. The species are selected considering its status in terms of threat, use in traditional medicine and demand in the pharmaceutical industry. Medicinal plants collected and conserved in the Field Gene Bank were characterized using species specific descriptors. The species wise blocks have been made and periodical observations on morphological characters, reproductive characters and pest and disease occurrence were recorded. The propagation studies for all the collected species have been undertaken and seed and vegetative Propagation methods were standardized. The results of the experiment are found to be useful for further multiplication and conservation of these medicinal plants for their sustainable use.

T1S3POS06

Success of Cuttings as Propagation Material in *Embelia ribes* Burm F. - An Endangered Medicinal Plant

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Embelia ribes Burm. F. is one of the red listed medicinal plant belongs to the family Myrsinaceae. This threatened medicinal plant valued for its thermogenic, carminative, depurative and laxative property. *E. ribes* is now reported as vulnerable due to over exploitation. The main threat of this plant is its unsustainable and indiscriminate harvesting for commercial purposes. The regeneration from seedling of this plant is very poor. Traditional propagation techniques are not successful in large scale production of this valuable species. Only accessible way for the conservation of this species is vegetative propagation through stem cutting. Exogenous application of IBA and combination of IBA and NAA has a significant positive effect on the percentage of rooting. Hardwood cuttings with two or three leaves, treated with IBA in 3500mg L^{-1} concentration appears to be a successful method for vegetative propagation (36% rooting) for producing sufficient number of propagules of this species. Significant increase in number of new root, leaves and shoots and length of roots was recorded in stem cuttings treated with 3500mg L^{-1} IBA.

T1S3POS07

Performance of Single Node Cutting on Propagation of Pepper (*Piper nigrum*) Treated with Different Concentration of IBA

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Pepper is a most important spice crop often revered as the King of spices or Black gold. Pepper botanically known as *Piper nigrum* belongs to Piperaceae family is extensively grown for its berries since time immemorial as a pure but often as a consorted crop in plantations of coffee, coconut, areca nut etc. The present day practice of preparing pre-rooted cuttings from the runner shoots in commercial scale unexceptionally take a longer time for establishment due to lack of roots at the nodes. From this study it was inferred that a single node cutting of pepper treated with 2000 ppm of IBA showed the higher number of roots and sprouts apart from longer root and sprout length. Further, the time taken for the initiation of fifty per cent of cuttings to sprout with maximum per cent of survivability in the treatment was also very less.

T1S3POS08

Impact of Different Sources of Silica with Varying Levels through Soil and Foliar Application on Yield and Quality of Alphonso Mango in Soils of Konkan Region

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Mango is known as a "King of Fruits". The holdings of the farmers are very less in the coastal region of Maharashtra so the field crops could able to fulfill their own requirements only. Silicon is well known beneficial nutrient which helps in overcoming the abiotic stress. With consideration of all the facts an investigation entitled "Impact of different sources of silica with varying levels through soil and foliar application on yield and quality of alphonso mango soils of Konkan Region" was carried for consecutive two years. The objectives of study were to check the suitable source of silica for application to the mango tree which could be able to give the maximum yield and also to determine the rate of application through foliar and soil. For the experiment, four sources of silicon were used with three different levels. For foliar application two sources were used Stabilized silicic acid and potassium silicate however for soil application two sources were used calcium silicate and rice husk ash. The all above sources were varied with three different levels. The results were obtained from the study showed variations with the application of sources, the application of foliar spray of 1.5 ml L^{-1} ortho silicic acid through Silixol showed beneficial effect on per cent fruit retention, average weight of fruit and fruit yield at various stages. The foliar application of stabilized silicic acid i.e, Silixol improves the quality parameter of fruits such as total soluble solid, total sugar, ascorbic acid, titratable acidity and pH. Foliar application of 1.5 ml L^{-1} Silixol increased the shelf life of fruit as compare to other treatments. Soil characteristic was not much affected by foliar application. Soil application of silica source i.e, rice husk ash was found to be beneficial in improvement of soil properties.

T1S3POS09

Studies on Organic Farming in Coriander [*Coriandrum sativum* (L.)] - Radish [*Raphanus sativus* (L.)] Cropping Sequence in Coastal Region of Karaikal

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A field experiment was conducted at Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal, Puducherry, India during 2017-20 under All India Coordinated Research Project on Vegetable Crops (AICRP-VC). The study was aimed to compare the sole organic and it's combination with inorganic sources of nutrients management in coriander radish cropping sequence. Variety Pusa Chetki of radish and CO 4 of coriander were used in the experiment. The conventional practices (recommended FYM + fertilizer + plant protection with chemicals) + IIHR microbial consortium @ 12.5 kg ha^{-1}[T4] registered the highest yield in the CO4 coriander - Pusa Chetki radish (130.93 q ha^{-1} of coriander leaves and 348.73 q ha^{-1} of radish roots, respectively) crop sequence with maximum B:C ratio of 4.42. It will ensure the sustainability in production and soil health along with pollution free environment.

T1S3POS10

Exploring the growth and yield performance of intercrops in cashew orchard under coastal zone of Karnataka

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An experiment was conducted to study the influence of intercrops on yield, growth, seed weight, plant girth, plant spread and growth performance of the cashew varieties under coastal climatic condition grown in Agricultural and Horticultural Research Station, Ullal, Mangalore. The intercrops like Elephant foot yam, Turmeric (varieties salem and cadapa), Banana (G-9), Tapioca, Bush pepper, Ginger and Mango ginger were planted for the study. It was observed from the three years study that, the intercrop performance was found to be good and given acceptable economic yield. The cashew varieties like Ullal-1, Ullal-2, Ullal-3, Ullal-4, Madakathara-2 and Bhaskara have shown good performance without affecting normal yield. Inter crops Elephant foot yam has recorded yield of 4.00 kg per plant, Turmeric varieties Salem (1.47 kg plant^{-1}) and Cadapa (0.14 kg plant^{-1}), Ginger (0.11 kg plant^{-1}), Mango ginger (0.21 kg plant^{-1}), Banana G-9 (17.60 kg plant^{-1}) and Bush pepper (0.25 kg plant^{-1}). The average cashew yield of 17.80 kg, 17.81 kg, 13.55 kg, 16.67 kg, 21.82 kg and 15.08 kg per plant were obtained from the varieties Ullal^{-1}, Ullal-2, Ullal-3, Ullal-4, Madakathara-2 and Bhaskara respectively.

Theme I:

Systems approach for coastal zone development: agriculture, horticulture & plantation crops and their tolerance to biotic & abiotic stresses

SESSION IV:

Plant protection measures: use of nanotechnology and integrated practices including natural therapies

T1S4I01

MANAGING MAJOR INSECT PESTS OF MANGO IN SOUTHERN COASTAL BELTS

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Abstract: Mango has not been a major crop of coastal lands of south India, which has a long coastline stretching from Karnataka in the west, way down southward to Kanyakumari, and further northwards to the east coasts up to Andhra Pradesh. In these, mango is found in about perhaps two lakh hectares, I have been travelling to these areas in the last two decades mainly for pest surveillance, and have observed an interest in mango among many, and mango could become a major crop here, like in the *Konkan* region of Maharashtra. There are two types of mango 'systems': one, the small backyard 'orchards' of Kerala and Goa, to large orchards in Tamil Nadu and Andhra Pradesh. In the former there would be a single tree to a dozen, often scattered. Coastal climate being hot and humid supports a different flowering behaviour with flowering throughout the year from Thiruvanathapuram southwards to Kanyakumari. Along the coast five major pests occur in mango. These are mango hopper (Idioscopus spp), stone weevil (*Strenochetus mangiferae*), fruit fly (*Bactrocera spp*) and the borer (*Deanolis albizonalis*- in the eastern districts of Andhra Pradesh) and the thrips (*Scirtothrips dorsalis*). Managing these pests can not only bring income to farmers but also contribute to area expansion. With labour shortage (especially in Kerala, and less profitability of rice) producing residue-free mangoes for both local and export market in the coasts is a worthwhile economic strategy. This is possible only if a viable and economic pest management to ensure residue free fruits is made available to the farmers. This is discussed in this paper integrating insecticidal and non-insecticidal methods.

T1S4I02

NANOFERTILIZER AND NANOBIOFORMULATIONS: BLESSINGS FOR GLOBAL FARMING

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Dr. J. C. Tarafdar did his Post Doctorate from Institute of Agricultural Chemistry, Germany. He got merit scholarship throughout his academic periods. He has made original and well recognized contribution on mobilization of native phosphorus. He has developed an in-vivo filter paper technique for phosphatase estimation. Biological phosphorus (Bio-phos) fertilizer developed by him is now being promoted by State Government of Rajasthan. He is the first in the world who successfully developed biosynthesized nano nutrients and nano induced polysaccharide powder for agricultural use. He also developed a sequential P fractionation scheme and a rapid method for assessment of plant residue quality. He has developed many new techniques now used in Soil Biology. The most notable are: Visual demonstration technique of germinating AM spore, Soil solarization technique for mass scale production of AM fungi, Freeze-drying technique to understand nutrient movement and Electrofoccusing technique to demonstrate the origin of enzymes. Dr. Tarafdar has travelled and lectured widely in many countries and published 360 research articles in national and international journals which include 35 book chapters and five books.

He has four patents and 73 new organisms in his credit. In recognition of his professional contribution, Dr. Tarafdar received many awards most notable are Sukumar Basu Memorial Award for the biennium 1993-94, IMPHOS-FAI Award 2006, Prof. S.K. Mukherjee Memorial Award 2008, Prof R.S. Murthy Memorial Award 2008, Bharat Jyoti Award 2011, Glory of India Gold Medal 2012, Prof. R. V. Tamhane Memorial Award 2013, Dr. Kartik Oaron Memorial Award 2014, Dr. N. S. Randhawa Memorial Award 2014, ISSS Platinum Jubilee Commemoration Award, 2016, Prof. N. P. Datta Memorial Award, 2020. Dr. Tarafdar is a Fellow of the most prestigious Alexander von Humboldt (AvH) Germany and DAAD, Germany. He is also a fellow of National Academy of Agricultural Sciences (2003), Indian Society of Soil Science (2002) and Indian Society of Salinity Research Scientists (2003). He is among the 2% of the best scientist in the world and secured 992nd position in the world. He has guided seven Ph. D. and 18 M. Sc. Students.

Abstract: Nanofertilizer application in agriculture may serve as an opportunity to achieve sustainability towards global food production. Important benefits of nanofertilizers over conventional chemical fertilizers rely on nutrient delivery system. For example, nutrient can be released over 40-50 days in a slow-release fashion rather than 4-10 days by the conventional fertilizers. The nutrient use efficiency also improved by 3-20 times, therefore, nutrient requirements is less as well as reduces the need for transportation and application costs. Another advantage of using small quantities is that soil does not get loaded with salts that usually are prone to over application using conventional fertilizer. Nanofertilizer also can be used as nanobioformulations. The formulations containing one or more beneficial microorganisms after blending of required nanoparticles to enhance soil productivity. Nanobioformulations can be helpful to enhance the stability of biofertilizers with respect to desiccation, heat and

UV inactivation. It can also solve some limitations of biofertilizers such as ease to handling, enhanced stability, protection against oxidation, retention of volatile ingredients, taste making, consecutive delivery of multiple active ingredients etc. In general, nanofertilizer mobilizes 30% more native nutrient than conventional fertilizer application. The average improvement of yield, irrespective of crops and soil types, varies between 24-32% as compared to 12-18% under chemical fertilizers. Nanofertilizers, with a particle size less than 100 nm, influence key life events of the plants that include seed germination, seedling vigor, root initiation, growth and photosynthesis to flowering. Additionally, nanofertilizers have been implicated in the protection of plants against oxidative stress as they mimic the role of antioxidative enzymes such as superoxide dismutase (SOD), catalase (CAT) and peroxidase (POX). But in spite of all these, nanofertilizer should be applied as recommended doses; because at higher rate of application have been proved to be phytotoxicity as they enhance the generation of reactive oxygen species (ROS). The elevated level of ROS may damage the cellular membranes, proteins and nucleic acids. The uptake rate of nanoparticles by plants also depends on their shape and sizes. In general, small sizes of nanoparticles can be penetrating through the cuticle while larger nanoparticles can penetrate through cuticle-free areas such as hydathodes, the stigma of flowers and stomata. Nanofertilizer can be applied both on soils and on leaves as foliar. This can also be applied through drip, hydroponic, aqua and aeroponic. The properties of nanofertilizers depend upon variety of parameters such as particle size, dispersity index, surface area, porosity, solubility, aggregation, zeta potential etc. With recommended doses of application, it can be envisaged to become major economic driving force and benefit consumer and farmers with no detrimental effect on the ecosystem.

T1S4I03

NANO-FERTILIZATION AND CHEMICAL INDUCING TO IMPROVE CROP GROWTH IN COASTAL AREAS

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Dr. Rafiq Islam is the director of the Soil, Water and Bioenergy Resources at the Ohio State University, Ohio, USA. He has more than 25 years of academic, research, and outreach experience with a focus on climate-smart agriculture; abiotic/biotic stresses and chemical inducing; biofeedstock and bioproducts; and organic farming and aquaponics. Dr. Islam has active research and academic collaboration with several Asian, African, European, and north and south American countries. He is a Fulbright teaching scholar and received several awards including U.S. Congressional recognition. So far, he has mentored more than 25 Fulbright, USDA-Norman Borlaug, Mandela-Washington, Tubitek, PHEC, Bolashak, and World Bank sponsored students, scholars, and fellows. He teaches graduate courses and serves as an advisor and a committee member to supervise graduate students. Dr. Islam is an academic editor of several journals including PLOS ONE and has published more than 100 peer reviewed articles in high impact journals and has written several books and book chapters. He was actively involved to organize and moderate several international meetings, workshops, and conferences on climate change, sustainable agriculture, soil quality and public health, marginal lands and carbon farming, and organic agriculture and aquaponics. So far, he has delivered more than 100 scientific presentations worldwide.

Abstract: Coastal agriculture is often subject to flooding and lack of drainage, soil salinity and water quality problems, land stability and soil erosion, and accelerated pest pressures; however, coastal areas offer adaptive conditions to grow crops sustainably based on proactive, novel, and holistic approaches. In our presentation, we will discuss possibilities on how nano-fertilization and chemical inducing can be utilized to grow high-value vegetables and agronomic crops in coastal areas. Results showed that nano iron (Fe) fertilization consistently increased the marketable yields and quality of fresh tomatoes and cucumber by 2 to 3-folds, when compared with the traditional and chelate Fe fertilizers. Likewise, dilute solutions of salicylic acid (Aspirin) as a chemical inducer, significantly improved plants tolerance to both abiotic and biotic stresses and increased the marketable yield, nutrient density, and metabolomics of processing tomatoes. Moreover, direct seed treatment with salicylic acid showed more promising results. Long-term studies have shown that salicylic acid treated irrigation improved plant's tolerance to drought and soil salinity, reduced irrigation frequency, and increased soybean (by 14.9%), wheat (by 5%), and corn yields (by 10.2%), when compared with the control. Similar studies are on-going to work with acetic acid and oxalic acid to improve plants tolerance to both abiotic and biotic stresses with economic crop yields under marginal agroecosystems.

T1S4ORAL01

Identification of an Effective Isolate of *Trichoderma harzianum* ACT1 for the Management of Basal Stem Rot Disease in Arecanut

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The basal stem rot (BSR) disease of arecanut caused by *Ganoderma lucidum*, also known as *Ganoderma* wilt or foot rot is one of the major diseases of arecanut (*Areca catechu* L.). The disease has been reported from almost all arecanut growing areas of India including north-eastern states and Andaman and Nicobar Islands. The disease is mainly soil-borne and mortality of 94 % has been reported in neglected gardens. The BSR being a soil-borne disease, biocontrol is the most suitable option for disease management since deploying fungicides to manage the diseases may result in high production costs and health risks to terrestrial and aquatic habitats. Application of *Trichoderma harzianum* enriched neem cake has been found to be effective in the management of basal stem rot of coconut caused by *Ganoderma*. It is known that the efficacy of biocontrol depends upon the strains of the biocontrol agent and the performance of native isolates of *Trichoderma* is always better in suppressing the disease incidence. Hence, the aim of the present study was to identify an effective strain of *Trichoderma* suitable for the management of BSR in arecanut. A total of 117 *Trichoderma* isolates were obtained from the soil samples collected from the rhizosphere of arecanut in major arecanut growing areas (Coastal Karnataka, Maidan and Malnad). Based on growth characteristics and spore morphology, 38 isolates were selected for evaluating antagonistic activity against the arecanut BSR pathogen *Ganoderma lucidum*. Antagonistic assay resulted in the identification of three effective *Trichoderma harzianum* isolates i.e., ACT1, APT38 and AT56 with 86.7%, 83.3% and 84.4% inhibition of pathogen respectively. All the isolates showed rapid growth with a mean colony growth rate of 3 cm day^{-1}. Growth promotion activity of six isolates studied under net house condition recorded significantly higher total biomass in arecanut seedlings treated with *T. harzianum* ACT1 (48.7 g) as compared to control (45.5 g). Holistically, *T. harzianum* strain ACT1 was found to be promising with respect to antagonistic activity, mean growth rate and total biomass production. Since this *Trichoderma* isolate is obtained from soil collected from arecanut orchards, the rhizosphere

competence of this isolate will certainly be more in arecanut gardens. Therefore the *T. harzianum* isolate ACT1 identified under the present investigation will help to formulate a biocontrol based eco-friendly integrated disease management for basal stem rot of arecanut.

T1S4POS01

Efficacy of Fungicides against Cashew Dieback Incited by Tea Mosquito Bug in Coastal Karnataka

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A field experiment was conducted at Agricultural and Horticultural Research Station, Ullal, Mangalore, during the period 2019-2020. Study was under taken to determine the efficacy of selected fungicides and insecticide against dieback of cashew. Among the tested chemical molecules, Propiconazole 25% EC recorded least percent disease incidence (11.25) with highest per cent disease control (78.32%) followed by application of Hexaconazole 5% EC (17.33 %) with per cent disease control (67.33%) over the control with the highest yield 28.25 and 25.74 kg per mean of 4 trees respectively. Difenconazole 25% EC recorded highest percent disease incidence (30.11) with least per cent disease control 43.27 per cent. The insecticide Quinalphos EC recorded 44.55 per cent reduction over the control. From this study it is confirmed that spraying with Triazoles group of fungicides like Hexaconazole, Propiconazole and Difenconazole 25% EC @ 0.1% twice @ 25 days interval recorded least percent disease incidence and play very important role in management of dieback.

T1S4POS02

Management of Wilt of Udupi Mallige in Coastal Karnataka

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Jasmine is considered the queen of flowers and is called the “Belle of India” or the “Queen of fragrance” as it is highly scented to soothe and refresh. It is reported that there are 300 varieties of jasmine. Jasmine is a major traditional flower crop of our country. Although more than 2,000 species are known, 40 species have been identified in India and 20 species are cultivated in South India (Bhattacharjee, 1980). There are several other important cultivars like Mysore Mallige (*Jasminum grandiflorum*) and Hadagali Mallige (*Jasminum auriculatum*). Recently, Mysore Mallige, Udupi Mallige and Hadagali Mallige have been registered under the Intellectual Property Rights (Anon., 2008). Jasmine, *Jasminum sambac* (L.) Aiton cv. Udupi Mallige belonging to family Oleaceae, commercial flower crop of coastal Karnataka. These days Udupi mallige is affected by major fungal disease i.e wilt casused by Fussarium spp. Causing 60-70 per cent yield loss. From studies it is confirmed that soil drenching and spraying with Hexaconazole 5% EC @ 0.1% twice @ 20 days interval recorded lowest percent disease incidence i.e 13.33 % during 2018-19, with highest per cent disease control (74.19%) followed by application of FYM enriched with consortia of bio-agents (*Trichoderma spp. + Pseudomonas spp.*) @ 250 g recorded the 64.52% reduction over the untreated control with the highest yield 572.14 kg ha^{-1} and 557.84 kg ha^{-1} respectively.

Theme II:

Technological developments in fisheries, livestock and poultry management, water pollution trends, and ecological security for coral reefs, farming system modules

SESSION I:

Fresh and brackish water aquaculture: technological innovations and emerging options including fish health and water management

T2S1I01

NEW PARADIGMS IN FRESHWATER AQUACULTURE IN COASTAL ECOSYSTEMS IN INDIA: HAPPINESS AND HOPE

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Dr. J. K. Jena, with 29 years of research experience in different fields of freshwater aquaculture and conservation genetics, has been holding the position of Deputy Director General (Fisheries Science) at ICAR. As the DDG (Animal Science), Dr Jena is also steered the programmes of Animal Science Division of ICAR for about three years, i.e. during April 2017-February 2020. Prior to this, he served as the Director of the ICAR-National Bureau of Fish Genetic Resources for over 5 years. Dr. Jena has contributed to the development of several technologies and research findings, including aquaculture diversification; intensive carp culture; treatment of domestic sewage through aquaculture; cryopreservation and applied nutrition. As National Coordinator, he has been operating the National Aquatic Animal Disease Surveillance Programme since last 7 years. Dr. Jena has published over 200 research papers in national and international journals. He has been conferred with several awards and recognition including prestigious Rafi Ahmad Kidwai Award of ICAR. He is also the Fellow of the National Academy of Agricultural Sciences and several others. In the past, he held the position of President, Asian Fisheries Society, Kuala Lumpur, and Secretary, NAAS. At present, he occupies the Chairmanship of the Asian Fisheries Society Indian Branch, and serving as the Chairman/Member of different national level committees.

Abstract: The 19-folds increase in fish production in the last seven decades, i.e. from 0.75 million tonnes in 1950-51 to the present level of 14.2 million tonnes amply justifies the importance of the fisheries sector, not only for the protein and the nutritional security of the masses in the country but also its increasing contribution to the national economy. When the production from capture fisheries was stagnating, aquaculture has become a saviour for enhancing the targeted growth in fish production. From the meagre 0.37 million tonnes in 1980 to over 9.0 million tonnes at present, a 25-folds increase in aquaculture production in just four decades has placed the country as a fore-runner on the global front. While the freshwater sector that shares over 90% of total aquaculture production is largely contributed by carps and meeting the demand of domestic front, the land-based coastal aquaculture has remained shrimp centric and contributing to about two-thirds of US$ 7.0 billion of seafood export. The coastal ecosystems not only is contributing to the total 0.8 million tonnes of shrimps produced through pond-based brackishwater aquaculture, the significant share of 8.2 million tonnes of freshwater aquaculture production too are contributed by the coastal states like Andhra Pradesh, West Bengal, and Odisha. Increasing production of diversified freshwater species including those of exotic pangas, paku, and tilapia again are largely contributed by Andhra Pradesh. While carp polyculture and monoculture of exotic pangas catfish have been steering the freshwater aquaculture production, a range of other non-conventional culture systems, viz., sewage-fed fish culture, integrated farming systems, cage & pen culture, and the new technologies like RAS and biofloc systems have made freshwater aquaculture an increasingly growing activity across the country. As a backyard avenue, ornamental fish breeding and rearing have been proved to be highly viable activity especially for the areas adjoining cities/towns due to their assured market.

The self-sufficiency in quality carp seed production through large-scale adoption of the technologies of controlled breeding, hatchery production, and seed rearing has been ensuring guaranteed seed supply and practically guiding the aquaculture development in the country. Success in the development of breeding and seed production technologies of over 65 cultivable finfish and shellfish species of freshwater, brackishwater, and marine origin further leading the farmers to the adoption of new species for culture diversification. In this endeavour, it is the coastal ecosystem led by the state of West Bengal contributing the bulk of the seed production in the country. Good rainfall, adequate quality water, productive soil, and favorable climatic conditions, besides scale-neutrality of a host of farmers' friendly technologies with varied production potential, availability of critical inputs at the doorsteps, increasing private investments, implementation of different technology transfer programmes through the institutional frameworks, and above all good local demand for fish due to higher percentage of the fish-eating population have been some of the important factors for the accelerated growth of freshwater aquaculture in the coastal eco-regions. At a time when the fisheries sector in India has been able to demonstrate a phenomenal average annual growth rate of 10.88% to the national GVA in the last five years, it is the freshwater aquaculture that would take the lead in meeting the projected production target of 22.0 million tonnes of fish by 2025 and continue to contribute to the economy and increasing employment generation.

T2S1I02

CHANGING LAND-USE PATTERNS FOR ENHANCING FISH PRODUCTION THROUGH COASTAL AQUACULTURE

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Dr. Baban Ingole has worked at CSIR-National Institute of Oceanography from 1981 and superannuated in 2018 as a Chief Scientist and Head of the Biology Division. Presently, he is working as a Visiting Scientist (full-time) at the National Center for Polar and Ocean Research, Ministry of Earth Sciences (Govt. of India) Vasco Goa under the Deep-sea Hydrothermal Marine Resource Assessment program. He was involved in prominent international research program such as *Census of Marine Life-CoML*, CoMARG -Continental Margin; CeDAMaR-Deep-sea Biodiversity; *GIBIF*, CBoL-DNA Bar-coding; *InterRidge*; *BioNET*; ISA-International Seabed Authority; *SEATOS*- Discovery Channel's International Tsunami Expedition; *INDEEP*-International Network for Scientific Investigations of Deep-sea Ecosystems is significantly high through direct participation in field projects and analysis of global scientific data. Moreover, he was also actively involved in various advisory committees of States and Central Government to evaluate and formulate and evaluate national level Mega projects and planning research projects related to the country's marine resource management. I have been able to publish high quality research papers and has completed >150 projects related to the marine Ecology, Biodiversity and Environmental Impact Assessment (EIA). I have successfully supervised over 80 M.Sc./B.Tech. dissertation and 12 Ph.D. students.

Abstract: India, the second-most populous country, needs to sustain its fast-growing gross domestic production (GDP) to cater to its rising population and fight poverty. Consequently, providing protein-rich nutritious food at

an affordable rate is an enormous and challenging task for any government. Traditionally, Indian has a preference for vegetarian-based protein food items in their everyday meals; however, this situation is changing with a rapid increase in meat-and-fish eaters, especially among the younger groups. Moreover, a quarter of the Indian population lives in the coastal zone, with the majority being fish eaters. Furthermore, awareness of the health benefits of fish consumption is also increasing among the urban population. As a result, the demand for fish protein is also growing every day. On the contrary, India's fish production, both from the capture and culture fishery is nearly stagnant, and future predictions do not show any better picture. The responsible factors for dramatic changes are changing climate, overfishing, and pollution. Thus, suggesting an urgent need for scientific intervention and policy shift. To address all the fishery-related issues, the government has recently formed a separate *Fishery Ministry*. India has a vast coastal land, most of which gets inundated during the high tide, and therefore cannot be used for conventional agriculture. This biologically productive, unutilized coastal wetland can be used efficiently for aquaculture practices with some modification. Even though the brackish-water aquaculture sector is doing very well in India, it is practiced in few coastal states and is restricted only to the fast-growing few shrimp species. Since the non-availability of the seed of the cultivable fish species has been the major hurdle in achieving the desired progress, more focused efforts, therefore, are needed to develop the chain of hatcheries, especially for locally available brackish water fish species. Similarly, the dissemination of knowledge has to be taken-up on a war footing, so that results, as preferred, can be accomplished in a limited time.

T2S1I03

BRACKISHWATER AQUACULTURE AS THE ECONOMIC ENGINE OF INDIAN BLUE REVOLUTION

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Dr K. K. Vijayan, a renowned aquaculture biotechnologist, is the Director of Central Institute of Brackishwater Aquaculture (CIBA), Chennai, since August 2014. Dr. Vijayan took his Master's degree from the Department of Marine Sciences, Cochin University of Science & Technology (CUSAT), Kerala in 1982 and Ph.D. in CAS in Mariculture–CMFRI, CUSAT in "Aquaculture/Mariculture: Crustacean Growth Physiology", and later selected for Indian Agricultural Research Service (ARS), and joined CIBA, Chennai as Scientist in 1989. He has R&D and research management experience of more than 28 years at various capacities in Indian ARS system. Dr. Vijayan started his research carrier on aquatic animal health with a focus on pathobiology and physiology of farmed aquatic species and later initiated molecular pathology and DNA-based diagnostics with a focus on shrimp viruses. During his post-doctoral research at the University of Mississippi-Gulf Coast Research Lab (GCRL), USA, during the late '90s and at the University of Liege, Belgiumin 2007, he worked on molecular virology and Genomics. His work on WSSV and molecular-based diagnostic tools awarded him the prestigious National Award from the Department of Biotechnology in 2003. During his carrier in Central Marine Fisheries Research Institute (CMFRI) as the Head of Marine Biotechnology Division (MBTD), he played a major role in initiating research on marine bioprospecting and the development of anti inflamatory nutraceuticals targeting arthritis using bioactive compounds extracted from

marine macroalga. Latter did pioneering work on the pathogen profiling among the farmed bivalves of the Indian subcontinent, with the first report of *Perkinsus olseni*, and other OIE listed pathogens, followed by DNA-based PCR diagnostics. Besides, he developed several methodologies, concepts, and novel products in mariculture/aquaculture biotechnology.

With the capacity as director of CIBA, since 2014, he was instrumental in the institute to achieve several milestone achievements in brackishwater aquaculture development in this country, in areas of seed production, feed development, and several other products and services related to aquatic health and disease diagnosis and management. Achieving the major break-through in breeding of candidate species, milk fish, *Chanos chanos* and grey mullet *Mugil cephalus* for the first time in the country, while the R&D efforts in the country started in 1980's, set a milestone in the species diversification for brackishwater aquaculture. In in any form of aquaculture, feed is one of the major rearing cost and catered entirely by the international players, where CIBA developed and commercialized cost-effective and quality desi feed, both functional and growout for shrimps such as *Vannamei*^{plus}, and finfish *Seabass*^{plus}, which help the farmers to regulate the cost of production and increase their profit share. Under the aquatic animal health, the institute has been in the forefront for solving the issues relating to emerging diseases in the sector, providing prophylactic products and novel diagnostic solutions including DNA-based diagnostic kits to cater the need of the sector. Major achievements in the genomics includes, deciphering the full genome of Indian white shrimp and important microbes such as *Vibrio parahaemolyticus*, *V.harveyi vibrio* campell and antagonistic aquatic isolate, the *Pesudomonas aeruginosa*. Many of the desi technologies developed by CIBA serve as 'import substitutes' and got appreciations from farmers and policymakers. Transfer of these technologies and products has been carried out through participatory and commercialization, thereby taking them to the farmers and other stakeholders. He authored about 90 peer reviewed research papers of international repute and 8 patents and many book chapters, and more than 8 technology commercialization's to his credit in research and development.

Abstract: Though aquaculture is possible in all types of water resources, realizing the full potential of the oceans and inland freshwaters requires a paradigm shift to embrace a new, responsible and sustainable approach to present it as more environmentally, socially, and economically effective. Therefore, in the future aquaculture development, the scope of expansion of brackishwater aquaculture is significant, with 1.2 million ha of resources, where only 12-15% is estimated to be used; hence the potential for horizontal expansion is there, unlike the agriculture sector. Further, the inland saline areas to the tune of about 8.0 million ha are available in Haryana, Rajasthan, Uttar Pradesh, Maharashtra, and Gujarat with surface and sub-soil saline water also can be explored for farming using the brackishwater resilient finfish and shellfish. Brackishwaters, which is otherwise considered as a zero-economic resource (not used in agriculture, drinking or construction), are ideal for aquaculture today and expansion in the future due to their biodiversity richness, high productivity and negligible footprint on potable water and carbon emission. As an added advantage, the high tolerance of brackishwater flora and fauna for extremes of the water quality makes them more appropriate for farming under controlled conditions. In addition to the food production, coastal aquaculture can generate huge employment opportunities in diversified fields across coastal India, contributing to the coastal folks' nutrition and livelihood security.

In India, brackishwater aquaculture is synonymous with shrimp farming, and estimates show that only 11-12% of the potential area is utilized for farming, and the export revenue generated from this sector alone is about 36000 crores in 2018-19. On the other hand, about 40% of freshwater aquaculture's potential area has already been utilized for farming practices (FAO, 2014), and freshwater is getting scarce day by day.

Besides, brackishwater has a line-up of seafood choices in its farming basket, ranging from seaweed, shrimps, clams, mussels, oysters, finfishes of different feeding nature, and gastronomic values, with ready demand in both domestic and export markets. At this juncture, brackishwater aquaculture comes with many scopes and hope due to several positivities, catering to the country's societal and economic development. ICAR-CIBA helps the govt

agencies and policymakers get precise data on the potential resource, technological backstopping related to seed, feed, genetics, aquatic animal health, and societal linkage, which are crucial for national planning, management, and policy decisions on brackishwater aquaculture. CIBA is at the forefront of technology backstopping for this dynamic sector by developing customized indigenous technologies for important aquaculture drivers, such as seed production and farming of diversified species, indigenous feeds, aquatic animal health solutions and stock improvement strategies. Fisheries being a state subject, to take the sector forward, partnership with institutions such as CIBA, State govt, Central govt, and other state and central agencies are imperative to construct the country's emerging blue economy.

T2S1I04

RIVER BASIN APPROACH FOR SUSTAINABLE WATER AND FISHERIES MANAGEMENT

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Abstract: Since water availability and uses have a spatial dimension, such assessments are always made over a geographical region, which may be bounded by natural or administrative boundaries. Flow of surface water follows natural boundaries and hence, river basin approach is also widely followed in assessment and management of surface water. River basin is also the commonly used unit in integrated water resources management (IWRM). In India, the major uses of river water are agriculture, industrial and domestic uses, and hydropower generation. Storage, withdrawal, and diversion of water for these uses has led to large alterations in river systems. Tributaries specific to the river basin have been observed to be the most critical for both hydrological and ecological sustainability. Any alterations in the tributaries or in basin significantly impaired the main river channel at both hydrological as well as ecological processes. These days, ecosystem approach at river basin level is considered to be the best strategy for conservation and sustainable management of water and aquatic/terrestrial life. Eco-hydrology forms a framework within the ecosystem approach protecting both physical alteration and biodiversity change. Fish is considered as one of the best indicators for the river health assessment and management. River water in terms of quantity and quality plays a vital role in biological processes governing their life, including migration, reproduction

and feeding. Any alteration in the quantity, quality, frequency and timing of the flows have significant impact on their sustainability and production. To that end, the concept of environmental flows has been developed as a way to protect the river ecology and fisheries. Environmental flows define the quantity, timing, and the quality of water flows that are required to sustain freshwater and estuarine ecosystems and the human livelihoods and well-being that depends on the ecosystems. A holistic management approach at river basin level that brings different disciplines and principles from hydrology, engineering, ecology and economics is needed for sustainable development and management of water and associated resources. It is also necessary and important to consider all the uses of water in a river basin, including the fisheries needs. Models that make use of hydrological and ecological approaches to simulate the response of a river basin and biological life to changes in inputs and management practices have been developed and are being refined. With this background, our talks will give perspectives on river basin approach for sustainable water and fisheries management. Some results of a case study on the Teesta river for estimation of environmental flows keeping fish as the indicator of the ecosystem health will also be presented.

T2S1I05

DEFINING ENVIRONMENTAL FLOWS FOR INDIA WITH HELP OF MesoHABSIM MODEL

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Assoc. Prof. PhD, Eng. Piotr Parasiewicz is a civil and environmental engineer and river ecologist graduated from University of Agricultural Sciences in Vienna and D.Sc. (dr hab.), associate professorship from S. Sakowicz Inland Fisheries Institute (SSIFI) in Poland. Expert in Ecohydraulics, creating management tools and modelling techniques for ecological river management. Creator of MesoHABSIM habitat simulation model, a multiscale approach for instream habitat modelling. He is an applied scientist engaged in application and promotion of river science in river restoration. Founder and Director of Rushing Rivers Institute in USA. As a member of Austrian Network for Environmental Research at Austrian Ministry of Agriculture he actively participated in development of EU Water Framework Directive. After his tenure at Cornell University and University of Massachusetts he is currently a Head of River Fisheries Department at SSIFI, adjunct professor at the University of Nebraska, Lincoln and visiting professor at the Technical University of Munich. He published 60 peer-reviewed papers and book chapters, and coordinated or participated in more than 30 international and national research projects. Among others he served on technical committee of European Inland Fisheries and Aquaculture Advisory Commission of FAO and recently on the Polish National Water Management Advisory Board. He was a work package co-leader in EU Funded Adaptive Management of Barriers on European Rivers (AMBER) project.

Abstract: This paper presents an approach for county wide determination of environmental flows with application of MesoHABSIM habitat simulation model. We propose general rules following a standardized approach, based on rigorous biological observations of fish assemblages and physical habitat modelling to establish a benchmark for ecologically sound instream flows. The concept follows the Natural Flow Paradigm and foresees dynamic flow

adjustments according to aquatic fauna needs over a range of bioperiods. This will allow for more efficient use of water while protecting natural heritage of India. The concept has been included in the Guidance Document for Environmental Flows Assessment and Implementation in India. The implementation requires building professional capacity and establishing data base of the relationships between environmental flows and fish habitat availability from strategically selected river sites. The paper will present the concept, steps to be taken as well as a pilot demonstration application of using MesoHABSIM on Ramganga River in this context.

T2S1I06

FEED AND FEEDING STRATEGIES IN FRESHWATER AQUACULTURE

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Dr. G. H. Pailan is currently working as a Principal Scientist and Officer-In-Charge at ICAR-Central Institute of Fisheries Education, Kolkata Centre. He has over 23 years of experience in the field of Animal/Fish Nutrition. He has been associated in the implementation of 30 research projects. He has guided 12 post graduate and Ph.D students. He is one of the key members for formulation and implementation of one year post graduate diploma in inland fisheries and aquaculture management for state fisheries officers. He has coordinated more than 150 capacity building training program in the field of aquaculture and allied subjects. He has over 60 research publications in different national and international peer reviewed journals and more than 30 training manuals. Some of the significant contribution he has done in the field of aquaculture and allied fields are development of carotenoid rich fish feed for color enhancement of freshwater ornamental fish, remedial measure of chronic arsenicosis in freshwater fish, composite fish culture model with small indigenous fish species, optimum utilization of plant based feed ingredients for aqua feed. He has also evaluated the biochemical changes and osmoregulatory activities in Hilsa (Tenualosa ilisha) during migration.

Abstract: Growth, health and reproduction of fish are primarily dependent upon an adequate supply of nutrient, both in terms of quantity and quality, irrespective of the culture system in which they are grown. Supply of feed has to be ensured so that the nutrients and energy requirements of the species under cultivation are met and the production goals of the system are achieved. Feed accounts for up to 60% of the recurring cost in aquaculture practice. So, feed must be nutritious and cost-effective which can be achieved through judicious feed formulation and use of cheaper, yet nutritious, ingredients. Feeding the fish at the right time, right place, and the right amount is paramount in increasing an aquaculture venture's overall efficiency. Good feeding practices and selecting proper types of feed can also help to reduce wastage of feed.

T2S1I07

BRACKISHWATER AQUACULTURE: OPPORTUNITIES AND CHALLENGES FOR MEETING LIVELIHOOD DEMAND IN INDIAN SUNDARBANS

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Dr. Debasis De has twenty years of research experience in the field of brackishwater aquaculture as a whole and finfish and shellfish nutrition and feed biotechnology in particular. He has worked for development of cost-effective feeds for brackishwater fish and shrimp through specific dietary nutrient optimization and alternative feed ingredients. His research interest includes nutrient enrichment of unconventional plant ingredients through microbial fermentation, cost effective feed development for brackishwater polyculture, farm made feed for brackishwater fishes, recycling of fish waste and its use as replacement of fishmeal and as plankton booster in aquaculture. His research area also includes captive broodstock development and culture of Hilsa shad (Tenualosa ilisha). He has developed and commercialized different technologies for enhancing production and profit in brackishwater aquaculture in India. He has also developed Mobile Shrimp App in Bengali language "CHINGRI" for shrimp farmer of India and Bangladesh. He has been awarded with Nanaji Deshmukh Award for Outstanding Interdisciplinary Team Research from ICAR, Govt. of India. He is also a recipient of Endeavour Research Fellowship of Govt. of Australia. He has served as an executive committee member of Society of coastal Aquaculture and Fisheries in India. He has published 56 research papers in International and national journals and presently working as Principal Scientist & Officer-in-Charge of Kakdwip Research Centre of ICAR-Central Institute of Brackishwater Aquaculture.

Abstract: The Sundarban delta is formed by the confluence of the Ganges, Brahmaputra and Meghna Rivers in the Bay of Bengal. Brackishwater area in the Indian part of Sundarban is around 30000-50000 ha, of which only 20-30% is under aquaculture. Brackishwater farming is mainly confined to the *bherries* (manmade impoundments in coastal wetlands) in Sundarbans. The Indian Sundarban region has immense potential for brackishwater aquaculture development amidst several constraints. The adoption of modern and scientific technologies developed by research institutes and government agencies has improved the fish/shrimp production in the region and meets the region's livelihood needs through different livelihood options. In India, scientific brackishwater aquaculture was synonymous with tiger shrimp (*Penaeus monodon*) farming initiated during the early 1990s. Growth of Indian aquaculture industry has gained its momentum with the introduction of Pacific white shrimp (*Penaeus vannamei*) in 2009. Successful domestication of Indian white shrimp (*Penaeus indicus*) and farming using hatchery-produced seed by ICAR-Central Institute of Brackishwater Aquaculture (CIBA) showed encouraging results as an alternate species in the Indian aquaculture basket. In addition, breeding, seed production and feed development of certain brackishwater fish such as seabass, mullets, milkfish, whisker catfish, pearlspot and hilsa have shown a lot of promise. Indian Sundarbans situated in the south-east end of West Bengal provides amicable environment for the growth of different shrimps and fishes. Due to higher economic return, the fishers of Sundarban started showing their inclination to shift from fishing to aquaculture for better livelihood. Frozen shrimp and live crab are the most important export items from brackishwater aquaculture in Sundarbans. About 28% of 2.1 lakh ha potential brackishwater areas in

West Bengal are underuse and the state has been the Indian leader in tiger shrimp production, while farmers started culturing white leg shrimp late, compared to other coastal states of India, after the successful demonstration by ICAR-CIBA at its research centre at Kakdwip, West Bengal. ICAR-CIBA also demonstrated cost-effective formulated feed, polyplus for brackishwater polyculture to get higher return for the farmers. ICAR-CIBA has demonstrated the potential of a plankton booster derived from fish waste, Planktonplus to enhance survival and productivity in shrimp culture by increasing healthy plankton in culture ponds and increasing net profit of the farmers. There is vast scope for sustainable development of brackishwater aquaculture in Sundarbans to meet the livelihood demand utilizing the unused and underused areas and adopting advanced farming practices like integrated multitrophic aquaculture, integrated livestock-horti-aquaculture, multispecies culture with suitable species combination using cost-effective feed, culture of Asian seabass with formulated feed etc. Challenges like availability of seed and species-specific formulated feed, lack of proper communication facilities to reach to the market, disease outbreak, lack of cold chain facilities, frequent cyclone and natural calamities etc. faced by Sundarbans aqua farmers need to be tackled by appropriate management tools like conducting awareness program regarding the availability of seed and feed, the formation of aqua producers' group, demonstration of recently developed technologies and its refinement and capacity building of aqua farmers.

T2S1I08

WATER MANAGEMENT IN BRACKISHWATER AQUACULTURE IN COASTAL ECOSYSTEM

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Dr. (Mrs). P. Nila Rekha is presently working as Principal Scientist in ICAR – Central Institute of Brackishwater Aquaculture. She has 25 years research experience on various issues of brackishwater aquaculture pertaining to the environment and aquaculture engineering which includes seepage control, soil and water quality management of shrimp ponds, Environmental impact assessment of shrimp farming, using GIS, RS and spatial modelling, salinity monitoring, mapping using hyperspectral remote sensing, discharge water treatment using mangroves, and seaweed bioremediation, RAS, BMP water management of coastal ecosystem and biosecurity aspects of both hatchery and shrimp farms. She is recipient of various awards which includes, Jawaharlal Nehru award for her Ph.D. thesis, Norman Borlaug International training award during 2008. She is also a team member in Nanaji Deshmukh ICAR Award for Outstanding Interdisciplinary Team Research during 2017. She has been associated with 32 projects which includes funded projects from Ministry of water resources, DST, NFDB, NABARD.

Abstract: Brackishwater aquaculture is a coastal farming activity which aims at deriving maximum benefits from unproductive and marginally productive coastal lands and brackish water bodies and it has contributed significantly to the progress of country's economy as well as the economic well-being of the rural poor. It is a fast-growing food industry and the success mainly depends on the availability of good and adequate quality source water and water management during culture. India with its long coastline of 8118 km is blessed with 3.9 million ha of

estuaries and 3.5 million ha brackish water resources of which 1.2 million ha are potential brackishwater area. However, the total area under brackish water farming is only just over 15 percent. The rapid expansion of coastal aquaculture without adequate planning and water management has a serious socioeconomic consequence including salinization of ground water and agriculture land, mangrove degradation conversion of agriculture and mangrove ecosystems, resource use conflict high organic and microbial load in the river, chemical contamination and changes in the distribution of flora and fauna etc. Hence, the water management in coastal brackishwater aquaculture is of paramount which starts with identification of suitable water resource viz, creek lagoon, estuary etc water monitoring during culture .and discharge water treatment or reuse technologies like bioremediation. Coastal watershed based integrated water resource management using the advancement in geospatial modeling, remote sensing and GIS helps to identify the potential site, water source and its salinity regime during different seasons. Moreover digital information system will help coastal rural farmers to site specific species specific brackish water aquaculture. Of late intensive coastal aquaculture is rapidly expanding which uses large water volume and high protein content in feed which results in significant amount of nutrient rich effluents. Recirculating aquaculture systems (RAS) seems to be a solution. Development and advancement of RAS, Raceways, IMTA, Zero water exchange systems with biofloc, seaweed bioremediation and aquaponics offer a scope for higher productivity with better water management practices that obviously maintain the serenity of coastal ecosystems. In the present article all the above-mentioned water management issues in brackishwater aquaculture have been discussed for sustainable coastal ecosystems.

T2S1I09

WASTEWATER MANAGEMENT THROUGH AQUACULTURE PRACTICES

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Dr. Subhendu Adhikari had joined as scientist in ICAR-Central Institute of Freshwater Aquaculture, Bhubaneswar and later became Principal Scientist in 2009. Currently, he is working as Scientist-in-Charge (SIC) in the Regional Research Centre of CIFA, Rahara, Kolkata. His research areas include soil and water chemistry management of fish pond, fish pond environment, water and nutrient budgeting, contaminants in fish pond, climate change and aquaculture. Presently, he is working in the different inputs management in the fish ponds in relation to the soil carbon sequestration and carbon footprint. He is the recipient of several awards in international conferences and ICAR award for outstanding team research as team member. He is the Fellow of International Society for Environmental Protection (ISEP), Gorakhpur. He has guided five PhD students, three M. Phil students, and twelve Master degree students. He has published more than 100 research papers and 1 book.

Abstract: The world's total water resource is constant; however, the wastewater production is increasing, and the infrastructure and management systems are not adequate for this increasing volume. Globally, two million tons of sewage, industrial and agricultural waste excluding the unregulated or illegal discharge of contaminated water is discharged into the world's waterways, This wastewater contaminates freshwater and coastal ecosystems which threaten food security, access to safe drinking and bathing water. This is also creating a major health and environmental management challenge.

Faulty ways of food production lead to the use of 70–90 per cent of the available fresh water, and much of this water returns to the system with additional nutrients and contaminants. Further downstream, agricultural pollution is joined by human and industrial waste. This wastewater flows untreated up to 90 per cent into the densely populated coastal zones. This can contribute to the growth of marine dead zones, which already cover an area of 245 000 km^2, approximately the same area as the entire world's coral reefs. This leads to further losses in biodiversity and ecosystem resilience, which in turn undermines prosperity and efforts towards a more sustainable future (https://www.greenfacts.org).

The per capita average annual availability of freshwater has been reducing from 5177 m^3 in 1951 to 1588 m^3 in 2010 due to population increase and all-round development in India. It can be further reduced to 1341 m^3 in 2015 and 1140 m^3 in 2050 (Kaur *et al*., 2012). In addition, global warming scenario will also aggravate the water crisis more. Increasing urbanization and industrialization emphasizes the need to explore possibilities of recycling wastes. The aquaculture authorities directed their efforts for obtaining new water resource towards recycling and reuse of waste water in line with the country's policy to control pollution. Recycling of sewage wastes through aquaculture assumes importance as it is an ecologically sound practice for handling wastes. For developing countries, a simple system like having stabilization pond is suggested for waste recycling as it is cost-effective. Sewage water is rich in organic matter, heavy metals and essential inorganic nutrients in readily available form for fertilizing fish pond. Sewage can be profitably used for fish culture due to utilization of its smaller detritus particles coated with bacteria and acceptable by zooplankton and benthos for their sustenance, larger particles of sewage are directly utilized by fish. The content of heavy metals in fish pond water gets reduced in the process of dilution by sedimentation process but they usually accumulate in bottom sediment or within the weeds grown at the pond. In India, there are 234-Sewage Water Treatment plants (STPs). Most of these were developed under various river action plans (from 1978-79 onwards) and are located in only 5% of the cities/ towns along the banks of major rivers (CPCB, 2005). Dissolved air floatation, dual media filter, activated carbon filter, sand filtration and tank stabilization, flash mixer, clariflocculator, secondary clarifiers and sludge drying beds, etc. are the different treatments methods adopted in these plants. Thus, the treatment of wastewater through the aquaculture practices is an excellent venture.

T2S1ORAL01

Constraints of Shrimp Farming in Maharashtra and Its Measures

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The fisheries sector occupies a very important place in the socio-economic development of India. The sector has been recognized as a powerful income and employment generator as it stimulates the growth of a number of subsidiary industries and is a source of cheap and nutritious food. More than 6 million fishermen and fish farmers in the country depend on fisheries and aquaculture for their livelihood. The fisheries sector has also been one of the major contributors of foreign exchange earnings through export. With third position in fisheries and second in aquaculture, the country has high potentials in the sector for rural development, domestic nutritional security, employment generation, gender mainstreaming as well as export earnings, that only few other activities can provide. It is in this context that it is very important that concerted efforts are put in for pursuing sustainable fisheries development and management in the country in the long run. The brackishwater resources of the State are confined to 5 coastal districts. Out of the total available area of 80000 ha, 14445 ha has been found suitable for brackishwater aquaculture. So far, 3067 ha brackishwater area has been allotted, of which 1056 ha has been

brought under shrimp culture. There is no fast development in brackish water shrimp farming due to constraints in declaration of shrimp farming as agricultural activity, re-survey of potential culture sites, allocation of government lands for shrimp farming, provision of loan, shrimp hatchery, crop insurance, cluster farming approach.

T2S1ORAL02

3P3C A Novel Model of Mix Farming in Aquaculture

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Financial sustainability of aquaculture depends on the two important aspect, production and profitability. Its significance gets more pivotal in the present scenario due to diminishing profit margin of Indian farmers in agriculture and the reducing per capita land due to burgeoning population. Therefore, a resource specific and fish species specific approach to explore the full potential of aquaculture systems is need of hour. Different models to explore the production potentials of different culture system, techniques and species under culture, are essentially required. These models will ensure the production and profit efficiency and will lead more income and cost effectiveness in aqua farming. Here is the key of sustainability and it is being held in integration, may be of different techniques or resources or tropic levels. Similar such effort of integration of carp culture with *Pangassius* catfish culture and intensive farming with pond culture has been tested by Regional Research and Training Centre (RRTC), Motipur of ICAR- Central Institute of Fisheries Education (CIFE), Mumbai and named as 3 phase 3 cycle (3P3C) Model. This model for mix farming of fish is with 3 different phases. In first phase nursery rearing is done in nursery ponds. Then it is followed by the phase out culture of seed to grow out stocking under intensive farming of the biofloc based culture. Finally grow out farming of carps and catfish together in mix farming in pond is done. Each of the three phase is for three months and the so the 3 cycle of the operation is repeated in grow out giving the three crops in year. It has led the three to five times more production from the same area of land or water, resulting the impetus to both production and profitability in efficient manner. The model helps to be useful for both the condition of flood and drought.In the flood prone and drought uncertain areas, the flood and drought periods can be surpassed in the intensive culture mode. Similarly, it gives better solution for overwintering of the extreme low temperature in India. As the winter season is quite unproductive in respect to fish culture as fish drop eating and finally the growth and health of fish get compromised. The phased-out seed for grow out through biofloc will create a production boost in open area of wetlands, in pens, cage or even in large bodies such as reservoirs. Here the intensive biofloc techniques can be used of phase out seed rearing and the other farming techniques can be integrated to it to produce table sized fish in shorter duration.

T2S1ORAL03

Changes in the Hepatosomatic Index (HSI) and Liver Histology of *Anabas testudineus* on Exposure to Two Agrochemicals

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The liver is a significant organ of fish and it has an important role in detoxification, protein synthesis, digestion,

and excretion. It is one of the most sexually dimorphic organs during the reproductive phase, because of different metabolic demands between the two sexes. In the case of female fish, it also acts as the main organ for the synthesis of oocyte constituents. Agrochemicals are used vigorously in the agricultural field to increase crop production. Since rural fields are found near water bodies, there is a high danger of water defilement by these agrochemicals with subsequent buildup collection in amphibian biota including fish. Looking into literature, Monocrotophos (MCP) and Glyphosate (GLY) are two agrochemicals, utilized as insecticides and herbicides separately in horticultural fields in India and other created nations. These two agrochemicals are used for this investigation. This investigation planned to know the harmful impact of sub-lethal concentrations of these two agrochemicals on the liver of Anabas testudineus. This fish is playing a major role in enhancing aquaculture production in rural areas of the Indian subcontinent. We have chosen this fish as an experimental animal because it is a good source of essential amino acids, protein, fat, and vitamins and its flesh also contains a high amount of iron and copper that support hemoglobin synthesis. The adult fish were exposed to three sub-lethal concentrations of MCP, for example, T_1: 3.5 ppm (1/30th of 48h LC50), T_2: 5.3 ppm (1/20th of 48h LC50), and T_3: 10.6 ppm (1/10th of 48 h LC50) and GLY, for example, T_1: 2.6 ppm (1/30th of 48h LC50), T_2: 3.9 ppm (1/20th of 48h LC50), and T_3: 7.8 ppm (1/10th of 48 h LC50) for 45 days with 12 fish in each tank. Changes in the hepatosomatic index (HSI) and histological damage in the liver were found in Anabas at 30th and 45th days exposure of both agrochemicals. Thus, it is concluded that these two agrochemicals affect major organ liver and ultimately fish health condition. Further work like biochemical and molecular can be done to know the toxic effect of these two agrochemicals on the fish health conditions. Subsequently, exacting guidelines should be followed on the utilization of these agrochemicals for the endurance of fish and other amphibian living beings.

T2S1ORAL04

An Innovative Nursery Rearing Method of Brackishwater Catfish, *Mystus gulio* at Varied Densities in Simplified Floc System

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Brackishwater catfish, *Mystus gulio* has good market demand as a high value species in Eastern India and Bangladesh. The hatchery produced fry are further reared in nursery to produce fingerlings suitable for stocking in grow-out system. Nursery rearing methods of this fish in net cages and ponds have been standardized for fingerling production. To develop an innovative and cost-effective method of nursery rearing, 25 days old fry (Mean body weight: 0.30±0.04 g) were reared for 60 days in a simplified floc system consisting of 2 ton tanks kept under shade with transparent roofing. Before 10 days of stocking, tank water was added with molasses, PlanktonPlus (a plankton booster developed by CIBA) and Bacillus subtilis DDKRC5 (JN641293) (4.6×109CFU ml^{-1}) at 0.05% (v/v) keeping carbon:nitrogen (C:N) ratio as 15:1 for development of flocs. Varied stocking density at three levels (50, 75 and 100 no./m3) was the test variable in triplicate tanks. A CIBA formulated feed (crude protein 30%, lipid 6%) was provided at 20% of biomass per day for the first 10 days, followed by 18, 15, 12, 10 and 8% adjusted at 10-day intervals, actually 50% of feed quantity was reduced. After 60 days, fry attained significantly higher growth (79.65±1.35 mm/5.48±0.25 g) at 50 no. m^{-3}stocking density compared to other groups ($P<0.05$). However, a significantly higher survival (95.14±1.11%) with lowest apparent feed conversion ratio (1.27±0.10) was obtained at 100 no. m^{-3} stocking density ($P<0.05$). Microbial dynamics in water examined at 20-day intervals revealed that total heterotrophic bacterial (THB) population was significantly lower at 50 no. m^{-3} stocking density as compared to other two stocking densities at the final day of experiment ($P<0.05$). However, total Vibrio count did not vary among treatments at any sampling time. Similarly, no significant differences were recorded among treatments for water

quality parameters. This study suggested that in brackishwater simplified floc system, *M. gulio* fry can be reared at higher density of 100 no. m^{-3} to achieve maximum survival and better feed conversion for economic benefit. This is the first report on nursery rearing of M. gulio in simplified floc system and the information has practical significance as a major step for establishing seed rearing package of practice, and would benefit the nursery operators.

T2S1ORAL05

Estradiol Dependent Stimulation of Brain Dopaminergic Systems in the Female Gold Spot Mullet, *Liza parsia*

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Goldspot mullet, *Liza parsia* attains maturity in captive condition but fails to achieve final oocytes maturation. Therefore, it is hypothesized that the reproductive failure in captivity might be due to inhibitory role of dopamine (DA) on the release of gonadotropins (LH, Luteinizing hormone). The higher level of 17-β-estradiol (E2) seems to increase dopaminergic inhibitory tone, thereby inhibiting ovulatory surge in LH release. To validate the hypothesis, we evaluated dopamine level in different parts of the brain (forebrain, midbrain and hind brain) and the different sizes of *L. parsia* through the expression of dopamine receptor protein (D2R-45 kDa). From this study, it was found that D2R was expressed in all three parts of the brain (forebrain, midbrain and hind brain) and in different size groups fish i.e.fry, fingerlings, sub-adult and adult. Further, to understand the E2 dependent regulation of dopamine in brain of *L. parsia*, adult mature females were equally distributed to four different treatments and E2 was injected to all fish @ 2 mg kg^{-1} (Weltzien *et al.*, 2006). After injection, fish were sampled at 12 h (0.5 day), 24 h (1 day), 48 h (2 days) and 7 days. Control fish (0 h) was injected with 0.9% physiological saline. Brain tissue proteins were separated in SDS-PAGE and then electro-blotted on to a nitrocellulose membrane. Expression of D2R (45kDa) and E2R (67kDa) was visualized by primary antibody (monoclonal anti DRD2, E2R- 1:1000) and horseradish peroxidase (HRP) conjugated secondary antibody (1:2000). Immunohistochemistry (IHC) of D2R and Vtg (vitellogenin) was performed in brain and gonad tissue, respectively. Primary antibody of D2R and Vtg and secondary antibody (HRP conjugated) were used. Sex hormones such as follicle stimulating hormone (FSH), LH, and E2 were detected using Enzyme linked Immunosorbent Assay (ELISA) kits. Results showed time dependent variations in FSH, LH and E2 levels. FSH and E2 gradually increased at zero/control to 2 days of sampling. IHC showed an intense expression of D2R (brain) and Vtg (ovary) at 48 h of sampling than in the other groups. Western blot analysis of E2Rin ovary resulted maximum signal value (band intensity) at 0.5, 1, 2 days after administration of E2. Similar trend was observed for expression of D2R in the brain. Overall, results confirmed that the expression of D2R in brain is directly regulated by E2 in *L. parsia*.

T2S1ORAL06

Growth Potential and Immunity of the Indian White Shrimp, *Penaeus indicus* (H. Milne-Edwards, 1837), Cultured in Grow-Out Ponds at Varying Densities and Salinities in Diverse Geographical Locations of India

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With an aim to evaluate the culture potential of Indian white shrimp *Penaeus indicus,* grow-out farming trials were carried out under different salinity regimes and stocking densities across the coastal states of India (West Bengal, Odisha, Andhra Pradesh, Tamil Nadu, and Kerala). The growth performance and immunity status were assessed under two different stocking densities (low and high) at each salinity regime (S1:3-7, S2: 8-15, S3:15-25, S4:25-35, and S5:40- 60 ppt) for a period of 80-120 days. Healthy post larvae (PL) 10 (0.01 g) produced in a shrimp hatchery were stocked after proper acclimatization under different salinities. Significantly higher growth was observed in the salinity range of 15 to 35 ppt with average daily growth (ADG) up to 0.195±0.032 compared to low ADG of 0.125 ±0.021 in very low and very high salinity range (<7 ppt & >40 ppt). Similarly, the final mean harvest weight of P. indicus reared at 15 - 25 ppt salinity was significantly ($P<0.05$) higher compared to other salinity ranges. The lower stocking density treatment demonstrated higher mean harvest weight (18 -30 g) compared to higher density ponds (12 -20 g). There was a significant ($P<0.05$) difference in the feed conversion ratio (FCR) and protein efficiency ratio (PER) across different salinities whereas stocking density does not influence the FCR much. The total productivity (kg ha^{-1}) significantly ($P< 0.05$) increased with increase in stocking density by 20-30 % while it was comparable between salinity ranges. The prophenoloxidase (PPO) activity gradually increased or decreased correspondingly to the salinity level with significantly lower PPO activity being observed at very low (5ppt) and very high (60 ppt) than other salinity ranges. The serum protein and lysozyme also varied with the salinity range. Different densities did not affect immune parameters much although lower stocking density was showing marginal increase. This study is based on large data from multi-location trials undertaken across different salinity ranges and stocking densities and provides a field-level assessment of growth potential of this native shrimp species in different geographic locations.

T2S1ORAL07

Beneficial Effects of Guava Leaf Extract for its Potential Use in Aquaculture

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From the ancient times, the different plant species are known to possess different bioactive compounds including antimicrobial compounds. Guava (*Psidium guajava*) leaf extract has been shown to possess antibacterial activities in addition to its popularity as delicious and nutritious fruit. Past studies have also shown that guava leaf extract have beneficial effects in treatment of patients with diarrhea, cough, diabetes and dental plaque. The anti-inflammatory, anti-tumor and anti-oxidants properties of guava leaf extract have also been reported. Guava leaf extract has also been used experimentally to prevent different aquaculture diseased conditions. The present study was undertaken to

study the inhibitory effects of guava leaf extract against selected aquatic pathogens as well as to study phytochemical composition of guava leaf extract. The efficacy of leaf extracts (ethanolic, methanolic and aqueous) of guava plant against *Vibrio mimicus, V. campbellii*, *Edwardsiella tarda* and *Aeromonas hydrophila* was assessed by Disk diffusion assay following measurement of Zone of inhibition. Minimum inhibitory concentration (MIC) of each type of extract was determined. Qualitative phytochemical property of guava leave was also studied. Antioxidant activity of guava plant extract was estimated by 2,2-diphenyl-1-picrylhydrazil (DPPH) radical scavenging assay and IC50 was determined. All the types of extract (ethanolic, methanolic and aqueous) exhibited inhibitory activities against all the four pathogens tested with *E. tarda* being the most sensitive pathogen with inhibition zones of 27.25 ± 0.25, 25.50 ± 0.29 and 27.25± 0.75 mm (diameter) against ethanolic, methanolic and aqueous extracts, respectively. MICs of ethanolic extract of guava were found to be 1.25, 20, 1.75 and 20 mg ml^{-1} against *V. campbellii, V. mimicus, E. tarda* and *A. hydrophila*, respectively. On the other hand, for methanolic extracts, MICs were recorded as 1.5, 20, 1.75 and 22 mg ml^{-1}, respectively against the same pathogens. On phytochemical analysis, it was observed that both ethanolic and methanolic extracts of the plant contain saponin, alkaloids, phenolic compounds, tannin, quinines and terpenoides. In DPPH radical scavenging assay, IC50 values were found to be low and it was recorded as 11.23 ± 0.12 and 11.23 ± 0.11 µg ml^{-1} in case of ethanolic and methanolic extracts, respectively. The leaf extract of guava showed potential antibacterial activities against four pathogens tested as evidenced by wide zone of inhibition and low MIC values. However, the antibacterial activities were found significantly higher in case of ethanolic and methanolic extracts compared to aqueous extract. The qualitative phytochemical analysis of guava leaf extract also revealed the presence of almost all phytochemical compounds required for antibacterial action. In addition to these beneficial effects, the guava leaf was also found to possess potent antioxidant properties in DPPH radical scavenging assay as evidenced by low IC50 values. Considering all beneficial properties, it may be stated that guava leaf may be considered as a potential candidate for preparation of commercial medicine in aquaculture.

T2S1ORAL08

Microbial Composition in Larval Development of Herbivorous Brackish water Fish, *Chanos chanos* (Milkfish)

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Healthy microbial association is crucial in successful larval production. Microbes attach to fish larvae and intestines of fish and their uptake generally coincides with the larval development and physiology. *Chanos* is a herbivorous euryhaline fish and one among top 20 finfish species contributing to total finfish production with 2.4% share and 1.327 million tonnes production for the year 2018 (FAO, 2020). Hatchery production of milk fish larvae is successfully carried out in ICAR-CIBA and the microbial association in larval cycle was analysed for 2018-2020 period. Enumeration of culturable bacteria in larvae, rearing water and diets revealed maximum number of bacteria in rearing water and live feeds in the order of 105 cfu ml-1 and were least from input water (0-100 cfu ml^{-1}). The number of heterotrophic bacteria in fish larvae was found in the order of 103 cfu ml-1 and was uniform throughout the larva cycles. Characterization of these bacteria revealed the dominance of family Vibrionaceae in the milkfish larvae with major representation from *V. alginolyticus, V. littoralis, V. proteolyticus, V. ruber, V. natriegenes, V. Neocaledonicus* and *Photobacterium ganghwense* and also *Pseudomonas spp*. Culture independent identification through DGGE revealed the uniform presence of *Fusibacter spp, Achromobacter spp, Candida spp, Catenococcus spp* in milkfish larvae. Metagenome sequencing of 16s amplicon profiles of milk fish larvae from 2, 8,18 and 30 DOC revealed the dominance of Phylum Proteobacteria on 2nd day (82.75%), 8th day (83.75%) and 30days (51.28%), whereas Bacteriodes (37.4%) and Firmicutes (31.19%) were dominated on 18DOC. Later on 30th day, Actinobacteria (23.92%) were progressing towards a significant component of Milkfish bacterial flora. This

study unravelled the progression and establishment of microbial flora in herbivorous euryhaline milk fish larval development. Similar studies with Asian Seabass have revealed the dominance of Phylum Proteobacteria with major representation from members of the family Vibrionaceae and Pseudoalteromonadaceae. The composition of Actinobacteria and Firmicutes were significantly reduced in Asian Seabass (<10%). The comparison of 16s amplicon sequencing of these species clearly indicated the difference in microbial composition and its progression during the larval development stages of these fish species. The difference in the two microbial communities observed in the two species and its impact on the health of the two species remains to be explored.

T2S1ORAL09

Grow Out Cage Culture Trial of Mangrove Red Snapper (*Lutjanus argentimaculatus*) in Brackishwater Ponds

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The mangrove red snapper (*Lutjanus argentimaculatus*) is a favourite food fish in many Asian countries. Most of the table-sized snappers comes from wild catch, while a limited quantity is cultured in floating net cages offshore or in ponds. The mangrove red snapper is an important fish to coastal fisheries and can be an ideal candidature species to culture in cages. The popularity of farming delicious food fishes is growing around coastal states. If the mangrove red snapper is reared in cages inside the ponds, the fish growth sampling and harvesting can be easily done. It also helps in preventing disease infection and securing fish stocks during flooding. An experimental trial on growth performance of the mangrove red snapper was undertaken in cages installed in brackishwater ponds at Marine Biological Research Station, Ratnagiri. The juveniles of red snapper were caught from the wild area nearby estuaries with initial average length of 19.06 cm + 0.42 and initial average weight of 115.91 g + 1.29. The fishes were stocked at the rate of 300 nos. per 9 m^3 in circular cage. The fishes were harvested after a period of ten months. The red snapper attained a size range of 600 g to 1 kg weight. During the culture periods the results were encouraging, and it can become the alternative livelihood option to fisherfolks during lean fishing season.

T2S1POS01

Suitable Fish Species Combination in Polyculture using *Hygroryza aristate* Asian Water Grass as Feed in the Coastal Wetlands of Bangladesh

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Commercial fish feed price increased globally which threats aquaculture as well as food security of poor all over

the world and creates problem for sustainable aquaculture development. Ideal species combination in polyculture is very important to maximize production with minimizing feed cost. An experiment was conducted using various species combination in the tidally flooded coastal wetlands of Bangladesh utilizing *Hygroryza aristata* Asian water grass as fish feed. The experiment was conducted under four treatments each with three replications for 6 months. Stocking densities were same in each treatment (75 fish per 60 m^2) but the species combinations were different among the treatments (in treatment one, T_1: grass carp 53, common carp 7, tilapia 8, mrigal 7; in treatment two, T_2: grass carp 53, common carp 7, silver barb 8, mrigal 7; in treatment three, T_3: grass carp 53, common carp 7, tilapia 8, silver barb 7; and in treatment four, T_4: grass carp 53, common carp 5, tilapia 7, mrigal 5 and silver barb 5). The *H. aristata* water grass was planted and grown on the bottom soil before stocking of fish in each treatment. Other than the water grass, no feed or fertilizer was applied throughout the study period. The survival, growth (weight gain and specific growth rate-SGR) and total production were calculated. The survival of fishes varied from 66.67 ± 8.25 to 91.20 ± 2.88% irrespective of fish species. The final weight, weight gain and SGR of grass carp and common carp were found significantly higher in T_3 followed by T_4, T_2 and T_1. The final weight, weight gain and SGR of silver barb were found higher in T_3 followed by T_4 and T_2, but in case of tilapia, the weight gain and SGR were found higher in T_4 in comparison with T_3. The final weight, weight gain and SGR of mrigal were found higher in T_1 followed by T_2 and T_4. Comparatively lower production performance was found in mrigal in comparison with other cultured fish species among the treatments. The growth and the total production were found significantly highest in T_3 among the treatments. The findings indicated that the species combination in T_3 (grass carp: common carp: tilapia: silver barb: 7.5:1:1:1) was ideal using *H. aristate* water grass as fish feed in polyculture in the coastal wetlands of Bangladesh.

T2S1POS02

Mapping of Aquaculture Potential Zones using Geospatial Multi Criteria Method for Sustainable Aquaculture Development-Thiruvallur District

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Aquaculture sector has developed rapidly since last decade and its development has been unregulated, which has caused many ecological problems. In this regard, this study has been undertaken with an aim to identify potential zone for sustainable aquaculture development. Thiruvallur district coastal sub watershed boundary has been taken as the study area which has been delineated using SRTM DEM, toposheet and also using watershed data collected from agriculture department, Tamil Nadu. Water source available in the study area are Pulicat Lake, Buckingham canal, Arani River and Kosathalaiyar River. Pulicat and Buckimgham canal are the major source for aquaculture in Thiruvallur district, since Kosathalaiyar and Arani River are ephemeral in nature. Pairwise comparison matrix has been used to assign weightage to each criteria based on its relative importance. Various thematic maps were integrated into multi criteria factors such as water quality, soil characteristics, infrastructure factors and Land use type to identify potential aquaculture zone using Remote sensing and GIS. To ensure sustainable aquaculture development constrain parameters has been framed according to Coastal Aquaculture Authority regulations (CAA) for mangroves, settlement, drinking water source and ecologically sensitive areas. Existing aquaculture farm in the study area has been mapped using sentinel 2, it is about 660.65 hectare and the potential extend of the area available for aquaculture development estimated using AHP method about 630 hectares.

T2S1POS03

Water Spinach Leaf Meal as an Alternate Feed Ingredient for Rohu

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Ipomoea aquatica (IA), a tender, trailing or floating plant, plenty available in water logged areas, commonly called as water spinach (family Convolvulaceae). It is also commonly used as a green leafy vegetable in rural India and cultivated commercially. The plant has proved to have water purifying properties, which is beneficial for aquatic organisms. It is easy to grow and cheap. On dry matter basis, it has 28.50 to 33.12% protein, thus a potential unconventional ingredient for aquafeed. In order to evaluate it as a fish feed ingredient, a 45 days feeding trial was conducted to study the effect of different inclusion level of *Ipomea aquatica* leaf meal based diet on the growth and physiology of rohu. The feeding trial was conducted with one hundred eighty *Labeo rohita* fingerlings distributed into three different experimental groups including a control (C) group in triplicates. Each group was stocked with fifteen fish per replicate and was fed with three different isonitrogenous and isoenergetic diets containing 10% (T_1), 20% (T_2) and 30% (T_3) of *Ipomea aquatica* leaf meal. Fishes were fed to satiation twice daily for 45 days. At the end of the experimental period, activity of AST and ALT in muscle and liver was estimated. In the muscle, the AST activity was found to be significantly different ($P<0.05$) with highest value observed in control group and the lowest was observed in T_2 group. In the liver, the AST activity in the different experimental groups was not significantly different ($P>0.05$) with highest value observed in T_3 group and lowest value was observed in T_1 group. The LDH activity in both muscle and liver showed similar trend and the highest values were observed in T3 and the lowest was observed in T_1. Immuno-haematological Parameters of a serum was estimated from different experimental treatments. Only the total serum protein values was found to have significant different with highest values was observed in T_1 group fed with 10% inclusion level of Ipomea aquatica leaf meal based diets. Weight gain and SGR was found to be higher in T_1 (10%) group. FCR was found lowest in group fed with 10 % *Ipomea aquatica* leaf meal based diet. Thus, the study suggests that high inclusion level of *Ipomea aquatica* leaf meal based diets may have adverse effects to growth and the data can be correlated with growth. At 10% inclusion level *Ipomea aquatica* leaf meal showed growth performance when compared with control and can be included in the diet.

T2S1POS04

The Presence of Aquatic Macrophyte and Soil Bottom in Concrete Tanks Positively Stimulates Gonadosomatic Index and Reproductive Hormones in *Channa striata*

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Spawning habitat plays a pivotal role in aquatic species for achieving successful gonadal development and reproduction. In order to investigate the role of habitat manipulation on the gonadal development and reproductive hormones of the air-breathing fish, *Channa striata*, experiment was conducted by rearing fish with and without soil bottom and microphytes in cemented tanks (Treatment 1: without soil bottom and macrophytes and Treatment 2: with soil bottom and macrophytes). The fish were sampled during their spawning period from each treatment. The gonad tissues were dissected for calculating the mean gonadosomatic index (GSI) in females for each treatment.

The highest mean GSI was 8.12 for females in T_2 compared to 6.6 in T_1. The histological analysis of the ovary depicted presence of a greater number of fully matured oocytes in their late yolk granule stage in T_2 as compared to the oocytes of T_1. The serum hormone analysis revealed a significant difference of follicle-stimulating hormone (FSH) in females of T_2 when compared to the females of T_1. A similar trend of increased estradiol (E2) level in T_1 directs its essential need for secondary oocyte growth in T_1 females. This study provides a clue for the modification of habitat in achieving successful gonadal development. The result of this study revealed that aquatic macrophyte and soil bottom plays an important role in captive maturation of *C. striata* in concrete tanks.

T2S1POS05

Utilization of Berseem (*Trifolium alexandrinum*) Leaf Meal as Deoiled Rice Bran Replacer in the Diet of *Labeo rohita* (Hamilton, 1822) Fingerlings: Effect on Growth Performance and Physio-Immunological Responses

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A 90-day feeding trial was conducted to evaluate the berseem leaf meal (BLM) as de-oiled rice bran (DORB) replacer in the diet of *Labeo rohita* fingerlings in relation to the growth performance and physio-immunological responses. Two hundred twenty five *Labeo rohita* fingerlings were randomly distributed into five different experimental groups such as control (0% BSLM), BLM25 (7.5% BSLM in replacement of 25% DORB), BLM50 (15% BSLM in replacement of 50% BSLM), BLM75 (22.5% BSLM in replacement of 75% DORB) and BLM100 (30% BSLM in replacement of 100% DORB) in triplicate with the stocking density of 15 fish per replicate tank. The fishes were fed with respective isonitrogenous (32% crude protein) and isoenergetic (360 Kcal digestible energy/100g) diet at satiation level twice daily. Results indicated that the fish of BLM50 group exhibited the higher weight gain percentage and similar specific growth rate, feed conversion ratio, feed efficiency ratio, protein efficiency ratio, survival percentage and crude protein, lipid and dry matter digestibility compared to control. Health and immune status were comparable between the fish of control and BLM50 groups. Higher dietary inclusion of BLM caused reduced growth, nutrient utilization and immune status of fish. Hence, the present study concludes that BLM with inclusion of 15% can replace 50% DORB in the diet of *Labeo rohita* without compromising the growth and health status of fish.

T2S1POS06

The Effects of Partial Replacement of Fish Meal with Roasted Guar Korma Meal on Growth, Feed Utilization and Survival of Tilapia (*Oreochromis niloticus*) Advance Fry

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Present study was undertaken to study the effects of partial replacement of fish meal with Roasted Guar Korma on growth, feed utilization and survival of tilapia (*Oreochromis niloticus*). Advanced fry diet was examined. The

experiments were conducted for 60 days in plastic tanks. Triplicates were maintained for each of the treatment. The five experimental diets were prepared which included a control diet (100% fish meal) and four treatment diets viz. fish meal replaced with Roasted guar korma at 25%, 50%, 75% and 100% of dietary protein levels respectively. The diets were formulated to provide 40% crude protein on a dry weight basis. Fish were fed with experimental diets for 60 days. The water quality parameters were found in the permissible range during entire experimental period. After the end of experiment, it was found that the T2 treatment led to higher weight gain (9.56 ± 0.49), SGR (1.57 ± 0.01) and PER (1.89 ± 0.02) and lowest FCR (1.65 ± 0.02) Thus, it can be concluded from the study that Roasted guar korma is a potential protein source and can be used to substitute fish meal in the diets of Tilapia (*O. niloticus*) advance fry.

T2S1POS07

Treatment of Wastewater from Fish Pond Using Rotating Biological Contactor

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Rotating biological contactor (RBC) consist of a circular disks (on the surface of which biofilm is formed) attached to central axis. Contractor is partly dipped in wastewater. As contactor rotates slowly, dissolved organic matter from wastewater and oxygen from atmospheric air diffuse into biofilm. Microorganisms present in the biofilm consume organic matter as food and produces more microorganisms. Dissolved oxygen is utilized by microorganisms and carbon dioxide is moved out in atmospheric air. RBCs is used for treatment of wastewater generated from fish ponds due to presence of uneaten food material, fish fecal matter, growth of algae and other microorganisms. RBC is easy to construct, operate, low cost and it utilizes oxygen directly from atmospheric air. It is observed that changes in various water quality parameters such as dissolved oxygen, suspended solids, organic loading, salinity, pH and other parameters in used water from fish ponds. This paper reviews use of rotating biological contactor for treatment of wastewater produced by fish ponds.

T2S1POS08

Optimization of Biomass Density of Estuarine Oyster, *Crassostrea cuttackensis* in Integrated Multi-Trophic Aquaculture (IMTA) System for Better Water Quality and Production Performance

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Integrated multi-trophic aquaculture (IMTA)involves incorporation of species from different trophic or nutritional levels in the same system to result in greater production based on mutual benefits to the co-cultured species and improved ecosystem health. However, in brackishwater, very few trials on IMTA have been conducted so far. Moreover, optimum density of extractive species like oyster and seaweed in IMTA is yet to be ascertained. Edible estuarine oyster, *Crassostrea cuttackensis* is abundantly available in Sundarban. Being filter-feeder, it can be used as an extractive species for organic matter removal in IMTA. Therefore, an experimental trial was conducted to

assess the effect of different stocking densities of *C. cuttackensis* on performances of milkfish (*Chanos chanos*) and Pacific whiteleg shrimp (*Penaeus vannamei*), and environmental remediation in the IMTA system. There were three densities of oyster, 0.6 (T_1), 1.2 (T_2), and 1.8 (T_3) kg m^{-3} distributed in 1000 litre FRP tanks containing milkfish (4.51±0.05 g) and whiteleg shrimp (4.50±0.03 g) at 25 and 50 no. m-3, respectively. Control tanks contained same number of milkfish and shrimp with no oyster. All the three treatments and control had triplicate tanks. The trial continued for 60 days, and fish and shrimp were fed with a common diet containing 30% crude protein. Results showed that the highest growth of milkfish (24.66±0.31 g) and shrimp (15.20±0.17 g) was obtained in treatment T_3 ($P<0.05$) compared to that of the control [13.97±0.08 g (milkfish), 11.83±0.13 g (shrimp)]. Apparent feed conversion ratio (AFCR) was the lowest in T_3 (0.92±0.01) ($P<0.05$). Although, survival of milkfish did not vary, shrimp survival was the highest in T_3. The inorganic nutrients (nitrogenous and phosphorus compounds) of water improved in all three IMTA systems in comparison to control. This trial suggested that oyster, *C. cuttackensis* can be an effective extractive species in IMTA system with a stocking density of 1.8 kg/m^3.Therefore, this IMTA model (T_3) proved to be productive and have a successful environmental bio-remediation effect.

T2S1POS09

Comparative Study of Survival and Growth Performance of *Penaeus vannamei* (boone, 1931) with Probiotic Supplementation at Higher Salinities

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The present research work was designed to compare the performance of *Penaeus vannamei* at different hyper saline condition under probiotics supplementation. The probiotics are considered as one of the most significant components of shrimp farming due to its several beneficial effects such as disease prevention, water quality maintenance, and growth performance. The present experiment was conducted at, Rajula, District Amreli, Gujarat. A 60 days experiment trial was carried out at different higher salinities (50, 55 and 60 ppt) with probiotic and 45 ppt as control. The healthy shrimps of average size 3-3.1 gm were stocked @ 45/tank in the experimental tank of 1000 litre capacity. Animals were fed at the rate of 5 % of their body weight. Feed probiotic (*Bacillus spp.*) was incorporated into the feed along with binder @ 10g kg^{-1}. The same probiotic added feed was used in all treatments and control. In the end of the experiment. The physio-chemical water quality parameters viz. TAN, Nitrite, Alkalinity, pH etc. were recorded within the optimum range throughout the experiment, whereas, significant better results was observed in the control and T_1 respectively. The ABWG and SGR of P.vannamei was found better and significantly higher in control and T_1 respectively compared to T_2 and T_3 respectively. The FCR showed significantly lower ($p<0.05$) in control with rest of the treatments. Whereas, T_1 and control showed high survival and found significant difference with T_3 respectively. The observation shows as the protein efficiency ratio (PER) was fund better in control and T_1 and showed significant difference ($p<0.05$) with T_2 and T_3 respectively. Therefore, from the present experiment it can be concluded that higher saline water viz.45 and 50 ppt can be used for culture of shrimps with probiotics supplementation.

T2S1POS10

Better Management Practices and their Adoption in Shrimp Farming: A Case from South Konkan Region, Maharashtra

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Among brackish water shrimp aquaculture, white leg shrimp (*Litopenaeus vannamei*) farming is getting faster attention in domestic market as well as export markets. Therefore, number of farmers and fishers are venturing into shrimp farming business. The shrimp exports from developing countries to developed countries are ever increasing during recent past. Despite of this increasing shrimp exports in recent years, a high percentage of shrimp consignment rejections by importing countries because of non-compliance with international standards. It is, therefore very much essential to adopt Better Management Practices (BMPs) in shrimp farming at each and every stage of shrimp farming to achieve sustainable development in shrimp farming. Considering this, study was undertaken in South Konkan districts (Ratnagiri and Sindhudurg) of Maharashtra state to study the adoption level among shrimp farmers about Better Management Practices (BMPs) in shrimp farming. Data was collected from 59 shrimp farmers from the South Konkan districts by using simple random sampling technique. Structured interview schedule was used to collect information. A total of 40 better management practices recommended by CAA and NaCSA were used as framework to study the adoption level of shrimp farmers. The adoption of each BMPs by shrimp farmers was measured on three-point continuum viz., three for complete adoption, two score partial adoption and one score for no adoption. Results revealed that around (43.18%) of the shrimp farmers were having low adoption level regarding overall better management practices in shrimp farming followed by 37.03 % of shrimp farmers were having were having medium level of adoption regarding BMPs and only 19.79 % of shrimp farmers were found with high adoption about overall better management practices in shrimp farming. The reason behind low level of adoption about BMPs is that maximum numbers of shrimp farmers in South Konkan districts, Maharashtra were having low to medium level of knowledge regarding BMPs as well as improved shrimp farming practices. Also, majority of shrimp farmers were unaware of the maximum number of BMPs used during shrimp farming. It is therefore suggested that adoption of BMPs in shrimp farming needs regular awareness, training, voluntary cooperation and motivation among the shrimp farmers.

T2S1POS11

Dietary Supplementation of Crustacean Shell Waste Derivatives on the Growth Performance and Survival of *Penaeus monodon* (Fabricius, 1798)

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A 30-day feeding trial was conducted to study the effect of crustacean shell waste derivatives (Chitin, Shrimp Head Meal (SHM)) incorporated feed on the growth and survival of post-larvae (PL) of *Penaeus monodon*. Fifteen pre-weighed PL-20 of P. monodon were stocked in 9 FRP tanks of 125-L capacity, filled with filtered 70L seawater each in triplicate and maintained 15 ppt salinity. Three experimental iso-nitrogenous diets were formulated by

incorporating the chitin at 5% (D_2) and SHM at 6 % (D_3) and D_1 as control diet (no chitin and SHM). The whole-body composition of shrimp after feeding trial showed significantly lower ($P<0.05$) crude fat content for D_3 (2.27±0.04%) than control group (D_1). Significantly higher value ($P<0.05$) of crude protein content was estimated from the PL fed with diet D_2 (18.87±0.00%). Average Weight Gain (AWG) of shrimp fed with SHM (353.33±61.10%) incorporated diet (D_3) is significantly higher ($P<0.05$) than that of chitin incorporated diet, D_2 (220.00±20.00%). Significantly higher ($P<0.05$) survival percentage was observed for diet D_2 (88.57±3.52 %) and lowest for diet D_1 (65.00±8.66%). Specific Growth Rate (SGR) was significantly higher ($P<0.05$) for D_3 (7.56±0.48 %) and lowest for D_1 (4.51±0.10%). No significant difference was found in Feed Conversion Ratio (FCR) between D_1 and D_2 ($P>0.05$). At the end of the investigation D_3 shown significantly lowest ($P<0.05$) FCR (1.13±0.17) than control diet, which shows better utilization of the diet D_3 for growth and body weight gain than diet D_1. Feed Efficiency (FE) was maximum for D_3 (SHM) at 89.71±14.86% and was significantly higher ($P<0.05$) than D1 (control). Significantly higher ($P<0.05$) Protein Efficiency Ratio (PER) was found for D_3 (1.89±0.31) than D_1 (1.32±0.053). Hence the result suggested that incorporation of shrimp head meal in the diet enhances the growth performance of post larvae of *Penaeus monodon*.

T2S1POS12

Biofloc System: A New Approach for Fish Seed Rearing

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In India, recently aquaculture growth rate is very fast. However, quality and quantity of seed are the major constraints in expansion of aquaculture activities. Since last so many years, farmers and hatchery owners are using earthen pond for nursery rearing of IMC. In such ponds, survival is very low ranging from 28 to 30 % only because of some pond management problems. This indicates that there is loss of 70 % spawn due to poor management aspects only. Therefore, it is an urgent need to concentrate on the intensive technologies for the nursery rearing of fish seed. The eco-friendly aquaculture system called "Biofloc Technology (BFT)" is an efficient alternative system since nutrients could be continuously recycled and reused. The sustainable approach of such system is based on growth of microorganism in the culture medium, benefited by the minimum or zero water exchange. This biofloc technology can be used in outdoor as well as indoor condition with full of intervention as per our choice and also play major role in water budgeting, reducing feed cost and eco-friendly aquaculture. This will ultimately help to increase the production in terms of quality and quantity of fish seed.

T2S1POS13

An Attempt to Characterize Seaweed-Based Biochar in Application of Its Quenching Ability on Pesticide Compounds for Its Incorporation in Water Purification System

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A highly beneficial technology of bioremediation of pesticide compounds was developed by engaging seaweed, *Ulva lactuca*. The seaweed sample was introduced into tank to which water recirculatory system was set up. Three pesticide compounds viz., 4'4DDE, 4'4 DDT, DIELDRIN were introduced into the water. Periodic collection of water and its examination was carried out GC-ECD to study the variation in concentration of the pesticide compounds present in water. A definite reduction in the pesticide concentration was observed all throughout this study. By the end of 5th week the presence of pesticide compounds were almost nil. The utilized seaweed samples were then subjected to pesticide extraction and analysis. Extracted sample had shown the presence of the three spiked pesticide compounds. Hence this study has proved the capability of seaweed *Ulva lactuca* to remove the contaminants present in water body and can be utilized as a bioremediation agent. It was observed, that discarding of this seaweed was a major concern in this study. As a remedy, it was decided to go for the preparation of seaweed-based biochar which was reported to exhibit the same quenching power of that of seaweed. Further, the incorporation of the biochar to a purification unit can also be done conveniently. Hence an attempt was made in preparing the *Ulva lactuca* based biochar. Seaweed was subjected to different temperature for the preparation of the biochar. Based on the yield and the presence of functional groups a temperature of 450°C was observed to optimal. Other characteristic study such as FTIR, SEM etc. along with physical characterization was also carried out for the better depiction of the biochar. Biochar has good adsorption capacity for typical pollutants like organic pollutants and heavy metals. Hence biochar adsorption technology can be effectively applied in waste water treatment.

T2S1POS14

Assessment of Intertidal Mangrove Zones along the Banks of Northern Cochin Estuary

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The mangroves are the near victims of urbanization and an assessment on diversity and spatial distribution of mangroves was carried out along the banks of the northern part of Cochin Estuary in various stations. A comprehensive analysis ofthe sediment quality was focusing on pollution problems also documented from these mangrove areas, considering for restoration activities in the future. A total of nine species of true mangroves were recorded from these areas with the maximum density was recorded from stations I and II. Among them, *Avicennia officinalis*, *Rhizophora mucronata* and *Acanthus ilicifolius* were the dominant species. The sediment was characterized by the mangrove-derived organic matters that showed a quantitative differentiation on macrobenthic fauna between the stations. The water and sediment salinity were showed a decreasing trend from Station I to VIII. Water and sediment pH did not show any deviation along with these stations. The sediment texture was showed a high sandy composition in Station V and station VII, with minor fractions of silt and clay comparatively. The total organic

carbon and organic matter content of sediment have differed between the stations and the values were ranged from 0.018 to 0.038 and, 0.031 to 0.065 respectively. High organic carbon content was recorded at station IV and station V. The distribution and abundance of the microbenthic fauna was showed a remarkable variation in all stations. The polychaete species belonging to the Capitellidae and Corophidae were the dominant groups which indicated the high organic content in the sediments. The other biotic indices were also showed the status of organic stress condition due to low density and diversity of benthic fauna with sparse mangrove vegetation.

T2S1POS15

Fishing Methods and Species Composition of Landings in Meenkara Reservoir, Kerala, India

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Meenkara reservoir is constructed across the river Meenkara, a tributary of river Bharathapuzha in Kerala. Documentation of fishing techniques from Indian reservoirs are scanty. The present study has been carried out to document the fishing craft and gears, their operational and technical details and fish species composition of landings from Meenkara reservoir, Kerala. Coracle locally known as *Parasal* made from Fibre reinforced plastics was the only fishing craft used in the reservoir and gillnetting were the main fishing practice followed in the reservoir. Other gears like hook and lines and dragnets were rarely used by the fishermen. Set gillnets without footropes and sinkers were used. Mesh sizes commonly in use were 120, 150, 200, 250, and 300 mm for the exploitation of commercial fishes in the reservoir. Material used for gillnet were Polyamide monofilament and multifilament. The hanging coefficient of the gill nets ranged from 0.21 – 0.43. During the present study 21 fish species belonging to 7 orders and 11 families were recorded. Family Cyprinidae dominated with 8 species, followed by family Cichlidae with 4 species. *Oreochromis niloticus* was the dominant species, followed by *Labeo rohita, Oreochromis mossambicus, Cirrhinus mrigala, Catla catla,* and *Etroplus suratensis*. The data generated from the present study will be beneficial for fishing gear optimization studies as well as for future stock management practices.

Theme II:

Technological developments in fisheries, livestock and poultry management, water pollution trends, and ecological security for coral reefs, farming system modules

SESSION II:

Estuarine and marine fisheries: resource management & technological innovations, fish processing technologies

T2S2I01

VALUE ADDITION AND OPTIONS FOR ENTREPRENEURSHIP DEVELOPMENT IN THE FISHERIES POST HARVEST SECTOR

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Dr. Ravishankar, C. N. has been involved in formulation, planning and implementation of research in various aspects of post-harvest technology of fish with emphasis on development of novel fish processing technologies, designing of zero waste commercial processing units, designing and layout of processing units for fish processing, development of products of nutraceutical and nutritional importance from fishery waste, designing and developing indigenous fish processing machineries and imparting training to various self-help groups including women and socially & economically backward communities. Developed and optimized appropriate processing and packaging technologies for chilled, frozen, dried, smoked, freeze dried, extruded, coated, canned and other value-added products from fish and shell fish. Developed retort pouch technology, Oxygen absorber and dual action sachet with CO_2 emitters and O_2 absorber, Fish Freshness Indicator, Time Temperature Indicators (TTIs) for frozen stored and refrigerated fish products. In order to ensure safety and to address the concerns of adulterants in fish, developed and commercialized paper based rapid detection kits for formaldehyde and ammonia. Successfully established first business incubation center in fisheries at CIFT and transferred developed technologies to more than 75 entrepreneurs.

Abstract: Value addition is the key word in the Indian context of Industrial fish processing to ensure maximum returns through diversification. Among the nations, India ranks sixth in marine capture fisheries and second in inland fish capture and aquaculture production. India ranks sixth in top ten exporters of fish and fish products. However, the bulk of the fishery products exported come under the category of frozen products which offer little scope for value addition. Hence new processes and protocols have to be developed and standardized for better utilization. Value can be added to fish and fishery products according to the requirements of different markets. These products range from live fish and shellfish to ready to serve convenience products of fishery resources. A large number of value added and diversified products both for export and internal market based on fish, shrimp, lobster, squid, cuttlefish, bivalves etc. have been identified and there are huge prospects for live fish marketing, chilled and minimally processed fish products, mince based convenience products, specialty products, coated products and shelf stable products.

Promotion of entrepreneurship in Fish value chain is critical for the sustenance of the value chain through creation of jobs and business ventures. The Agri Business Incubation Centre in ICAR-CIFT is a platform to create new technology-based industries particularly in the fisheries sector. This entrepreneurial support system caters to its clients through strong technical and advisory support, and assist them to orient their resources in most optimized manner thereby yielding high productivity and economic value. Pro-active and value-added business services are provided to registered incubatees in the form of technology transfer, contract research, consultancy, contract service, office space, certified state-of-the-art pilot level production facility, on-site guidance and specialized trainings to establish technology-based business enterprises.

This paper outlines entrepreneur-ready value addition technologies in fisheries post-harvest sector and gives a glimpse of the mechanisms for promoting entrepreneurship development through the Agri Business incubation centre.

T2S2I02

DIVERSITY IN FISHED TAXA ALONG THE INDIAN COAST

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Dr. T. V. Sathianandan is working as Principal Scientist & Head, Fishery Resources Assessment Division, CMFRI, Kochi. His areas of expertise are design and management of national level sample survey for marine fish landings estimation, fishery modelling, fish stock assessment, fishery management, time series modelling, database management, development of computer software and simulation modelling. Two national level marine fisheries census in 2010 and 2016 covering all the maritime states were conducted under his supervision. He was instrumental for enhancing the resolution of estimation and reporting of landings to species level and introducing online data collection system in marine fisheries. He was a member of the committee constituted by the government of Kerala to study and report the impact of fishing ban and he was a member of sub-committees constituted by the central government for drafting the national policy on fisheries and revalidation of potential yield and optimum fleet size for Indian EEZ. He is heading the Fishery Resources Assessment Division of CMFRI from 2010 onwards.

Abstract: The marine fisheries sector in India supports livelihood of about four million fisher population in addition to meeting the nutritional requirements of a significant proportion of its population. Also, there is export earnings to the tune of nearly $ 6.5 billion from the marine fisheries sector. Being a natural resource harvest of marine fishery resources need to be at sustainable levels keeping in mind the related social and economic issues. India has the advantage of having highly diverse marine fishery resources in its Exclusive Economic Zone (EEZ) which also need intensive attention and periodic evaluation to examine the changes that are happening over time. The ICAR-Central Marine Fisheries Research Institute is mandated with assessing and monitoring the marine fishery resources in the Indian EEZ which it does through its extensive scientific data collection system covering 1269 marine fish landing centres in the mainland of India. The diversity in the fished taxa along the Indian coast during 2007-2018 was examined using the species wise landings information available in the database of the National Marine Fisheries Data Centre (NMFDC) of ICAR-CMFRI.

Average taxonomic distinctness (AvTD) and variation in taxonomic distinctness (VarTD) are two widely accepted diversity measures which were used here to study the changes over space and time in the diversity in the fished taxa along the Indian EEZ. These measures takes into account the path length in the taxonomic tree between each pair of species with AvTD indicating the average path length and VarTD indicating the taxonomic spread considering all possible pairs of species in the data representing the ecosystem. Changes during the 12 year period in these measures were determined for all the 11 maritime states / union territories in the main land and also at regional and national levels. From the analysis it was observed that more than 1200 species occurred in the landings during 2007-2018 and the maximum number of species was landed in Tamil Nadu followed by Kerala and the least was for West Bengal. Another important observation is that diversity in the fished taxa was high for Gujarat than that of Tamil Nadu which had the maximum number of species in the landings during this period. This indicates that the species that are landed in Tamil Nadu are taxonomically very close to each other compared the species that are landed in Gujarat.

T2S2I03

MOVING INDIA'S MARINE FISHERIES TOWARDS SUSTAINABILITY

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Dr. K. Sunil Mohamed has taken his master's in marine biology in 1981 and Ph.D. in crustacean physiology in 1990. He served in in the Central Marine Fisheries Research Institute (CMFRI) since 1986 on molluscan fisheries and mariculture. He was the head of the division of molluscan fisheries in CMFRI for fifteen years. He has contributed to understanding of Indian cephalopod biology and population dynamics. In mollusc mariculture, he has contributed to the growth of commercial bivalve mariculture in the country. He has interests in marine ecological modelling particularly its application to fisheries management. He was the leader of a team of researchers from CMFRI working on trophic modelling of Indian marine ecosystems and has modelled the Arabian Sea ecosystem off Karnataka and Kerala State, the northwest coast ecosystem, and the Gulf of Mannar ecosystem. He has published more than 300 research articles in international and national journals. Dr Mohamed was the Secretary of the Marine Biological Association of India from 2008 to 2018 during which time 3 international symposia on marine ecosystems (MECOS Series) were conducted under his leadership. He has won the Jawaharlal Nehru Award for best Ph.D. thesis from ICAR in 1991 and the prestigious TVR Pillay Aquaculture Award 2011 for outstanding aquaculture research and extension. For 8 years, until 2019, he was the member of the Technical Advisory Board of the Marine Stewardship Council (MSC), London, which is global non-profit organization fostering certification and ecolabelling of sustainable seafood. He has served in several national expert committees on marine fisheries management in the country. He has guided and mentored several master's and PhD students for their degrees in affiliated universities.

Abstract: As a developing nation, India's marine fisheries are in the process of attaining full development. India's marine fish production has increased more than seven times, from 0.53 million tonnes in 1950 to 3.9 million tonnes in 2012, and has been fluctuating since then. The resources support the livelihoods of nearly 4 million fishers of which nearly 0.9 million are active. There are about 239,000 fishing crafts engaged in marine capture fisheries, of which 59,000 are mechanized crafts, 76,000 motorized and the rest non-mechanized. In the mechanized sector, there are about 29,000 trawlers. Though fishing is concentrated mainly in the depth zone up to 100 m, trawlers operate up to 400 m depth zone. Fishing is carried out through a multitude of crafts and gears (more than 30 craft-gear combinations). Besides, the fished taxa diversity is very large (~1200 species) making the management of this multispecies and multigear fisheries very complex and difficult. As per the Constitution of India, division of subjects, fisheries in the territorial waters (up to 12 nm from the coast) is regulated by the maritime states. The zone from 12 to 200 nm or the EEZ of India is regulated by the Union Government. All the maritime states of India have promulgated marine fisheries regulation acts (MFRAs), and these laws are used by the State Department of Fisheries to regulate and manage their fisheries. The Union Government is in the process of developing a law for the 12-200 nm zone. The draft bill which is in circulation is called the National Marine Fisheries Regulation and Management Bill 2019. The maritime states manage and regulate their fisheries through their MFRAs. Fisheries management is

done through input or output control. These regulations have been amended by different states from time to time. The Government of Kerala has recently amended the KMFRA to bring in the following regulations: Regulation on fishing methods, Limits on net sizes and net mesh sizes, Cap on engine HP/use of VMS for mechanized vessels, Regulation on minimum legal size of fish (MLS), Zonation of fishing grounds, Regulations on closed season, Regulation on fishing effort and Regulations on co-management of fishery resources. Some of the challenges and successes in the management of marine fisheries of India are outlined in below table.

	Coastal & Marine	
	Conservation	**Research**
Challenges	1. Highly bio-diverse marine fauna and flora	6. High fished taxa diversity
	2. Varied ecosystems and habitats and large geographic area	7. Multi-species, multi-gear/fleet fisheries in an open access system
	3. Spatial management, MPAs and fish refugia not adequately used	8. A suitable management model and reference points yet to be developed for such fisheries in India and globally
	4. Terrestrial forest conservation principles which underlie IWPA do not apply to marine systems	9. FMPs and HCRs not adequately developed and overcapacity not addressed adequately
	5. Conservation is currently through blanket bans which are not subject to periodic reviews and this leads to clandestine trade. This needs to be changed to management and regulation	10. Current methods underestimate growth and overestimate longevity for a majority of species
Success	11. Conservation of whale sharks through community awareness and participation	16. Aspects of biology and life history of most commercially exploited stocks are well studied and documented
	12. Several input controls (registration, licensing, closed season, net and gear controls etc.) developed and practised	17. Most commercial species are being periodically assessed for stock status
	13. Limited output controls (MLS and protected species under IWPA) partially practised	18. Threshold levels of marine pollutants are assessed and continuously monitored
	14. Principles of co-management through management councils applied in some states	19. Several ecosystem models developed which allow for scenario exploration and simulations
	15. Comprehensive marine fisheries policy harmonized with best available science developed and adopted by the Government	20. One small-scale fishery has obtained the global sustainability standard of MSC, and several more are moving toward such certification

As a gradual move toward sustainability, several fisheries in Kerala and Tamil Nadu are in the process of obtaining the MSC (Marine Stewardship Council) certificate which is a global ecolabel for sustainable fisheries. The future of marine fisheries in India depends on how best they are managed in a sustainable manner ensuring equity among all stakeholders.

T2S2I04

APPLICATION OF GENETICS AND "OMICS" TECHNOLOGY TOWARDS SUSTAINABLE AQUACULTURE PRODUCTION

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Dr. Jitendra Kumar Sundaray, working as Head, Division of Fish Genetics and Biotechnology at ICAR- Central Institute of Freshwater Aquaculture, Kauaslayaganga, Bhubaneswar. Presently he is actively involved in fish genetics and biotechnology research. He is leading a multi discipline team on Center of Excellence project from DBT for the genetic improvement of freshwater fish. In addition to this he is involved in research areas like endocrine disruptor chemicals in fish with collaborator from Viswa Bharathi University and ICAR-CIFRI, Barrackpore. The work on application of molecular endocrinology in quality seed production of *Ompok pabda* is undertaken with the collaborator from Central Agricultural University, Imphal. He along with collaborator from Ahmadabad University is working on environmental DNA and its application in managing alien fish species in open water system like East Kolkata Wetland. Advance OMICS approach is another area of research where the team is unraveling the molecular mechanism of murrel reproduction along with collaborator from ICAR-IASRI, New Delhi. He is Editor in Chief of International Journal of Fisheries and Aquatic Studies, associate editor in Journal of Indian Society of Coastal Agricultural Research, Journal of Fisheries and Life Science, Journal of Cold water Fisheries. Recently he has joined Review Editor on the Editorial Board of Aquatic Physiology-section of Frontiers in Marine Science and Frontiers in Physiology. Presently two Ph.D. and two Master students are working in different aspects of Aquaculture biotechnology.

Abstract: Aquaculture could provide a more sustainable alternative to meat; indeed, fishery product is already the highest value globally traded food commodity. It also serves as a means of livelihood to the farmers by providing employment opportunities to them. Despite the increased demand for fish meat, the aquaculture sector faces several challenges that hamper the adequate supply of fishes. Some of those challenges faced worldwide are overfishing, inconsistency in growth rate, weakened immunity, diseases, dysbiosis of the microbiome, and toxicity due to xenobiotics. India is the second largest aquaculture nation in the world after China. Freshwater aquaculture with a share of 34 percent in inland fisheries in–mid 1980 has increased to about 80 % in recent years. In total inland fish production of the country Indian Major Carps (IMCs) contributes about 67%. IMC are the vital species and preferred by the farmers primarily due to its taste, market demands and consumer preference. To improve growth of rohu a project on genetic improvement was initiated at Central Institute of Freshwater Aquaculture (CIFA) in collaboration with the Norwegian Institute of Aquaculture Research in 1992. The genetic gain of 18% per generation after eight generations of selection. The common carp selection program has yielded good results in India. In addition to rohu and common carp institutes are working on selective breeding of, magur, pearlspot and Freshwater Prawn for different traits. The selective breeding program has been challenged by many factors. Understanding the genetics and environment interactions is of utmost importance in the design of selective breeding programs to develop improved strains that express optimal growth and adaptability in a wide range of environments. The ideal genotype

is judged to be one with the maximum yield potential in all environments (high mean performance) with maximum stability. However, to get an ideal genotype, there are many hurdles which need to be addressed. The lack of genetic and genomics information in many species has been identified as the major bottlenecks. Aquaculture genomics research aims to develop a comprehensive understanding of the molecular basis of production-relevant traits such as growth rate, resistance to stress and disease, resilience with high temperature and low oxygen environments, and economic traits of high importance. With the development of genomic sequencing and advance genetics in the aquaculture, this has lead to understand the molecular mechanisms during infections, sexual development, growth etc. The new technologies like transcriptomics, metagenomics, proteomics, and metabolomics are increasingly being applied to gain unprecedented insight into the biology of many aquaculture species. The development of omics sciences provides a remarkable contribution to species conservation biology, significantly increasing the ability of researchers to obtain insights into the molecular mechanisms adopted by species to cope environmental change. Use of these technologies can support selective breeding and help the aquaculture industry effectively employ genomic selection in target species. At a larger scale, significant benefit will be available to the industry from food omics-based approaches to support the development of new aquaculture feedstuffs. Moreover, all OMICS technology platform may prove effective in controlling pathogens, advancing the industry during its ongoing expansion in the future. In particular, this presentation highlights the status, utility and suggested path forward for continued development, and improved use of genetics and omics resources in aquaculture.

T2S2I05

PACKAGING OF FISH AND FISHERY PRODUCTS

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Dr. C. O. Mohan, during his master and Ph.D. studies has became specialized in Fish Processing Technology from ICAR-CIFE, Mumbai, India and presently working as Senior Scientist in ICAR-Central Institute of Fisheries Technology (CIFT), Cochin, India. He has obtained his training from University of Wisconsin-Madison, USA as Honorary Associate / Fellow on Sensor based applications including bio-indicators. His areas of interest are RTE food products, thermal processing, smart packaging and nanotechnology. He has helped many entrepreneurs to establish RTE food processing units. He has guided many students and published many articles in reputed national and international journals. He is conferred with 'Associate Fellow' from National Academy of Agricultural Sciences, New Delhi. He has been awarded with 'Jawaharlal Nehru Award' from ICAR, New Delhi & 'Dr. Karunasagar Best Post-Graduate Thesis' Award from Professional Fisheries Graduates Forum (PFGF), Mumbai for his Doctoral Thesis Research.

Abstract: Consumption of fishery products are on rise globally, due to its proven health benefits. The per capita apparent fish consumption exceeded 20 kg in 2018 and is projected to reach 21.3 kg in 2028. As per UN FAO, nearly 35% of the global harvest from fisheries and aquaculture is either lost or wasted every year. The major reasons for this are the perishable nature of fish apart from insufficient infrastructure to process and preserve effectively. As 800

million people go hungry every year across the globe, loss of this highly nutritive commodity is to be minimized by adopting appropriate interventions. Selecting suitable packaging is one such intervention to reduce post-harvest losses. Packaging is crucial to current food distribution and marketing systems as it helps in containing the product, and to protect and preserve. Packaging materials with appropriate characteristics are to be selected for different preservation methods to maximize the benefits. However, the conventional method of packaging has limited functionality and are not interactive. Latest trend in packaging of food is the use of Smart packaging technology which improves the safety and shelf life of perishable commodities. Smart packaging involves a combination of specialized materials, science and technology to provide additional advantages over their traditional counterparts. Smart Packaging enhances packaging functionality through two methods: Active Packaging and Intelligent Packaging. Active packaging helps in altering the condition of the packaging atmosphere favorably and maintains these conditions throughout the storage period to extend shelf-life and safety. This involves incorporation of certain additives into the packaging film or within packaging containers with the aim of maintaining and extending product shelf life. Active packaging technique is either scavenging or emitting systems added to emit (e.g., N_2, CO_2, ethanol, antimicrobials, antioxidants, odour, flavor) and/or to remove (e.g., O_2, CO_2, odour, moisture, ethylene) gases during packaging, storage and distribution. For fishery products, active packaging systems like O_2 absorber, CO_2 emitter, moisture absorber, release of antioxidants and antimicrobials, finds its application. Intelligent packaging is distinctly different from active packaging in which it monitor the condition of packaged foods to provide information about the quality of the packaged food during transport and storage. A variety of indicators such as temperature, time-temperature, pack integrity, microbial growth, and presence of pathogen, product authenticity and freshness are of interest to the fish packaging industry. These smart packaging techniques offer new opportunities to the ever expanding fish processing industry to cope up with the consumer's expectations. Apart from these, there is an increased interest in the development of edible biomaterials, biodegradable packaging materials utilizing fishery waste and seaweed resources to develop functional food packaging materials.

T2S2ORAL01

Occurrence of Marine Ornamental Fishes in Trawl Net Operated along Ratnagiri Coast and a Novel Approach to Transport Them to the Market for Fishermen

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The marine ornamental fish industry is gaining popularity due to their vibrant attractive colouration, peaceful nature and improvement in the rearing technology all over the world in recent years. During 2012–2018, nearly 2 billion live ornamental fishes are transported annually over 50 exporting countries globally. India is blessed with abundant marine ornamental resources and have chance to gain more export earnings. Trawl is the major gear operated along the Ratnagiri coast and many ornamental resources are being discarded along with trawl by-catches.The present study was conducted to assess the occurrence of marine ornamental fish caught in trawl net landed at Mirkarwada and Sakhari Nate landing centres of Ratnagiri coast during the year 2017-18. Specimens were collected from trawl net bycatch and identified using standard literature. The study revealed that Mirkarwada landing centre harbours more diversity (63%) of marine ornamental fish than Sakhari Nate (37%). The Marine Biological Research Station, Ratnagiri has attempted to standardise technology on transportation of live marine ornamental fishes and developed transportation boxes for mechanised and non-mechanised vessels. If trawl net fishermen use these boxes on board, they can bring live marine fishes to the market and earns additional income from these valued resources.

T2S2ORAL02

Food and Feeding Habits of *Otolithoides pama* (Hamilton, 1822) from Hooghly-Matlah Estuary of East Coast of India

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We studied the diet of *Otolithoides pama* (Hamilton, 1822), a predatory fish collected from Hooghly-Matlah estuary of the east coast of India for a period of 18 months (November 2016 to May 2018). A very high percentage of empty stomachs frequently were recorded in the fish throughout the year. The species is a macrophagous carnivore and feeds mainly small fishes and prawns. The feeding intensity was more in the juvenile stage with prawns and fishes both dominated the gut contents while teleosts were preferred by the adults. Among the teleosts, the main food items were *Otolithoides pama, Harpadon nehereus, Secutor insidiator, Sardinella* spp., Setipinna spp., other sciaenids such as *Johnius* spp., other clupeids such as *Tenualosa ilisha, Ilisha megaloptera; Polynemus paradesius, Arius* spp., mullets such as *Mugil* spp. and *Chelon* spp.; *Rastrelliger kanagurta, Coilia dussumieri, Bregmaceros maclellandi, Trichiurus* spp. Among non-penaeid prawns *Acetes spp*. was the most dominant food item, among penaeids *Parapenaeopsis* spp., *Metapenaeopsis* spp., *Metapenaeus* spp., *Parapenaeus* spp., *Solenocera* spp. constituted the food items. GaSI was found high during February, June, and October while low during July-August for both the sexes. The monthly mean RLG values were highest during October for males and March for females. Both seasonal changes in diet composition and ontogenetic changes were noticed between juveniles and adults.

T2S2ORAL03

Fishery Resources of *Pristipomoides filamentosus* (Valenciennes, 1830) and *Pristipomoides multidens* (Day, 1871) from Andaman Water

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Andaman and Nicobar Islands marine fishery resources are known for its vast and abundant fishery potential. Estimated Fishery Potential Yield for demersal resources is 32,000 tonnes. Snappers contribute more than 730 tonnes year^{-1} landings to dermersal resource and *Pristipomoides* spp. (Mrigal) are abundantly landed fishery at South Andaman, Port Blair, Junglighat fish landing centre. *Pristipomoides filamentosus* commonly known as Crimson Jobfish/ Crimson Snapper are locally known as Kala Mrigal and *Pristipomoides multidens* is commonly known as Gold banded Job fish are locally known as Jat Mrigal. Kala Mrigal name is due to its brownish dusky appearance for *Pristipomoides filamentosus* as compare to Jat Mrigal which is distinguished with presence of golden strips bordered with blue at side of snout and cheek. Despite of having its commercial value and market price ranging from

Rs. 150 kg^{-1} to Rs. 250 kg^{-1} and consumers demand, Mrigal landings has not been documented so far from Andaman Water. A study was undertaken to know the landings of the Mrigal at Port Blair, South Andaman Water for a period of two years from January 2016 to December 2017. The fishery is mainly targeted by long liners. Total Long liners operating at Port Blair, South Andaman is 40 numbers which are exclusively targeting for demersal fishery. During the study period it has been found that *Pristipomoides filamentosus* (Kala Mrigal) and *Pristipomoides multidens* (Jat Mrigal) were landed maximum during the month between October to April and peak landing in the month of January. The fishery is available in deeper rocky bottoms and fishing is carried out maximum when sea is not rough. The fishing season starts after the south-west monsoon and maximum catch during winter. The annual average landing for *Pristipomoides filamentosus* and *Pristipomoides multidens* are 250 tonnes $year^{-1}$ and 480 tonnes $year^{-1}$ respectively. Study showed that Mrigal is an important fishery resource of Andaman water contributing with an average landing of 730 tonnes $year^{-1}$ to the demersal resources.

T2S2ORAL04

Genome Wide Characterization and Analysis of Simple Sequence Repeats in Cultrinae Species

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Simple sequence repeats markers also known as microsatellite markers have been used to answer several biological questions. It is the marker of choice for several genetic studies such as population genetics, individual identification and parentage analysis etc. Cultrinae is one of the thirteen subfamilies of family Cyprinidae encompassing economically several important freshwater aquaculture species. With the advancement of the next generation sequencing and simultaneous development of bioinformatics tools it is now possible to decipher the whole genome sequence of several model and non-model species. The whole genome sequence of three Cultrinae species is available in the public database. In the present study, we identified and compared simple sequence repeat markers in three Cultrinae species i.e. *Anabarilius grahami, Megalobrama amblycephala* and *Culter alburnus.* The genome sequence of above species was retrieved from the NCBI genome database. The completeness of the genomes was evaluated using the program BUSCO. Identification of SSRs was performed using the program PERF. The genome size of *A. graham, C. alburnus* and *M. amblycephala* was found to be 0.9 GB, 1.02 GB and 1.08 Gb, respectively. Evaluation of completeness of the genomes using BUSCO revealed 96.8%, 96.6% and 94.9% completeness, respectively. In total, 398473, 522850 and 579378 perfect SSR repeats with 1-6 bp nucleotide motifs were identified encompassing 8391632, 11457461 and 12860863 repeat bases, respectively in *A. graham, C. alburnus* and *M amblycephala.* The simple sequence repeat motifs cover 0.85%, 1.13% and 1.18 % of the present *A. graham, C. alburnus* and *M. amblycephala* draft genome. The frequency and density of SSR repeat motifs in the three Cultrinae genomes were 401.73, 513.75 and 532.57 and 8460.27, 11258.12 and 11821.74, respectively. The mono, di, tri, tetra, penta and hexa nucleotides repeat in *A. graham, C. alburnus and M. amblycephala* genomes were found to be 119554, 195336, and 240710, 134985, 157238 and 178370, 39066, 51112 and 51684, 87395, 99004 and 88985, 14323, 18646 and 17772, 3150, 1514 and 1857, respectively. Mono-nucleotide repeats were the most frequent repeats and hexa-nucleotide repeats were least frequent repeat motifs. The repeat motifs ranged from12-318, 12-368 and 12-774, 7-58, 7-1865 and 7-79, 5-285, 5-100 and 5-133, 4-21, 4-168, 4-1095 and 4-2269, 4-17, 4-18 and 4-27 for mono, di, tri, tetra, penta and hexa nucleotide repeats, respectively. Among the mono-nucleotide A, among di-nucleotide AT and AC, among tri-nucleotide AAT, among tetra-nucleotide AAAT and AGAT, among penta-nucleotide AAAAT, AATAT and AAGTG and among hexa-nucleotides AAAAAT, AACCCT and AAATGT were the most frequent repeat motifs. The repeat motifs in all the genomes were A+T rich. The information generated in the present study may facilitate research on role of simple sequence repeat motifs in genome organization and gene regulation etc. in the above species.

T2S2ORAL05

Estuarine Fisheries and Covid-19 Pandemic: Lesson Learnt from Small-Scale Estuarine Fisheries

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Estuarine fisheries sector contributes to about 10% of the world's fisheries sector. In India, about 2 million fishers and stakeholders are engaged in estuarine fisheries sector. The catch from the estuarine fisheries is approximately 1-lakh tonnes. Here we analysed the impacts of lockdown and covid-19 pandemic employing a questionnaire survey from traditional fishermen of Mandovi-Zuari estuarine system. The major setbacks were decline in demand, reduction in fishing operations, access to resources and loss of employment. We also highlight the recommendations and suggestions to safeguard and protect the traditional fisheries. In the concluding remarks, some of the positive signals received from estuarine fisheries are also discussed.

T2S2ORAL06

Natural Growth-Medium in Promoting or Inhibiting Cell-Growths with the Principle of Biotechnology

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All we know plant and animal are to grow in different mediums, excepting a few common natural mediums. Generally a plant cell can grow normally or experimentally in a medium where most animal cell can grow well. Reversed happenings may be a remote phenomenon. Biochemically every cell needs a certain level of pH and energy supporting mechanisms. Growth mediums for plants cells are usually consisting of more reactive inorganic or organic biomolecules. Permeable cell-wall can take care such adverse reactions of plant growth mediums, usually soils. In other situations, when plants grown in reverse medium such plant can grow well and content of fibrous cell wall become less as compare to plant grown normally. Food value of such plants may enhance. Therefore, we recommend that plant grown hydroponically may be a better alternative in years to come. It is also found that growth rate is extremely poor or restricted when animal cell experimentally grown in growth mediums of a plant cell. Author has undergone on study of preventative controlling of diseases found that Indian Ayurved supports sustainable inland fisheries with no-disease with optical concentration level with. Tentative pH <5.0 and pH>8.0) and with a opinion that any-germ experimentally in inland-fisheries and broad spectrum to mankind can be protected by either chemical or biochemical means and methodically there is no DNA/RNA-replication as biochemically by de-activating bases or nucleic acid of genetic-material of individual germs' with one or more of the following applications and can be prevented (100%) completely by natural or applied virtues, digitally and found valid till date in tropical environments, this however, may remained un-revealed . Malic Acid (Mango) in controlling all Bacterial and Viral Diseases. Citric Acid (*Citrus spp*), Ascorbic Acid (*Citrus spp*), Tartaric Acid (*Tamarindus indica*), Humic Acid (Cattle). These mentioned are to prevent all fish-pathogenic controls and also by Fulvic Acid (Organic, a farm source). Base/ Lime (Banana Plants) in controlling Virus and EUS (Epi-Ulcer-Synd) diseases of fishes in inland waters.

T2S2ORAL07

Effect of Zinc Oxide - Carboxy methyl cellulose - Sodium Packaging Film on the Quality and Shelf Life of Refrigerated Stored Fish Cutlets

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Use of biodegradable films for packaging of fishery products is an emerging area of research. Present study was undertaken to evaluate use of sodium carboxymethyl cellulose and Zinc oxide (ZnO) nano and bulk particle coated composite packaging film in fish mince based product – cutlet. Fish mince cutlets were prepared in 3 forms namely; cutlet without coating (CWC), cutlet with ZnO bulkparticle coating (CBC) and cutlet with ZnO nanoparticle coating (CNC). Biochemical, organoleptic and microbiological quality changes in fish cutlet were analyzed as a function of refrigerated storage. No significant difference was observed between moisture, crude protein, crude fat, ash and carbohydrate content of fresh, bulk particle and nano particle coated fish cutlet at the beginning and at the end of the storage study ($p<0.05$). Extent of increase in expressible moisture content during the storage of CWC (from 10.20±0.72% to 22.53±0.36%) was significantly higher than that in CBC (from 10.12±0.44% to 14.65±1.97%) and CNC (from 10.21±2.41% to 15.42±0.62%). However, no significant difference in expressible moisture content of CBC and CNC was observed. Fat Oxidation as indicated by TBA value was higher in CWC samples. TVB-N values of CWC exceeded acceptable limit on 12th day of storage period whereas TVB-N values of CBC and CNC were within the acceptable limit throughout the storage period. Psychrophilic and mesophilic bacterial counts of CWC were significantly higher than that of CBC and CNC whereas no significant difference was observed in bacterial counts of CBC and CNC ($p<0.05$). *Pseudomonas* count was higher in CWC sample. Overall results demonstrated significant effect of ZnO nano and bulk particle packaging film on restricting the spoilage activity and extending the shelf-life of fish mince based product from 12 days to 16 days under chilled conditions.

T2S2ORAL08

Development of Soup Powder from Hooded Oyster *Saccostrea cucullata*

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This study was carried out in order to prepare a soup from oyster *Saccostrea cucullata* which is nutritionally rich and which is not at all time consuming. No any different and costly ingredients were used for preparation. The local ingredients such as oyster meat, black pepper powder, cornstarch, ginger, garlic, green chili paste, preservatives like Carboxy Methyl Cellulose and the taste enhancer Mono Sodium Glutamate. Even the ingredients like soya sauce, green chili and red chili sauce were used for soup preparation. Standardization of some of the ingredients like oyster meat (40:60) of total soup powder, type of starch used was corn starch (10%) which added a better consistency to the soup powder, Black pepper powder (1.5%) which added spice to the soup powder, Ginger garlic Paste (10% each) which added taste to the soup. At every stage of standardization of the ingredients, organoleptic evaluation by panelist was carried out. After standardization of ingredients the final soup powder was kept in the four packaging

materials like Metalized film, trend pack, HDPE film pouch and LDPE film pouch for a storage period for 90 days (3 months). During storage it was discovered that the biochemical and microbial changes were least in the metalized film pouch then further in trend pack. They were worst in LDPE film pouch. It was further stated that metalized film pouch was best suitable for packaging of soup powder. Proximate composition of oyster soup powder was 10.22% moisture, 43.07% crude protein, 25.09% fat, 12.38% carbohydrate, 9.31% ash. Total Plate count (TPC) in the initial days was 4.0 X 103. It showed an increasing trend in all other packages except the metalized film pouch. Mold count was absolutely nil from the day of storage at the end of storage in all packages. Even the pathogenic organism like *Staphylococci* was absent.

T2S2POS01

Quantification of Otolith Characteristics of Fishes Inhabiting Dharamtar Estuary, Arabian Sea

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Correct identification of the fish species is a fundamental key for the species conservation, aquatic ecosystem management and optimum utilization of resources. Present investigation has been carried out to avoid the miss identification of species with overlapping diagnostic characters. We analysed and checked the discrimination capability of saccular otolith shape and size as tools to discriminate the fish species. An array of methods, such as Stepwise Discriminant Function Analysis (SDFA) and dendrogram of otolith and species closeness evaluation, is used for species discrimination. Otoliths possess various shapes such as oval, circular, triangular, spindle or elliptic. There was no considerable difference between Left and Right otoliths at a significant level ($P<0.05$), hence only left otolith was considered for analysis in the present investigation. SDFA based on morphometric variables showed high classification accuracy (89.71%) for twenty-five fishes; squared Mahalanobis distance showed the least distance between species of the same family. The dendrogram based on Euclidean distance also supports the conclusion, and revealed recent divergence in species belonging to the same family. Discrimination of the species based on multiple approaches provided a better interpretation of species separation than that obtained from shape analysis of fish body because otolith is linked with ecological strategies such as feeding, swimming, and sound-based communication. The present work will be helpful for species identification, biological study, ecological study such as prey and predator relationship, and conservation of fisheries resource.

T2S2POS02

The Relationships Between Fish and Otolith Sizes of PamaCroaker, *Otolithoides pama* (Hamilton, 1822) from Narmada Estuary, India

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In the present study, the relationships between fish and otolith sizes of pama croaker, *Otolithoides pama* (Hamilton, 1822) were established with the fish specimens collected from the bagnet catches from Narmada estuary, India for a period of 8 months (November 2018 to June 2019). To establish the relationships between fish and otolith size,

the sagittal otoliths were extricated, cleaned, measured, and photographs. The Otolith length (OL), breadth (OB), and weight (OW) were measured from each specimen to the nearest 0.01 mm and 0.01 g, respectively. The length and weight of each fish individuals and otoliths were ranged from 85.00 to 288.00 mm (175.79±33.13 mm, mean± SD) and 3.00 to 186.56 g (43.68±27.67 g) and 2.65 to 12.54 mm (7.20±1.77 mm) and 0.02 g to 0.75 g (0.23±0.11 g), respectively. The recorded Otolith breadth range was 2.01-10.48 mm (5.95±1.33 mm). The data fitted well to the power model for the OL, OB, OW, and fish length and weight. High value of coefficient of determination (R^2) was found between fish length and otolith length ($R^2 = 0.978$), fish length and otolith weight ($R^2 = 0.931$), fish length and otolith breadth ($R^2 = 0.985$), fish weight and otolith length ($R^2 = 0.942$), fish weight and otolith weight ($R^2 = 0.922$), and fish weight and otolith breadth ($R^2 = 0.962$). Thus, the study depicted a high correlation of Otolith dimensions with the size of the fish.

T2S2POS03

Traditional Knowledge on Cast Net Design and Selectivity along the Coastal Area of Sindhudurg, Maharashtra, India

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Traditional knowledge of the size-selectivity of cast net is crucial to fisheries management in order to maximize a sustainable yield and ecological point of view. The fish species and size selectivity of cast net design with monofilament nylon polyethylene netting materials were studied along coastal area of Sindhudurg. Cast nets are operated as falling gear and conical in shape with lead sunken or weights attached at regular intervals on the lead rope forming the circumference of the cone. The nets are operated at a depth ranged from 0.40 m to 5.50 m. The cast nets were used for fishing of mullet, lady fish, silver billies, glass fish, shrimp, Snapper and crabs etc. The nets are locally known as Konashi/ KarelShendi/Pag. The selectivity of cast net with regards to the catch of fishes depends upon the size of the fish, the direction the fish tries to escape, the area or diameter of the net mouth, the depth of the water, the depth at which the fish is dwelling and the sinking speed of the cast net. This art of designing the fishing net needs to be preserved among the fisher community through dissemination of the traditional indigenous knowledge among young fishers.

T2S2POS04

Studies on Growth and Mortality of Spineless Cuttlefish, *Sepiella inermis* from Ratnagiri (Arabian Sea; Northwest Coast of India)

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Growth and mortality parameters of spineless cuttlefish, *Sepiella inermis* were estimated based on length frequency

data collected from Ratnagiri waters during March 2015 to February 2017.The specimens of *S. inermis* were sampled from commercial trawl bycatches at weekly intervals. The growth parameters such as asymptotic length (L∞) and growth coefficient (K) were estimated to be 107 mm DML and 1.6 $year^{-1}$ by ELEFAN I. Age at length zero, to was estimated to be 0.00969 year by von Bertalanffy plot. The instantaneous rate of total mortality (Z), natural mortality (M) and fishing mortality (F) were estimated to be 4.47 $year^{-1}$, 3.23 $year^{-1}$ and 1.24 $year^{-1}$ respectively. *Sepiella inermis* was found to attain a DML size of 60 mm, 86 mm, 97 mm and 103 mm at the end of six, twelve, eighteen and twenty four months respectively. Length at first capture, Lc50, was found to be 41.10 mm DML. The current exploitation ratio (E) was determined to be 0.28.

T2S2POS05

Length-Weight Relationship, Gonadosomatic Index and Fecundity of *Pristipomoides filamentosus* (Valenciennes, 1830) from Andaman Sea

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Snappers are highly commercial, commonly caught and most abundantly landed fishes from Andaman waters. *Pristipomoides filamentosus* is commonly known as Crimson Jobfish/ Crimson Snapper and locally known as Kala Mrigal, are found at deeper rocky bottoms. A study was conducted from the Andaman Sea and samples were collected from Junglighat Landing center, Port Blair, South Andaman. Data on length weight of *P. filamentosus* from January 2016 to December 2017were recorded for a period of two years. A total of 315 nos. of specimens were used for length and weight study. Each sample measurement was taken for Total length (TL), Fork length (FL) and standard Length (SL) and individual body weight (BW). The length weight relationships for male, female and pooled were carried out separately. The length weight relationship for maleswere estimated as $y = 2.6574x - 1.3816$ ($r^2 = 0.7708$), for female $y = 2.3512x - 0.8115$ ($r^2 = 0.7191$) and for pooled $y = 2.9388x - 1.7865$ ($r^2 = 0.9045$). Regression analysis showed as $a = 0.0292$ and $b = 2.7835$. Gonadosomatic Index (GSI) values varied from 0.141 to 0.391 with peak values during Dec, March, August and October. Absolute fecundity ranged between 24,126 to 1, 37,310.

T2S2POS06

Antibacterial Activity of Two Seaweeds from Ratnagiri Coast

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The green seaweed, sea lettuce, *Ulva fasciata* (Delile, 1813) and the brown seaweed, *Sargassum tenerrimum* (J. Agardh, 1848) handpicked from Bhatkarwada rocky shore of Ratnagiri in the month of October. Crude extracts were prepared using the solvent ethanol and methanol from both the seaweeds, and screening for their antibacterial activity against 8 bacterial pathogens were carried out. The test bacterial strains were *Escherichia coli, Stapylococcus aureus, Klebsiella pneumonia, Pseudomonas aeruginosa, Salmonella typhi, Shigella flexneri, Corynebacterium diphtheria* and *Sarcina lutea*. The disc loaded with the extracting agent was tested as control, whereas the disc loaded with the penicillin 0.2µg antibiotic were tested as standard. The extract of *Ulva fasciata* (0.50µl) extracted in methanol as well as in ethanol were tested against above eight strains and result depicted in this paper. The result showed that the green seaweed, *Ulva fasciata* and the brown seaweed, *Sargassum tenerrimum* from Ratnagiri coast are found potential source of natural antibacterial substances, which are reported in this paper.

T2S2POS07

Diversity, Distribution and Conservation of Commercially Important Groupers (Epinehelinidae), Snappers (Lutjanidae) and Emperors (Lethrinidae) of Andaman and Nicobar Islands with Two New Records

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As larger species become overfished, smaller fish species previously considered of little fishery significance are targeted. So, fisheries move into deeper water in search of untapped fish populations and thus, encountered deeper living species as new recent findings of groupers, snappers and emperors. Commercially important component of rocky, coral reef and mangrove ecosystems of Andaman and Nicobar Islands are the biologically diverse Snappers (48 species), Groupers (65 species) and Emperors (27 species). These Islands are experiencing a rapid quantitative enhancement in the landing and export of bottom dwelling fishes that comprise groupers (32%), snappers (48%) and emperors (20%). Overfishing and habitat degradation are the major threat for most of these fishes. Especially, the groupers aggregate during spawning, which make them target fishing and are rarely effectively managed. Some species are now even considered threatened with extinction unless action is taken to conserve them. Four species of Epinephelids known from Andaman and Nicobar Islands, viz., *Cromileptes altivelis, Epinephelus lanceolatus, Plectropomus laevis and Plectropomus areolatus*, are classified as Vulnerable according to IUCN Red List (IUCN 2017), while six more species, namely, *Epinephelus bleekeri*, *E. coioides, E. fuscoguttatus, E. malabaricus, E. polystigma* and *Plectropomus pessuliferus* are assessed as Near Threatened. Initiative studies on underwater visual census surveys, helped to develop our knowledge of relative abundance and distribution patterns for different commercially important benthic fishes, a snapper of the genus *Etelisis* yet to be described.

T2S2POS08

Is the Sea off Odisha, North-Western Bay of Bengal a Favourable Feeding Ground of Bryde's Whale [*Balaenoptera edeni Anderson*, 1878]?

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Seasonal occurrence of baleen whales along Odisha coast is investigated based on critical evaluation of the stranding data collected from primary and secondary sources during 2016- 2020. The study reveals that there have been 19 instances of whale stranding in Odisha of which baleen whales accounted for 63% and Bryde's whale (*Balaenoptera edeni*) alone accounted for 58%. As the lengths of 55% of the individuals of this species stranded in Odisha were less than the size at which they attain sexual maturity (<39 feet), their seasonal migration to this coast could not be conclusively attributed to mating, breeding or calving purposes. However, a critical review of the seasonal distribution data showed that 91% of the stranding of Bryde's whale in Odisha beaches occurred during post-monsoon season (November-February), which coincides with the period of high productivity and availability of plenty of food. This leads us to hypothesize that Bryde's whales, the inhabitants of all tropical and warm temperate waters between 40ºN and 40ºS, migrate to seawaters off Odisha coast, along north-western side of Bay of Bengal for feeding purposes. The study calls for further investigation on the migration patterns of these giant filter feeders and the causes of their stranding, particularly in the light of the increasing instances of stranding and mortality of baleen whales along the Odisha coast.

T2S2POS09

Chitosan - Gold Nanocomposites as Smart Indicator for Frozen Storage Temperature History

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Frozen stored food products will have very long shelf life and the frequent opening of freezers in the retail outlet will results in inferior quality products ultimately influencing its shelf life. Proper temperature control and its reflection in the retail pack will help the consumer to get appropriate quality product for the price paid. A metal nanoparticle based smart packaging device can be developed for this purpose. Present study aimed to develop gold nanoparticles (AuNPs) using chitosan as reducing and stabilizing agent and its application as TTI. Gold nanoparticles were prepared under isothermal conditions using chitosan (0.1 to 0.5% w/v) of three different types of chitosan with varying degrees of deacetylation. The AuNPs synthesized had ruby red colour and the maximum absorbance (λ_{max}) was observed between 517 to 530nm. TEM analysis revealed that the increase in the concentration of chitosan resulted in smaller AuNPs. Up on exposure to frozen condition (-18±20C), the visible ruby red colour of AuNPs synthesized using lower concentration of chitosan changed drastically while the colour change reduced with increase in concentration of chitosan. The lowest concentration of chitosan that had no change in colour was

selected for temperature abuse studies and were exposed to different time ranging from 1hr - 52 hrs at different temperatures of 10°C and 37°C. There was distinguishable colour change of the nanoparticle upon exposure to 37°C and these colour changes indicate its application as smart packaging to indicate the temperature abuse of frozen stored products.

T2S2POS10

May the Few Rules in Digital-Fisheries viz. Growth & Fecundity are Negatively Correlated with 'TDS' and 'CEC' and Approximated Linear Models

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Present communication dealt a few digital-rules in fisheries, along with linear models that are described according to the environments persist. As already known in natural fisheries, every fish-species has got a certain range of osmotic pressures to perform to breed naturally. As for example IMCs breed naturally when the osmotic pressures of an ecological-waters prevail in the range of alow osmotic pressure, equivalently the ecological Total Dissolved Solids (TDS) varying 100 to 120 ppm found digitally. Also studied that all other inland species of fresh water can breed naturally when the TDS prevail below 160 ppm. *Tilapia spp* the exotic, can breed naturally in a TDS varying 190 ppm or less. A lowering the value of TDS in Ecological waters is more congenial in natural fish breeding. Study found that colloid clay particles in aquatic environment may reduce the growth rates both physiologically and reproductive. Study found egg-laying capacity of fecundity may negatively correlated with TDS. Other than this important phenomenon, amount of egg-laying capacity or fecundity greatly varies with environments. In inland fisheries fecundity of individual fish species may better when there is a sandy-bottom ecological environment, a higher value of CEC cation exchange capacity (with a range 0 to 200 meq) at bottom-soil or suspension particles may deleterious to the egg-laying capacity and extent of CEC value may negatively correlated with egg-laying capacity, with individual species. As per study with various species, *Puntius spp* closer to clay has a range of fecundity 300 to 1000, whereas *Glossogobius giuris* has the value doubled and a Seabass, closer to sandy environment has got TDS to breed,values bellow 250 ppm on a sandy bottom with fecundity manifolds, ranging around 107. Present communication also dealt with an average *Tenulosa ilisha* with fecundity range 10 to 20 Lacs and its successful hatching (Y) tends to negatively correlated with TDS (X) and given an algorithm, $Y=-14865*X+3E+05$ ($R^2=0.8176$), as this species preferably breed naturally in range of TDS (X), having a very low ppm to near 110 ppm. Whereas fecundity (Y) may again negatively correlated with CEC(x) in most *Puntious spp* and approximated linear model $Y = -15.406*X + 3370.8$, $R^2 = 0.99$.

T2S2POS11

Fecundity of any Fish may Environmentally Controlled and Values are Negatively Correlated Both with the 'TDS' and 'CEC'

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During the global warming days a vast water-resource prevailing is the consolation worldwide. Situation makes

that fisheries may be an obvious choice to many people. This fishery may be a must go practices when water gets polluted, as most fishes can clean a water in a better way in inland or any conditions. Present communication dealt a digital application in fisheries. In recent days we find fisheries in a digital-go. In natural fisheries every fish-species has got a certain range of osmotic pressures to perform to breed naturally. As for example IMCs breed naturally when the osmotic pressures of an ecological-waters prevail in the range of a low osmotic pressure, equivalently the ecological Total Dissolved Solids (TDS) varying 100 to 120 ppm found digitally. Also studied that all other inland species of fresh water can breed naturally when the TDS prevail below 160 ppm. *Tilapia spp* the exotic, can breed naturally in a TDS varying 190 ppm or less. A lowering the value of TDS in Ecological waters is more congenial in natural fish breeding. Study found that colloid clay particles in aquatic environment may reduce the growth rates both physiologically and reproductive. Study found egg-laying capacity of fecundity may negatively correlated with TDS. Other than this important phenomenon, amount of egg-laying capacity or fecundity greatly varies with environments. In inland fisheries fecundity of individual fish species may better when there is a sandy-bottom ecological environment, a higher value of CEC cation exchange capacity (with a range 0 to 200 meq) of clay at bottom-soil or suspension particles may deleterious to the egg-laying capacity and extent of CEC value may negatively correlated with egg-laying capacity, with individual species. As per study with various species, *Puntius spp* closer to clay has a range of fecundity 300 to 1000, whereas *Glossogobius giuris* has the value doubled and more, a Seabass, closer to sandy environment has got natural TDS to breed, values bellow 250 ppm on a sandy bottom with fecundity manifolds, ranging around 107.

T2S2POS12

Novel Product: Ready-To-Eat Fish Spread and Its Quality Assessment

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Fish and fish products are valuable sources of animal protein and is now considered a healthy food. But, its spoil very fast as compared to other animal meat. Croaker, locally known as “Dhoma” are sold at low prices, though they are rich in proteins. The croaker fish landings of India was 1,35,750 tons in 2019. Efforts are being made to utilize the uneconomic varieties of fishes through appropriate technological processes and converting them into different kinds of value added products. Efficient utilization of low cost fish in foods may revolutionize the fish industry by standardizing appropriate and economic technology for processing such underutilized fish into value-added meat products that are palatable and economically viable. Present marketing trends reflect a rapidly growing demand for processed foods that are more convenient to handle, store and prepare. Spreadable product is a kind of convenience, ready to eat form of product which is spread on or sandwiched in a base like bread e.g. butter, jam, mayonnaise, cheese spread, and they form a large constituent of the present market. In the present study spreadable products fish spread was developed from low valued Dhoma fish and its storage characteristics were assessed.

T2S2POS13

Photo-Protective Effect of Cuttlefish Ink Melanin on Human Hair

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Studies on melanin from biological sources have been documented to a certain extent in literature, however, limited to extraction, microstructural characterisation and compositional details. The role of melanin present in hair cortex in protecting the hair fibres from photodamage is well understood. Ideally, the protection offered by endogenous melanin is limited to the cortical layer, as the presence of melanin is restricted to the cortical matrix. The integrity of cuticular layer is important in maintaining the appearance and mechanical strength of hair fibres. Hence in the present study, the photoprotective efficacy of exogenous melanin extracted from cuttlefish ink on human hair was assessed by giving a melanin coating on cuticle surface. Melanin extracted from cuttlefish ink was applied on black hair and irradiated using a solar simulator. The extent of photodegradation was determined by microstructural, morphological and mechanical testing. The UV-VIS spectra of melanin extracted from cuttlefish indicated strong absorption at UV region. Likewise, the melanin coated samples indicated significant protection to hair cuticle against UV radiations, as indicated by microscopic images (SEM). Conversely, visible cracks were evident on uncoated hair shafts, when exposed to UV-radiations. Also, the melanin coated hair samples indicated negligible alterations in disulfide linkages, free sulfhydryl group content, water retention index (WRI) and swelling index (SI) on UV exposure, as compared to that of uncoated samples. Correspondingly, the mechanical strength of the uncoated hair fibres was far compromised by UV irradiation compared to that of melanin coated hair fibers. The observations of present study postulate cuttlefish melanin as a potential photoprotective agent in hair-care formulations, which is otherwise considered as a process discard from cephalopod processing industry.

T2S2POS14

Enzyme Assisted Peeling of White Leg Shrimp (*Litopenaeus vannamei*) for Efficient Pre-Processing

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An enzymatic method to promote the peeling of whiteleg shrimp (*Litopenaeus vannamei*) was investigated. In this study, *L. vannamei* shrimp of an average length of 13.85±0.86 cm and weight of 21.7±1.25 g were treated with proteolytic enzymes viz., endoprotease and exoprotease to felicitate the shell loosing prior to peeling. The investigation of the efficiency of the endo and exoprotease in shrimp shell-loosening during enzymatic maturation was carried out with enzyme concentration 0.5% v/v, combination of endo and exo protease at the ratio of 1:1, 2:1 and 1:2, temperature 5°C, time 1 h at constant stirring at 150 rpm and without pH adjustment. Shrimp were analyzed at 15 min interval for peelability, effect of proteolytic enzyme on texture, organoleptic changes and moisture. It was found that the proteolytic enzyme treatment effectively improved the peelability of the shrimp. A combination of endo and exoprotease (1:1) resulted in the best peeling of shrimp followed by endo and exoprotease (1:2) after 30 min of enzyme maturation. However, shell became very soft after 45 min of enzyme maturation in all the

treatments. It was also that enzymatic maturation did not affect the texture, colour and organoleptic taste of the shrimp as compared to the control. Therefore, combination of endo and exo protease can be used to improve the shrimp peelability and assist in automated shrimp peeling.

T2S2POS15

Quality Characteristics Fish Oil Microencapsulates Incorporated Restructured Fish Product

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Restructured fish products were prepared from Nile Tilapia (*Oreochromis niloticus*) fish mince by incorporating fish oil microencapsulates. Microencapsulation of fish oil was done by spray drying. To improve the oxidative stability fish oil microencapsulates, essential oil from citrus peel (CT)and pomegranate peel extract (PM) were added in fish oil emulsion and spray dried. Restructured fish product were prepared by incorporating 4% corn flour, 0.5% fish oil/ fish oil encapsulates and 1% salt in to fish mince.Product without incorporating fish oil/fish encapsulates was served as control. All the samples were kept under chilled (4ºC) condition. Biochemical, microbiological and sensory quality of the products were analysed up to 17 days. Higher TVB-N values were observed for (8.4- 23.8 mg %) bulk fish oil added one than control (8.4-19.6), fish oil encapsulates incorporated (CT: 8.4-16.8 mg %; PM- 8.4-14.2 mg %). Unlike TVB-N, TBA also showed a similar trend during storage. Sensory and microbiological analysis revealed that bulk oil incorporated product had a shelf life up to 12 days and others had a shelf life up to 14 days. TPC crossed the acceptable limit (5log cfu g^{-1}) on 17th day in all treatment.

T2S2POS16

Effect of Spice Extract on the Quality of Dried Bombay Duck

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Effect of spice extracts (cinnamon extract, pepper extract and clove extract) on the quality of dried Bombay duck (*Harpodon nehereus*) were studied. Highest DPPH activity was found in cinnamon extract (85.83%) followed by clove (63.11%) and Pepper (23.58%). Fresh Bombay duck were split opened, cleaned, dip treated (10 min) with clove extract (20%), cinnamon extract (20%). Bombay duck without any treatment was kept as control. All the samples were dried at 60°C and kept at ambient condition. Biochemical, microbiological and sensory quality of dried Bombay duck were analyzed up to 4 months. Clove extract treated Bombay duck had lower total volatile base nitrogen than cinnamon extract treated and control. Clove extract treated also reduced the oxidation in Bombay duck during drying as indicated by lower PV and TBA values. Total plate count showed increased trend during storage. Based on sensory and microbiological analysis clove extract treated Bombay duck had a shelf life up to three months. However, control and cinnamon extract treated sample had a shelf life up to two months.

T2S2POS17

Peptides from Anchovy Head Waste for Its Application as Foliar Spray

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Bioactive peptides have gained prominence for their agricultural application on account of their potential to increase the germination, productivity and quality of a wide range of horticultural and agronomic crops. Hydrolysate production from industrial discards is a promising option for addressing environmental pollution issues as well as for effective waste upgradation to valuable commodities. The present study focused on the optimized extraction of peptides from anchovy head waste collected from processing industry. Response Surface Methodology was employed for deriving optimized peptides using enzyme papain. The effect of hydrolytic parameters viz., enzyme-substrate ratio (1.0 - 5.0 %) and hydrolysis time (2 - 24 hours) under optimized temperature and pH, on the protein recovery, and yield was considered. An enzyme-substrate ratio (E/S) of 5 % and 23.48 hours of hydrolysis time with a desirability of 0.942 was found to be optimized protocol for deriving peptides with maximum yield (8.26%) and protein recovery (73.63%). Further studies on its application as a foliar spray in microgreens indicated promising results with improved growth and sensory attributes. Studies suggested selection of optimized hydrolytic conditions for deriving specific hydrolysates for the foliar spray formulation to incorporate into the plants for encouraging their growth. Further studies are recommended to completely explore the beneficial properties and mechanisms of these peptides as well as to determine different product formulations and application methods under a range of agro-ecological conditions.

T2S2POS18

Effect of Electron Beam Irradiation in Combination with Thermal and Non Thermal Treatments on Shrimp Allergen, Tropomyosin

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Allergnicity to food materials is problem of public health importance not only in developed nations but also in developing nations. Food allergy is the abnormal immunological response to certain food proteins by sensitive individuals which is mainly mediated by immunoglobuline E (IgE). Shellfishes are included in eight major food allergens listed as per Food and Agriculture Organization (FAO) of the United Nations and World Health Organization. Severe allergic reactions can lead to anaphylactic conditions. Tropomyosin is the major allergen identified in case of shrimps. Processing treatments can be effectively utized to alter the allergencity. Electron beam irradiation, a non thermal processing technique using ionizing irradiation gained attention due to minimal processing effect. Here a hurdle technology based approach for the reduction in immunogenicity of allergen, tropomyosin from flower tail shrimp, *Metapenaeus dobsoni* was investigated by combining electron beam irradiation at 5 KGy and treatments such as boiling, autoclaving, trypsin and chymotrypsin. Peeled raw shrimp was used as control. After irradiation shrimp

extracts were prepared and subjected to SDS PAGE profile, IgE binding ability and immunoblotting technique using pooled sera of shrimp sensitive individuals. Electron beam irradiation resulted significant ($p<0.05$) decrease in the IgE activity in the case of all treatments. The SDS PAGE analysis showed the presence of tropomyosin in all the treatments except autoclaving in combination with or without electron beam irradiation. A pronounced reduction in allergenicity was observed in treatment of autoclaving in combination with electron beam irradiation. The combined application of autoclaving and electron beam irradiation can be utilized for the preparation of hypoallergic shrimp.

T2S2POS19

Biochemical Quality, Microbial Safety and Heavy Metal Content in Dry Fish Samples Available in Local Markets of Navi Mumbai

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Commercial production and marketing of dried fish and shrimp is an economically important activity among coastal communities. Inadequate curing procedures, unhygienic handling practices during process of sun drying, storage and marketing can deteriorate the quality and safety of cured products. In this background a study was carried out to evaluate the biochemical quality and microbial safety of dried fish and shrimp samples collected from local markets of Navi Mumbai. A total of fifty three samples were collected and which included samples of Bombay duck, Ribbon fish, Anchovy, *Acetes spp.*, Indian mackerel, shrimp and golden anchovy. Biochemical and microbiological parameters were evaluated along with analysis of heavy metal content using Inductively coupled Plasma Photometer (ICP). Moisture content of samples was varying and 11% of samples contained moisture content above 40%. Salt content was ranging from 1.9 to 20.11% and samples of salt dried mackerel contained salt content above 12% as per FSSAI limit. Sand content exceeded the 1% limit only in case of 2% of samples. TVBN content was above 100 mg% in 72% of samples. Similarly, 72% of samples showed TMA content higher than 20 mg%. Histamine content was less than the maximum limit of 200 mg kg^{-1} as specified by FSSAI. Aerobic plate count was above the limit of 5 log CFU g^{-1} as per IS14950 in 35.8% of samples and the yeast and mould count was above 2 log CFU g-1 in 92.4% of samples. Mercury content was found to be absent in all the samples. Presence of cadmium and lead above 0.5 ppm was detected in 3.8% and 1.8% of samples respectively.

T2S2POS20

Protein Powder from *Squilla sp.* - Improved Utilization of an Unconventional Coastal Resource to Meet the Nutritional Security

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Squilla sp., belong to stomatopod crustaceans and are often caught as a non-targeted species during shrimp trawling operations. In India, this shrimp by–catch is either discarded at the sea or utilized for the production of squilla meal, chitin and silage for animal feeding purpose. *Squilla spp.* contains 13-15% protein, however, higher moisture content and hygroscopic characteristic of its protein restricts large scale squilla's processing. Considering the

depletion of commercially important fish resources day by day, it is high time to explore this underutilized resource for developing commercially significant food products to address the nutritional security. In this context, a simple cost-effective technology was developed to convert this underutilized biomass to a protein rich flavor ingredient. Protein powder from squilla was prepared using foam mat drying technology. Mince from Squilla was collected by hot blanching of uniformly cut squilla pieces followed by centrifugation. The mince was dried by foam mat drying technique which involves whipping of the mince along with foam stabilizers and drying the foam as a mat in a tray. Yield of squilla protein powder prepared by foam mat drying was 12% from raw material. The squilla protein powder had 60% protein and showed good foaming, emulsion and antioxidant properties apart from possessing good solubility in water. Addition of squilla protein powder to fresh water fish nuggets (5%) can greatly reduce the muddy and fatty odour of those products. Addition of squilla protein powder can also impart antioxidant properties in the food products as the protein powder has good antioxidant properties. Noodles prepared with squilla protein powder (2.5 to 5%) enriched the protein content of noodles apart from imparting shrimp flavor to the product. These studies have proven that the protein powder prepared from *Squilla sp.* has wide applications in food industry as a protein source or as well as a flavour enhancer in low protein products like soup, noodles, pasta etc.

T2S2POS21

Effect of Different Drying Methods on Quality of Squid Rings

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Dried squid is a popular food due to its convenience for consumption and its long shelf life. Drying is an effective and common preservation method of seafood. This study investigated the effect of drying methods on dried squid rings prepared from Indian squid (*Uroteuthis duvaceli*, D'orbigny, 1835). The whole fresh squid dressed into squid tubes/mantle, by removing head, tentacles and viscera. The skin of mantle peeled, the remainder washed with the tap water and further cut into rings of about 1cm. The squid rings were blanched in boiling brine solution (20% brine conc.) at above 80°C before drying. The mechanical dryer took 16 hrs to dry the squid rings at constant temperature of 50°C where in open sun drying it takes 4 days to achieve desired moisture content (below 16%). The achieved yield of fresh squid rings was 38.97% however after drying by mechanical and sun drying method the yield achieved for squid rings was 5.87 and 6.84% respectively. In the present study based on the quality evaluated for microbiological, biochemical and sensory characteristics, it was found that the quality of mechanical dried squid rings was found better compared to traditional sun dried squid rings.

T2S2POS22

Development of Ready-To-Eat Crispy from Fish Scales

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Ready to eat crispy, was prepared from fish scales. The processing was done in three major steps. Standardization of acid treatment was done using three different concentrations of acid, 1, 5, and 10%. Proximate composition,

differential scanning colorimetry, sensory characterization and invitro protein digestibility were studied for the treated scales. The crispy had increased sensory acceptability with increased acid concentration. The enthalpy of denaturation decreased with increased concentration. The invitro protein digestibility was 84% for the crispy developed with highest acid concentration. The essential amino acid index (EAAI) of selected crispy was 0.77 and was found to be a good source of Ca, P, Na, K and Mg. The crispiness of the product was confirmed using lower brittleness value on instrumental analysis and score of 8.7 for sensory evaluation. The lipid oxidation measured as TBARS value was 0.47 mg malonaldehyde kg^{-1}. Thus, the fish scales which was generally considered as a waste from fish industry can be effectively utilised for the development of a delicious and nutritious snack.

T2S2POS23

Design, Development and Performance Evaluation of Fish De-Scaler Cum Knife

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Demand for fish and fish product is increases in national and international market. Before the fish is ready for processing or preparation of various delicious food its needs to undergo series of pre-processing operations such as washing/ cleaning, cutting of fins, descaling, beheading, evisceration, deskinning, filleting, slicing of whole fish into pieces etc. Fish is covered with scales, which are prominent outgrowths of skin, or epidermis, with numerous mucus glands found on fish body. Fish marketing and processing is unorganized chain prevalent in India and other developing countries. In the commercial plants or retailers carry out washing/cleaning, descaling, cutting of fins, and beheading operations with their indigenous tools just prior to sale/processing. This is not only a time consuming and cumbersome operation but also frequently causes harm and wounds to the hands of persons involved in performing the task. In the present study, designed and developed of fish de-scaler cum knife, which showed better performance with respect to time consumption without human drudgery, better yield, safety, no skin damage to the fish, and also hygienic handling with better quality of dressed fish.

T2S2POS24

Extraction of Chitin, Chitosan and Preparation of Meal from Mantis Shrimp (*Squilla*) and Study their Functional Properties and Shelf Life.

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The present study was carried out for preparation of chitin, chitosan and squilla meal from mantis shrimp off Ratnagiri coast. The chitin was prepared from squilla shells by using HCl (3%) and different concentrations of

NaOH (3%, 4%, 5% and 6%) during demineralization and deproteinization. The functional properties of chitin such as viscosity (2.140±0.0245 to 3.100±0.0316 cP), solubility (51.44±0.199 to 65.16±0.150%), emulsification capacity (22.320±0.061 to 24.250±0.297%), WHC (298.512±0.324 to 318.55±0.203%) and whiteness (70.133±0.301 to 72.452±0.084) were analysed. Findings showed significant increase in all properties of chitin with increase in concentration of HCl and NaOH. Chitosan was prepared from squilla shells by using different concentrations of NaOH (45%, 50%, 55% and 60%) during deacetylation. Functional properties of chitosan were analysed and there was significant decrease in viscosity (2.06±0.024 to 1.98±0.020 cP) and solubility (40.900±0.187 to 40.080±0.150%) whereas emulsification capacity (26.508±0.244 to 30.136±0.083%), WHC (342.90±0.244 to 372.49±0.157%) and whiteness (74.900±0.075 to 76.876±0.034) significantly increased during the experimental study. During storage study of 90 days, proximate composition, functional and biochemical properties of squilla meal in both control and sample (0.2% BHT) were analysed at 15 days sampling interval. There was significant decrease in protein (%), fat (%) and ash (%) whereas, significant increase in moisture (%) of squilla meal in both control and sample (0.2% BHT) was observed. The functional properties of squilla meal such as bulk density and emulsification capacity significantly increased. However, WHC and viscosity decreased in both control and sample (0.2% BHT). In biochemical analysis, there was significant decrease in peroxide value and TVB-N of squilla meal with increase in storage period in both control and sample (0.2% BHT). The present study suggests that squilla shell is good source of chitin and chitosan. The squilla meal showed desirable properties during 90 days storage period.

T2S2POS25

Beneficial Effects of Spices in Seafood Preservation: A Review

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Plant products such as leaves, flowers, seeds and roots which are used as spices due to high content of essential oils and aromatic properties. Due to the adverse effects of chemical preservatives on human health, there is an increasing demand for organic preservatives such as spices in food processing. Various health benefits of spices have been recorded for preventing and treating a wide variety of human diseases such as cancer, aging, metabolic, neurological, cardiovascular and inflammatory diseases. After harvesting, the nutritional value, biochemical properties of fish and shellfish are lost due to early spoilage and post-harvest handling. In order to maintain quality of seafood, natural preservatives have been widely employed in the seafood industry. This review provides a critical evaluation of natural antioxidant and antimicrobial properties of spices such as ginger, garlic, turmeric, chilies, cardamom, coriander, cumin, clove and black pepper in maintaining the quality and to enhance the shelf-life of seafood products. Thus, the role of phytochemical compounds of spices in delaying the bacterial spoilage and biochemical processes is summarized.

T2S2POS26

Effect of Different Drying Methods on Biochemical Characteristics of Sole Fish, *Cynoglossus macrostomus* (Norman, 1928)

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Salt dried sole fish is a popular dried product along the Indian coast line. The sole fish dried by traditional method not maintains hygienic condition that result in to get the lower quality of product. That wise in present study sole fish were dried adopting improved methods, namely STD and CD with comparison TSD method. The biochemical quality of fresh sole fish showed moisture, Protein, Fat, ash and salt content were 77.82%, 17.30%, 1.87%, 2.66% and 0.35% respectively. The TMA-N, TVB-N, FFA and pH were 9.93 mg N/100g, 16.54 mg N/100g, 0.9% and 6.8 respectively. Sole fish dried in STD and CD and packed in HDPE bag can be kept in acceptable condition up to 150 days while TSD sole fish packed in gunny bag up to 90 days. The sole fish dried by STD and CD method added advantages of superior quality, fast and hygienic drying with longer shelf life than sole fish dried by traditional sun drying method.

Theme II:

Technological developments in fisheries, livestock and poultry management, water pollution trends, and ecological security for coral reefs, farming system modules

SESSION III:

Water pollution: sedimentation, eutrophication & formation of dead-end zones - threat to fisheries, corals & coral reefs

T2S3I01

AQUATIC POLLUTION "VIS-A-VIS" FISH HEALTH

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Dr. Basanta Kumar Das is one of the leading fish health management Scientists of the Country, serving as the Director of ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata. He is also the President of Inland Fisheries Society of India, Professional Fisheries Graduates Forum, India and Odisha Fisheries College Alumni Association. Dr. Das studied in the College of Fisheries, OUAT, Bhubaneswar and also conducted Post-Doctoral work in fish immunology from Aberdeen University, UK and in nano-sensors from University of California, USA. He specialized in aquatic animal health management along with prospecting novel biomolecules for industrial applications. He is having twenty-six years of professional experience with expertise in diversification of inland cage, aquaculture practices, pen culture and feed development. He has developed molecular diagnostic kit for Tilapia Lake Virus, besides the technology like GI Cage, HDP Pen, Cage grow feed were commercialized. The Fish Disease Advisory App serves as advisory for stakeholders and farmers. Dr. Das published more than 300 research articles. He has received numerous awards and honours including the Best Indian Fisheries Scientist by the PFGF, India; Krushak Ratna and Krushak Gaurav Awards during 2016 and 2017. He is a Fellow of most prestigious National Academy of Agricultural Sciences (NAAS).

Abstract: Fisheries being one of the most important sectors of Indian Agriculture is contributing immensely to nutritional food security. This sector contributes 1.07% to the national GDP, and 5.30% to agriculture and allied activities with a growth rate of 7% per annum. Pollution is considered as one of the most serious threats for declining fisheries production and altering aquatic biodiversity. Inland fresh water resources such as rivers, wetlands, canals and reservoirs, which supports rich biodiversity are gradually getting polluted by diverse types of hazardous and toxic materials. Organic matter enrichment in rivers are frequently encountered since these water resources are mostly serving as the drainage channels, collecting all sorts of wastes on its way. These are leading to the increase in BOD, nutrient enrichment and associated eutrophication. Our holy river Ganga has been thoroughly studied at ICAR-CIFRI under the National Mission for Clean Ganga. The Kanpur to Varanasi stretch has been recorded to have relatively higher levels of BOD especially in the premonsoon months. Such organic matter induced eutrophications are the primary reason of associated low dissolved oxygen in the natural waterbodies causing mass mortality of fishes. In the wetland systems, these are also aiding prevalence of unhealthy environment and recurrence of fish diseases as recorded at the East Kolkata Wetlands.

Pesticides and heavy metals are most frequently occurring toxic substances in the inland resources affecting health of fish and other aquatic species. The commonly found pesticides belong to three groups of insecticides viz., organochlorines (OC), organophosphates (OP) and synthetic pyrethroids (SP). Out of these the organochlorine pesticide contaminations are most dominant in the Indian water bodies. Heavy metals such as Cd, Cr, Cu, Ni, Pb,

Zn, etc. contents in open waters might pose threats to the health of fishes and other biotic community. The Indian rivers are the worst victim of such pollution.

Microplastics pollution in open waters has become a great concern. Our study in the East Kolkata Wetlands recently exhibited dominance of microplastics (63 µm - 5 mm) in the surface water and sediments of treatment ponds (7.87 to 20.39 items L^{-1} and 2124.84 to 6886.76 items kg^{-1}) and associated wastewater canals (30.46 to 137.72 items L^{-1} and 1108.78 to 34612.87 items kg^{-1}). Besides, microplastics were also found in the body mass of cultured Indian major carps (IMC), small indigenous fishes and benthic fauna. High content of toxic metals (As, Cd, Cr, Cu, Ni, Pb and Zn) were also found on the microplastics. In another study, sediments of river Ganga were analyzed for distribution of microplastics at seven different locations viz. Buxar, Patna, Bhagalpur, Nabadwip, Barrackpore, Godakhali and Fraserganj. All the sediments were found to contain microplastics with varying degree of mass fractions (11.48 to 63.79 ng g^{-1} sediments), numerical abundance (99.27–409.86 items kg^{-1}) and morphotypes. The abundance of microplastics in fresh water systems with high anthropogenic activities are emphasizing the attention to be given to this emerging pollutant in the inland aquatic system. Furthermore, antibacterial compounds, widely used in different personal care products, like Triclosan [TCS, 5-chloro-2-(2,4-dichlorophenoxy)-phenol], one of its more persistent metabolite methyl-triclosan (Me-TCS) and Triclocarban (TCC, 3,4,4'-trichlorocarbanilide) were found as contaminants in the fresh water resources. They have been found in the water and fish samples from the East Kolkata Wetlands and river Torsa. In water, the level of TCS was 0.09-4.01 g l^{-1} which exceeded the predicted no effect concentration of 0.05 g $l-^{1}$. TCC concentration (0.05-1.49 g l^{-1}) was comparatively lower than that of TCS. They are also found in the muscle tissue of fishes (*Oreochromis mossambicus* and *O. niloticus*) at levels 0.04-0.57 mg kg^{-1} respectively. However, keeping in view the acceptable daily intake (ADI) of TCS i.e. 50 g kg^{-1} body wt the present level of TCS detected in fish would not pose any health hazard to the consumers.

Various types of synergistic effects are prominent with the above mentioned pollutants at their existing levels in the aquatic systems. Also, in many cases the impacts are non-specific. Pesticides and other pollutants are reported to cause degenerative changes in gonads and arrest gametogenic processes either by acting directly on the gonads or by interfering with the secretory activity of the hypothalamo-hypophyseal-gonadal/thyroid axis that regulates various reproductive events. Secretion of hormones such as gonadotropin-releasing hormone (GnRH), gonadotropin, growth hormone, adrenocorticotropic hormone (ACTH), testosterone, estrogens, 17, 20 β-dihydroxy progesterone and thyroid hormones are in general lowered, leading to cessation of gametogenesis, vitellogenesis, oocyte maturation, ovulation, spermiation, etc. Adverse effects of pesticides have also been demonstrated on fecundity, fertilization, hatching, and postembryonic development. Because of severe pollution caused due to the pesticides and EDCs, the fish populations in aquatic ecosystem are at alarming situation. Hence, there is an urgent need for the rapid assessment and development of mitigational measures towards these pollutants for ecosystem health monitoring and sustenance of the fish biodiversity in these aquatic resources. Fishes serve as an indicator of aquatic ecosystem. Deterioration of water quality by different pollutants as explained above could lead to the alterations in the body physiology and therefore, directly impacting the recruitment and sustainability of open water fisheries, on which millions of poor fishers are dependent. Our presentation would cover an overview of the aquatic pollution, associated pollutants and their impact on fish health for developing suitable strategies or management plans for conservation of biodiversity and fisheries.

T2S3I02

BIOSENSORS FOR WATER POLLUTION MONITORING USING ENZYME-MIMIC NANO SYSTEMS

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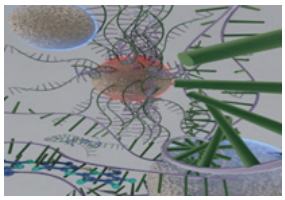
Professor Vipul Bansal is the Founding Director of Sir Ian Potter Nano BioSensing Facility at RMIT University. He has a diverse academic background with a bachelor's degree in agriculture sciences, master's in biotechnology and PhD in nano-biotechnology. He has published over 200 papers (10,000+ citations, h-index – 56), filed over 20 Patents, and supervised more than 20 PhD theses. He has secured over $25 Million in research funding from diverse sources (Australian Research Council, Gates Foundation USA, Ian Potter Foundation, Helmsley Trust USA, the Juvenile Diabetes Research Foundation and industry bodies). The focus of his team is to develop crosscutting technologies for applications in sensors and diagnostics, biomedical imaging, cellular immunotherapies, microbial and wound management, and environmental remediation. Two of his products are currently under clinical trial, including a dual PET/MRI imaging agent that has successfully completed a phase I trial, and a diagnostic device for monitoring vaginal health. He is the founder of *NexGen NanoSensors Pty Ltd* that is currently commercialising a wearable UV sensor technology to protect individuals from skin cancer.

Abstract: The enzyme-mimicking activity of nanoparticles, referred as 'NanoZyme' is receiving significant interest, and has found applications in microbial control, pro-drug activation, antioxidant therapy and photo-thermal therapy. The robustness of these nanoparticulate systems combined with their mimicry to the natural enzymes offer unique opportunities to develop new detection and sensing technologies. To this end, our group has invested concerted efforts in establishing the NanoZyme activity of more than 100 nanomaterials for a range of enzymatic reactions. This has allowed discovery of new NanoZyme design principles, and identification of certain unique nanomaterials that can compete in performance with natural enzymes. Additionally, compared to natural enzymes, these NanoZymes offer high stability, low production cost and multifunctional enzyme activity. We have combined such promising NanoZymes with molecular recognition elements such as aptamers to develop colorimetric sensors against a range of targets of high environmental (pesticides), food (antibiotics), and clinical (glucose, virus, bacteria, cancer cells) significance. We have also demonstrated the applicability of these sensors in real-world samples, ranging from river water to seafood, human serum and urine. Many of these biosensor technologies are likely to be suitable for monitoring water pollution, both for the detection of small molecules, such as pesticides and for human pathogens in seafoods such as norovirus. These sensors are colorimetric, ultrafast (few minutes response time), highly sensitive (e.g. 10 virus particles), and highly selective for the detection of a range of analytes. We have also started to incorporate pattern recognition algorithms in these sensors that generate unique fingerprints of target analytes, bringing the sensor operation closer to our olfactory system that can detect subtle flavour profiles in food and wine. This talk will discuss our efforts and upcoming new developments in this area.



T2S3I03

ARSENIC CONTAMINATIONS IN THE AQUATIC ECOSYSTEMS AND ITS ASSOCIATED IMPACTS

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Dr. Srikanta Samanta is presently serving as the Head, Riverine and Estuarine Fisheries Division at ICAR-Central Inland Fisheries Research Institute, Barrackpore. After studies at BCKV, WB he pursued Ph.D. program at IARI, New Delhi. His professional carrier started as Scientist at the ICAR-CIFRI, Barrackpore. He has specialization in aquatic chemistry, pesticide, metal and arsenic contaminations and associated impacts. He has research experience of more than 25 years and published 50 research articles. He has comprehensively worked in arsenic contaminations in the inland aquatic systems of the endemic areas of West Bengal. The aquatic health associated aspects of rivers, wetlands and lakes were extensively studied by him.

Abstract: Arsenic is considered as the number one environmental contaminant due to its associated harmful effects especially in the contaminated areas. The Ganga-Brahmaputra-Meghna basin is one such endemic zone where millions of people are exposed to arsenic contaminations and facing challenges with associated ailments. Although the drinking water is considered as the major source of such problem, basically the entire ecosystems and all the existing food chains are contaminated with different levels of the toxicant. In the uncontaminated freshwaters the reported concentrations are up to 0.45 ppb while in the seawater, its concentrations are usually less than 2 ppb. In rural Bengal, majority of the households are having ponds of different sizes and under existing environmental conditions the water levels of most of such ponds gets reduced due to prolonged dry post-monsoon and pre-monsoon months. To sustain perennial aquaculture, agriculture and household activities many of such ponds are refilled using shallow or deep tube well water. When such ground water sources are contaminated with arsenic, the pond systems also get contaminated. Our studies in the arsenic endemic districts of Nadia, North and South 24 Parganas exhibited that the water phase of ponds and *beels* had contaminations in the range of 2-174 ppb with respect to the levels of 1-8 ppb in the nearby uncontaminated area of Hooghly district. The associated guideline value for the protection of aquatic life is 5 ppb. In the pond sediments the recorded concentrations were 1.3-37.3 ppm in the contaminated areas with respect to 1.4-5.2 ppm in the uncontaminated areas. The associated guideline value for pollution limit is 10 ppm.

Contaminations of As in the phytoplankton community exhibited wide variability in the range of 480-9927 ppb in the above studied areas. Almost similar trend was recorded in zooplankton community also with recorded concentrations of 387–8874 ppb. The highest accumulations were noted at Bhomrabeel for both the planktons. Accumulation of arsenic was also recorded in the aquatic plants and in general, the highest arsenic concentrations were recorded in plant roots (392-900 ppb), followed by leafs (59-95 ppb) and stems (46-55 ppb).

The fishes *Amblypharyngodon mola, Puntius sophore* and *Sperata seenghala* collected from river Ganga exhibited

total arsenic concentrations of 20-140 ppb while in *Tenualosa ilisha* it was 1400 to 3300 ppb. The fish samples collected from the mentioned ponds and beels were studied in detail. The Indian major carps showed varied concentrations and catla (*Labeo catla*) was recorded as the highest accumulator of the toxicant in their fleshes (34-516 ppb with mean of 147 ppb) followed by rohu (*Labeo rohita*, traces -1000 ppb with mean of 110 ppb) and mrigel (*Cirrhinus mrigala*, traces -335 ppb with mean of 72 ppb). Our recent studies reconfirmed similar trend and levels of relatively higher accumulations in catla. The market samples were also assessed for their arsenic content. As per expectations, the local fishes from the contaminated zone exhibited higher content while those transported from distant probable uncontaminated areas were almost free from such contaminations. The gastropods and bivalves exhibited relatively very high levels of arsenic accumulation (260-3068 ppb; average 990 ppb).

The impact of presence of such different levels of arsenic contaminations in both abiotic component and biotic communities were thoroughly assessed. An overall decrease in metabolic activities in the aquatic system has already been reported. In the microbial community, with increase in the concentration of As, in P deficient situations, it has been reported that the As ions serves the role of P as the electron accepters in the metabolic processes. This is more prominent in the anaerobic environments. The activities of the As tolerant microbes becomes low while the As resistant microbes gradually dominates. Under anaerobic condition a significant increase in As reduction process takes place as the defense mechanism in the microbes. The activities of plankton communities also get affected at higher levels of As. The As accumulation is also found high in these organisms.

Indian major carp rohu (*Labeo rohita*) were exposed to As at 0-15 ppm for 12 days. At ≥ 10 ppm typical skin lesions with prominent patchy discolouration-dark and white patches and cataract in the fish were reported for the first time from ICAR-CIFRI. Histopathological examinations revealed fatty degeneration and necrosis of hepatocytes, glomerular necrosis and tubular degeneration in kidney. Thus, it was concluded that the human being residing in arsenic endemic areas are probably getting predisposed to As for early onset of cataract. Our studies with Labeo rohita proteomic studies exhibited fish liver damage. This fish model may provide clue as the early detection technique of human arsenicosis and protecting from sufferings from this painful disease which many a times leads to carcinoma. To understand the immune response, the cytokine and HSP gene expression analyses were carried out with kidney and liver tissues of arsenic-exposed *Labeo rohita* fishes. It was observed that arsenic has a generalized immune-suppressive effect leading to down regulation of both Th1and Th2 cytokines; while up regulation of the HSP genes. Thus arsenic exposure made the fishes immunocompromised and which could increase its susceptibility to pathogen attacks.

Lessons learnt from experiments with arsenic gave the clue that more emphasis should be given on judicious use of surface water resources with rain water harvesting since such water bodies are free from as contaminations. One should remain cautious with ground water lifting. Only As contamination free deep tube well resources should be considered. Fishes are the simplest and most popular non-vegetarian sources of proteins in rural Bengal. People should be encouraged to consume more fishes to alleviate the arsenicosis associated problem. Consumption of mollusks and bivalves should be avoided in the as endemic areas due to their higher as accumulation capabilities.

T2S3I04

EUTROPHICATION IS AN OPPORTUNITY FOR THE UTILIZATION OF ALGAL RESOURCES FOR RURAL DEVELOPMENT

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Dr. J. G. Ray is interested in Ecology and Eco-technology. His research is focussing on the ecology of algae, symbiotic fungi (Mycorrhiza and other endophytic fungi in plants) and metal accumulating plants. Currently, he is working as Professor, School of Biosciences, Mahatma Gandhi University, Kottayam, Kerala, India. He has vast teaching experience of 34yrs and research experience of 30yrs. He has received Environmental Lead Auditor Certificate from British Standard Institution (BSI), 2008, BSI India. He is postgraduate Diploma in Ecology and Environment with Distinction, from the Indian Institute of Ecology and Environment, New Delhi. He is Ph.D. in Biology, with the highest grade, obtained in 1992 from Dnipropetrovsk State University. Recently, he has delivered an 'Invited lecture on Sustainable water resources' to Faculty and Students of the Global Institute of Environment Studies, University of Sophia, Tokyo, Japan. He has a total publication of 62 in Peer-Reviewed Journals to his credit. He has guided 14 Ph.D. students and currently guiding 7 students.

Abstract: Eutrophication is considered a negative biological outcome of nutrient enrichment in natural waters. It is quite widespread in the entire world's backwaters around agricultural farms due to leaching of excessive nutrients into nearby water bodies from the fields. Simultaneously, eutrophication is also a positive change of natural waters into an increase in its productivity. But when the fast-multiplying algae in the natural aquatic community use the increased nutrient content toward its favour, some untoward ecological incidents also occur in waters. The excessive growth of specific algal species turns the clean and transparent natural waters into an opaque, algal bloomed appearance, making waters uninhabitable for most natural flora and fauna species. The curse includes less light penetration, oxygen depletion, secretions of algal into waters, fish death and the like, which depends on the species that outnumber the natural algal assemblage in response to specific nutritional variations in waters. But it's an opportunity to search for algal species that respond quickly to an increase in particular nutrients in waters. Now the world needs fast-growing specific new microalgal species and their genes for various productive and curative purposes. Many of the fast-growing microalgal species are nutritionally and medicinally valuable biomass resources. They are amenable to the industrial production of biomass for fuel, food, and feed purposes. Some species are useful as a biological tool for environmental remediation and the like. In this context, we explored the microalgal density of bloomed waters to understand the fast-growing species in diverse kinds of bloomed waters of Kerala State. The subsequent biochemical profiling of many of the identified fast-growing algae species has shown that they are excellent candidates for various industrially producible bioresources. Some are useful as cattle and fish feed resources or lipid resource for biofuel. Certain species among them are found rich in nutritionally valuable compounds such as omega -3-fatty acids, qualifying them as candidates for potential nutraceuticals. Algae are industrially producible fastest growing biomass resource. Thus, eutrophication can be considered as an opportunity that provides a golden chance to identify industrially useful algal species from eutrophicated for sustainable rural development purposes.

T2S3I05

CORAL GROWTH AND SUSTENANCE UNDER WATER POLLUTION AND GLOBAL WARMING

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Dr. Dam Roy was former Director of ICAR-Central Island Agricultural Research Institute, Port Blair. All through his career he has served the underprivileged North-East region and Andaman and Nicobar Islands. He has made striking contributions to the fisheries sector of the respective region in various capacities as extension worker, researcher, research manager, development planner and policy maker. He has bagged a number of national awards for his outstanding research like ICAR Team Research Award, Fakhruddin Ali Ahmed Award, Hooker Award, Dr. Rajendra Prasad Award etc. He is the Fellow of NAAS, Zoological Society of Kolkata and Fellow of ISCAR. He has made significant contribution in the study of the ecology of mangrove and coral reef of Andamans. He has received lifetime achievement award by the Andaman Science Association. He has handled 17 externally funded projects. He has 166 research papers in national and international journals, 40 books, bulletins and manual, 30 book chapters, 74 conference papers and numerous reports including policy documents on fisheries and road map of fisheries development of Andaman & Nicobar Islands to his credit. He has guided 2 Ph.D. and 4 M.F.Sc. students and has been in the advisory board of numerous Ph.D. and M.F.Sc. students of CIFE Mumbai and other Universities. He is currently the President of Andaman Science Association and Vice President of Indian Society of Coastal Agricultural Research. At present, he is working as a Principal Scientist at ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata.

Abstract: Coral reefs are found in pristine pure environments, which are habitat of a wide variety of organisms such as brightly coloured coral fishes of various shapes and sizes, assortment of gastropods, bivalves and nudibranchs, starfishes sea cucumber and sea urchins. Brightly coloured crabs, prawn and lobsters and a host of other organism add the aesthetic values to the ecosystem. Naturally they provide valuable ecological services to the organisms living in the coral habitat which also attracts ecotourism. Corals also provides the first line of defense to the coastlines from the impending waves and sea surges. Development of infrastructure and agricultural activities in the coastal areas, disturbs and erodes the soils, this disturbed bulk soils are carried away to the sea by the runoff water. Further due to the tidal action, the soil is carried to the coral areas, where sedimentation takes place. Coral reefs need clean water to survive, when sediment enter the water, they smoother the coral reefs, damaging the algae and lower water quality. On the healthy coral reefs, the algae are kept at low level due to intense grazing by the herbivorous fishes like parrot fish and surgeon fish etc. When there are over fishing, fishes disappear, and the delicate balance is lost. Coral reefs are adapted to low nutrient levels, so an excess of nutrient due to agricultural runoff can lead to growth of algae that blocks sunlight and consumes oxygen, which coral needs for respiration. Toxic substances including metals, organic chemicals and urban agricultural runoff, can affect the symbiotic algae. They damage their partnership with corals and result in bleaching. Trash such as plastic bags, bottles and discarded fishing gears makes the way into the sea, can snag on corals and block sunlight needed for photosynthesis. Degraded plastics

and micro plastics can be consumed by fish, sea turtles and other reef animals, blocking their digestive tracts and potentially introducing toxins. When corals are abraded by the plastics, they create openings for the pathogens to the corals, thereby increases incident of diseases. Commercial recreational and passenger vessels can threaten reefs by discharging contaminated bilge waters, fuel, raw sewage and spreading invasive species. Oil leakage from ship can cause corals to tissue death, change their rate of calcification, expel zooxanthellae and lead to larval death among other stress responses. The combinations of higher sea level rise and more intense storm system is likely to increase the force exerted by wave action on coastal areas, thereby damaging the corals. Global change projected responses to rapid ocean warming and acidifications. Approximately 30% of atmospheric CO_2 emitted by human being is taken up by the ocean (IPCC 2013), where it combines with water produces carbonic acid, which impedes coral formation. The close relationship between mass coral bleaching and mortality and short period of elevated temperatures are well documented. The present paper discusses above mentioned issues in detail.

T2S3I06

CLIMATE CHANGE, CORAL REEFS AND FISHERIES SUSTAINABILITY: EMERGING PARADIGMS

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Prof. Biju Kumar, A. currently serves as Professor and Head of the Department of Aquatic Biology and Fisheries, University of Kerala. Earlier he functioned as Dean, Faculty of Science and Director of Research, University of Kerala, Scientific Officer in State Committee on Science, Technology and Environment (STEC), Govt. of Kerala and Member Secretary (in-charge), Kerala State Biodiversity Board. Dr Biju is the member of IUCN Species Survival Commission and in various expert committees related to biodiversity. Dr Biju's research areas include marine biodiversity and taxonomy and impacts on marine biodiversity, including climate change, invasive species and microplastics. He has published over 200 Research Papers in peer-reviewed journals and 24 Books and serves as the Editor in Chief of the Journal of Aquatic Biology & Fisheries. He has described over 30 new species/genus of marine species from reef-ecosystems and elsewhere.

Abstract: Coral reefs are one of the most diverse and productive ecosystems in the earth, ensuring a multitude of ecosystem services, including protecting the coastlines from erosion and supporting over one-quarter of marine species globally. In India, the coral reef ecosystems with about 500 coral species, are distributed in 2,375 km^2, primarily along the Andaman and Nicobar Islands, Gulf of Mannar, Gulf of Kutch, Palk Strait and the Lakshadweep islands. The coral reefs in India support thousands of fishers' livelihood in both islands and mainland, besides ensuring nutritional security of the coastal populace. Besides about 1,000 species of fish, the coral reef ecosystems in India, particularly in the Gulf of Mannar and coral islands, remain as the primary source for commercially valuable molluscs such as pearls and sacred chanks, crustaceans, echinoderms and seaweeds. The coral reefs and associated biodiversity are under increased pressure from global climate drivers, land-based anthropogenic interventions, and overharvesting practices. This paper fundamentally addresses the question: Will the coral reef ecosystems in India

in the Anthropocene sustain the fishery resources and fishers' livelihood in the coastal belt? This question is framed based on the specific characteristics of coral reef-associated fishes, the dependence of the biology of fishes on the health of the ecosystems, functional role of reef fishes, and impacts of climate change and other natural and anthropogenic drivers on coral reef fisheries. The paper also explicitly analyses the climate change impact and the resultant coral bleaching on coral reef fishes, including effects on trophic linkages, distribution and stock structure and connectivity, reproduction and larval development, and migration patterns and behaviour. The paper highlights the limitations of current fisheries management strategies focusing on a few climate-driven factors and highlights the need for holistic data support to frame better projection models for management and adaptation to climate change. The paper also highlights the neglected role of community-based decision making systems and the use of a sustainability window that would support conservation paradigms, promote social-ecological resilience, and extend the coverage of Marine Protected Areas to ensure the sustainability of fisheries resources.

T2S3ORAL01

Accumulation of Heavy Metals in Some Aquatic Vegetation and Crustaceans at Lower Part of River Hooghly

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The aquatic environment is always susceptible to get polluted with diverse substances coming from a variety of sources adversely affecting the aquatic life and the ecosystem. The holy river Ganga is no exception, threatened by different pollutants mostly contributed by sewage discharges. In the present study, we have assessed the accumulation of heavy metals (Cd, Cr, Ni, Pd, Fe & Zn) in river water, sediment, aquatic vegetations (*Eichhornia sp., Hydrilla sp. & Myriophyllum sp.*) and crustaceans (*Macrobrachium rosenbergii & Scylla serrata*) from five sites (Titagarh, Adyapith, Ghusuri, Botanical garden & Godakhali) at lower stretch of river Hooghly. Cadmium was below the detection level (BDL) in water but detected in sediment, aquatic vegetation and crustaceans at average concentration of 4.37 mg kg^{-1}, 1.74 mg kg^{-1} and 3.2 mg kg^{-1} respectively. Chromium was detected at an average concentration of 0.028 mg l^{-1} in water, 51.23 mg kg^{-1} in sediment, 5.55 mg kg^{-1} in aquatic vegetation and 3.82 mg kg^{-1} in crustacean. Nickel was found present in water (0.004 mg l^{-1}), sediment (3.59 mg kg^{-1}), aquatic vegetation (1.95 mg kg^{-1}) but was BDL in crustacean. Like Cd, Pb was at BDL in water, but accumulated in sediment, aquatic vegetation and crustacean. The average Zn concentration was 0.001 mg l^{-1} in water, 62.28 mg kg^{-1} in sediment, 284.128 mg kg^{-1} in aquatic vegetation and 25.35 mg kg^{-1} in crustacean. Iron was present in all the components at much higher level than Zn. Concentration of elements detected in water was within the USEPA recommended limit of water quality Criteria for Aquatic Life except Fe and Zn. The sediments were moderately polluted with Cr and Cd and other elements were below the USEPA guideline for sediments. However, concentrations of Cd, Cr and Pb were above the USFDA safe limits for human consumption. The authors recommend further elaborative studies in this area and suggest strong measures to control the point and non-point sources of entry of pollutants into the river to maintain the sustainability of the ecosystem.

T2S3POS01

Consequences of Pollution on Fishes and Marine Ecosystem

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The ocean is home for millions of marine species and creatures. Marine ecosystem contributes significantly for the human life through securing livelihood to 10-12% of world's population and provide cheap source of nutritional food to nearly 80-85% of people around globe by supplying 16% of proteins. However, the healthier and wealthier marine ecosystem is under stress due to anthropogenic activities like pollution. Marine pollution occurs when potentially harmful things enter into oceans which degrade the water quality and leave harmful impacts on marine ecosystem. The marine environment gets polluted through various manmade sources such as domestic waste, industrial effluents, agricultural runoff, ocean mining, oil spills, plastic pollution, shipping emissions, radioactivity, waste and noise pollution, etc. The changes in physico-chemical parameters of water were reported due to pollution in aquatic environment. Also, the pollutants have direct and indirect effects on the behaviour of terrestrial and aquatic organisms especially in fish. On the basis of duration and level of pollutant discharged in marine environment, the effects on the marine organisms are categorised as acute and chronic. The acute effect includes mass mortality of marine organisms; while chronic effect includes retarded growth, outbreak of diseases, failure in reproduction etc. The coastal marine environment around the globe is under insistent stress due to urban development, hazardous substances, habitat destruction and natural toxins causing serious threat to marine organisms and posing public health risk. Globally, the initiatives were taken to protect the marine environment from anthropogenic activities through the Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter (London-Dumping Convention), UN Convention on the Law of the Sea (LOSC), Global Programme of Action (GPA), International Convention for the Prevention of Pollution from Ships (MARPOL), International Convention for the Prevention of Pollution of the Sea by Oil (the "OILPOL Convention"), The London Convention and Greenpeace organization, etc. To overcome the problem of pollution there should be proper and adequate waste management, promotion of the environmental impact assessments to ensure an acceptable level of environmental quality, implementation and enforcement of acts and policies for regulation of environmental pollution, etc. Every individual has to adopt Green Life style to reduce marine pollution by properly disposing the wastes, properly treating the industrial effluent, avoid littering garbage in the sea, follow organic farming, undertake clean-up activities and use of renewable source of energy.

T2S3POS02

Impact of Commercial Cultivation of *Kappaphycus alvarezii* in Palk Bay on Coral Reefs of Palk Bay and Gulf of Mannar, South India

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Kappaphycus alvarezii, a red seaweed cultured in tropical waters for extraction of carrageenan, is widely considered a bio-invader of coral reefs. In India, this seaweed is cultivated in Palk Bay, South India by the coastal community amidst the concern of its invasion in the sub-tidal reef regions of adjoining Gulf of Mannar Marine National Park (GoMMNP). The current paper reports the extent of coral reefs in Pak Bay and Gulf of Mannar (GoM) affected by this red alga based on extensive field survey. The study was carried out in Palk Bay and 19 emergent and 2 submerged Islands of GoM. The reef zones with *K. alvarezii* were mapped using GIS. The study showed that *K. alvarezii* has not spread over the coral reefs in Palk Bay, a region where the cultivation is underway for over ten years. Nevertheless, the algae had spread in some of the islands in Gulf of Mannar region. The temporal change in the extent of live corals (between 2002 and 2014) in Palk Bay and GoM corroborated a possible phase shift i.e.,from a coral dominated reef to an algal dominated reef, with *Halimeda* spp., *Caulerpa* spp. and *Ulva reticulata* being the dominant macro-algae. The paper provides an evidence-based commentary on the possible causes for the spread of algae in GoM, based on a critical analysis of the sourcesof fragments for the spread of the alga in GoM and the factors that aid in their dispersion. The study calls for evolving codes for cultivation of seaweeds so as to leave least ecological footprints over the coastal ecologically sensitive ecosystems like coral reefs.

T2S3POS03

Feedback loop between Parrot fish and Coral reef

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Reef dwelling crunchy parrotfish may bring one's attention rather than most of other reef fishes by their own exclusive ecological as well as economical services they provide to our world. The parrot fishes are key grazers on coral reefs as well as bioeroders dominating the reef sediment production. They primarily feed on dead corals, rubble substrate and algal turfs. Rise of sea surface temperature and frequent El nino phenomena lead to coral bleaching leaving the psychedelic coral ecosystem into barren land. Researches indicate that bleached corals are immediately colonized by microalgae and cyanobacteria which create an internal and external layer of scunge that provides abundant food and nutrition for the parrot fish. The highly prized, herbivorous and corallivorous Bump head Parrot fish, *Bolbometopon muricatum* is the largest parrot fish in the world, categorized as Vulnerable on the IUCN Red List. They enhance the coral growth and recruitment by balancing between coral erosion and calcification by preventing macroalgae growth and maintaining sediment flow in the reef. The investigations led by Wildlife Conservation Society-India on the bump head parrotfish was done in Andaman and Nicobar archipelago of India between 1995 to observed that the presence of a protected area, live coral and algal cover significantly

influenced the distribution and abundance of *B. muricatum*. Being an important protein resource it's consumed by people in many parts of the world. Often they are considered to address iodine deficits in highland communities. Investigating the ecological impacts of extirpation of large parrot fishes due to over fishing in the time of global warming and climate change, the paper argues for focused management and further research for the conservation of Parrot fish species of Andaman, especially in degraded reef areas.

T2S3POS04

Change Detection of Water-Inundated Areas of Pirotan Reef, India using Object Based Image Analysis

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Coral reefs are ecologically valuable resources to humankind. The coral reef ecosystem is degrading for the last few years due to human and natural disturbances. There is a need for conservation of coral reefs for better coastal ecosystem management. In most cases, causes of degradation have been thoroughly studied for global and Indian reefs. However, the reef-specific, geospatial solution towards conservation efforts for reef ecosystems is largely missing in Indian scenarios. Here in this study, we have identified the micro-conservation area for the Pirotan Reef from the Gujarat coast of India using change detection analysis on Indian satellite data. Water inundated area is critical for microhabitat maintenance in a coral reef environment as this zone has maximum diversity and abundance of corals. This zone provides a suitable condition for corals to grow and continue their physiological processes. Water inundation in a reef environment essentially changes with the tidal amplitude and exposure patterns, especially in a macro-tidal environment like Gulf of Kachchh in Gujarat coast. Local seasons also have a bearing on the inundation and exposure pattern. We have selected high-resolution, low-tide LISS-IV images (Linear Imaging Self Scanner-IV sensor) from Resourcesat-2 satellite for three consecutive years: 2016, 2017, and 2018 for this study on Pirotan reef. We identified water inundated areas (which includes the tidal pool and turbid water on the reef) using object-based image analysis. The different rule sets were generated to determine the reef's water inundated area, it achieved high accuracy (91.42%). This analysis is carried out on the spatio-temporal scale to identify the changes. We calculated the extent of change in inundation area by estimating the extracted area for tidal pool and turbid water. To identify the water conservation zones, the common water inundated area was calculated, which remained constant throughout the study years. We also tried to correlate water inundated area with coincident tide levels during the image acquisition to understand the correlation between tide levels and extent of inundation. Tide level and water inundated area show a high correlation (0.95). We generated two scenarios with 10 m and 30 m buffer around the common water inundated area to propose micro-conservation area within this reef. This area can be considered for protection and conservation within the reef. This study demonstrates a geospatial analytical technique to identify conservation areas specifically for reef benthos within a reef that experiences semi-diurnal tidal desiccation.

Theme II:

Technological developments in fisheries, livestock and poultry management, water pollution trends, and ecological security for coral reefs, farming system modules

SESSION IV:

Livestock& poultry: technological innovations & options for management and production developments

T2S4I01

STRATEGIES FOR DEVELOPMENT OF LIVESTOCK SECTOR IN INDIAN ISLAND REGIONS

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Dr. Anandamoy Kundu, born on 1st January,1961 was an Ex-Director (Acting), ICAR-CIARI, Port Blair and ex-faculty members of Veterinary Physiology and Climatology Division, as well as Poultry Science of IVRI, Deemed University, Izatnagar, qualified as M. V. Sc. & Ph.D. in Poultry Science from IVRI (Deemed University), Izatnagar. He worked also as Head Animal Science Division, ICAR-Central Island Agricultural Research Institute located at A & N Islands having more than 30 years of experience as Scientist in ICAR institutes besides worked as a Veterinary surgeon in West Bengal for about 3 years. He is experienced in working under Indian island ecosystem and agriculture in both Andaman and Lakshadweep Islands since 1999, and completed 8 external and 23 institute funded projects as PI and CO-PI. He has published more than 171 research papers in reputed national and International journals besides having 20 published books in his contribution. Presently Dr. A. Kundu has taken up the assignment of Professor Veterinary Science cum controlling officer and Project Director (RGM) of Animal production research Institute, RPCAU, Pusa, Samastipur, Bihar.

His major achievements include Documentation, characterization and conservation of precious indigenous goat, pig and poultry germplasm of Nicobar group of islands for sustainable livelihood and Nicobari fowl, Nicobari pig and Teressa Goat have been identified and registered. He has developed various improved varieties of livestock and poultry namely Crossbred cattle and buffalo, Boer cross goat, Nicorock, Nishibari, Dweep Raja, Dweep Rani and Dweepika. He has also made significant contribution in Development of Livestock Disease Map and forecasting module for incidence of livestock and poultry diseases in A&N Islands. He is a recipient of ICAR Team research award for Island Livestock Development activities.

Abstract: In Andaman, livestock farming is considered to be a profitable complementary enterprise and constitutes an important activity for accelerating the rural economy of the union territory. The livestock farming is done in the areas that have been cleared from the forest regions of the island. The share of island livestock in the value of output of island agriculture and allied activities is more than 30%. The milk is the main output of livestock sector accounting for 66.7% of the total value of output of livestock. Meat and egg shares are 17.5% and 3.6% of the value of livestock output. Three genetic groups of cattle are available in these islands namely- Trinket cattle (<500), Local cattle, Crossbred cattle (cross of local cattle with Jersey / Holstein). The buffaloes are mongrel population which constitutes the inheritance of Murrah, Nagpuri, Bhadawari, Marathwada and nondescript population. They are water buffaloes and poor milk producer. Goats constitute 42.21% of the total livestock. The available goats are as follows: Andaman Local Goat, Feral/semi feral goat, Teressa goat, Malabari and its crosses. The local goat resembles Black Bengal and are well adapted to the island condition. Feral and semi feral goats are available in Barren islands. Teresa goat is found in southern group of island. These goats generally resemble the Kambing

Katchang of Indonesia. Malabari goat was introduced from Kerala and Tamil Nadu during 7th five-year plan. These goats were mainly introduced for upgradation of indigenous goats. Pigs constitute 23.21% of the total livestock and are mostly owned by tribes. There are four distinct populations of pigs available in these islands viz. Nicobari pig, Andaman Wild pig, Local/Desi pigs, Large White Yorkshire and its crosses. Poultry germplasm available are mostly non-descript except a few indigenous birds such as- Nicobari fowl, Frizzle fowl, Naked neck, Aseel, Barred desi, Red jungle fowl, Indigenous birds are well adapted to the Island ecosystem.

The island animal husbandry activities are barely 150 years old. With the settlement of penal colony by Britishers, livestock farming came into existence to meet out the demand of meat and milk. The existence of Animal Husbandry is traced back to 1947 and became independent functioning for the first time in 1952. The farming system of the island by default is organic and the animal husbandry is practiced in integration with agriculture. In 1980s the department of Animal Husbandry and Veterinary Services (AH&VS), A&N administration introduced cross breeding programme to improve the local/desi cattle through Artificial Insemination technology using pure bred semen of Jersey and Holstein Friesian cattle. Out of 38 islands, 12 islands have no livestock and another 4 islands have a population less than 200 numbers. The North, South and Middle Andaman have major chunk of livestock in Andaman group of islands and Car Nicobar, Katchal are the centres having more concentration of livestock in Nicobar group of islands. The economically important farm animal genetic resources comprise of cattle, buffalo, goat, pig and poultry. Among them, Nicobari fowl, Nicobari pig and Teressa goat are the important indigenous germplasm of the islands.

The per capita availability of 225.2 eggs per person annum^{-1}, of meat 1.20 kg annum^{-1} and for milk is 110 g day^{-1} per person where as ICMR recommendations per person per annum are Meat: 11 kg; Eggs: 180 numbers; Milk: 280 ml per person day^{-1}. Hence there is huge gap. The paper details about the strategies to tackle and mitigate the problems to overcome this.

T2S4I02

GENETIC RESOURCES OF LIVESTOCK & POULTRY IN COASTAL ECOSYSTEMS OF INDIA

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Dr. Ajoy Mandal is presently working as Principal Scientist in Animal Genetics & Breeding division at ICAR-NDRI, ERS, Kalyani, Nadia, West Bengal. He obtained his Bachelor of Veterinary Science and Animal Husbandry degree from Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, West Bengal in the year 1993. Subsequently, he received his PhD degree from National Dairy Research Institute, Karnal, Haryana in the field of Animal Genetics & Breeding in the year 1998 and earned his postdoctoral from INRA, France in 2006. He is having 25 years of research experience in the field of Animal Genetics & Breeding. He is primarily involved in the research with large ruminants, which deals with use of theory and computer analysis of data for genetic evaluation of animal. Particular

areas of interest include breeding and management systems of cattle and genetic improvement of production and reproduction traits. Earlier he worked on genetic evaluation of production and reproduction traits of goat and sheep. He has also been engaged in the study of disease resistance of these species and molecular characterization of goat genetic resources. He has received several awards and honors. He is serving as an editorial board member of several reputed journals & expert Reviewer for different national and international journals. Dr. Mandal has published more than 125 research papers in peer-reviewed national and international journals and is an author of several book chapters. So far, he has guided 12 M.V. Sc / M. Sc students and two Ph.D. students.

Abstract: Coastal ecosystem commands the world's highest importance by virtue of their biological diversity and productivity. Animal husbandry has an important role along with agricultural activities and provides considerable income for the farmers of coastal regions. The vast population and diversity of livestock in the coastal India could prove to be a vital asset for the country and a sustainable livestock production system will continue to propel coastal agriculture through sound integration. The Coastal region of India is enormously rich in animal genetic diversity, which includes 35 well recognized livestock and poultry breeds. Coastal region constitutes about 14.2% of total Indian landmass of the country, but the region possesses 19.5% of the livestock population of total Indian livestock. The coastal region of India is mainly dominated by cattle followed by goat, sheep, buffalo and pig. The cattle and buffalo population in coastal region of India is 19.41 and 9.08 million, respectively in 2019 and there was 6.5% reduction in population size of these species as compared to cattle population (20.79 million) and buffalo population (9.71 million) in 2012. The coastal region registered a significant increase for sheep and goat population in the tune of 16.6 (from 8.73 to 10.18 million) and 7.8% (10.48 million to 11.29 million) from 2012 to 2019, respectively. Further, highest decrease (17.6%) in the population size of pig was observed from 2012 to 2019 in these coastal regions. This region also registered significant increase in the share of poultry from 17.6 per cent in 1992 to 23.6 per cent in 2003. Andhra Pradesh and Tamil Nadu which comprise long coastal areas have emerged as the powerhouse of poultry production. Cattle breeds like Gir, Kankrej, Tharparkar, Dangi, Ongole, Vechur, Malnad Gidda, Shweta Kapial, Umblachery, Kokan Kapila, Amruth Mahal, Hallikar, Ghumusari and Binharpuri are available in the coastal regions of India. Jersey and Jersey crossbreds are also found in some coastal regions. Different buffalo breeds like Banni, Jaffrabadi, Mehasana, Murrah and Surti are found in coastal region of Karnataka. Chilika and Gounti /local breeds of buffalo are available in coastal regions of Odisha and Karnataka, respectively. Small ruminants play an important role for rural economy of coastal regions of India. Goat breeds like Ganjam, Gohilawadi, Kutchi, Mehasana, Konkan Kanyal, Kannai Adu, Attapay Black, Teressa and Black Bengal are prevalent in different coastal areas of the country. The coastal habitats of sheep breeds like Ganjam and Kendrapara in Odisha, Patanwadi and Marwari in Gujrat, Nellore in Andhra Pradesh, Chevadu, Kilakarsal, Madras Red, Vembur in Tamil Nadu and Garole and Chottanagpuri in West Bengal cover large areas in these coastal regions. Backyard poultry such as Ankaleshwar, Danki, Kalasthi, Bursa, Haringhata Black, Nicobari, Tellichery, Giriraja and dual purpose poultry birds are boon to rural areas of coastal regions. Crosses of Yorkshire, Agonda Goan and Nicobari pigs are identified as suitable breed for coastal tropical humid climate and popularized. Horse breeds like Kachchhi-Sindhi, Kathiawari, Marwari and Kutchi are found in the coastal regions of Gujrat. Halari and Kachchii donkey breeds are also found in coastal region of Gujrat. Coastal ecosystem of the country, especially the east coast, is more prone for the natural disasters like cyclones, tsunamis, sea rise etc. while the West coast faces problems such as heavy rainfall, sea-water intrusion, causing severe damage to agricultural crops as well as livestock. Livestock in these regions are more susceptible for stress due to the climate change and leads to the outbreak of the vector borne diseases. Shortage of feeds and fodder and availability of quality germplasm for breeding of the animals are the major constraints for livestock development in coastal regions of India. Some of the local coastal germplasms are in the verge of on extinction (eg: Ongole breed of Coastal Andhra and Vechur cattle breed of Kerala) due to non-scientific breeding practices and need immediate intervention. Due to high human population density and influx of floating population, there are more threats in the form of outbreaks of diseases and recurrence of infectious diseases. To increase the productivity of the livestock to achieve the self-sufficiency for the coastal regions, efforts are to be made adopt better breeding practices among the livestock, improve the feed and fodder sources, health care facilities, support rural poultry and piggery development.

T2S4I03

RESPIRATORY DISEASE COMPLEX IN POULTRY: DIAGNOSIS AND CONTROL STRATEGIES

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Abstract: Diseases affecting the respiratory system continue to present a significant challenge to the health management of poultry flocks and constitute an important cause of economic loss to the poultry industry in terms of mortality, impaired growth, reduced egg production and egg quality, condemnations etc. Respiratory disease in poultry is often the result of a combination of primary and opportunistic infectious agents. In addition, adverse environmental and management conditions play an important role in the multifactorial nature of respiratory disease in poultry. Although primary respiratory infectious agents can cause serious disease on their own, more often uncomplicated infections with these agents are mild and transient. It is when these primary infections become complicated with opportunistic bacteria that more serious and chronic respiratory disease results and the most economic loss is incurred. Primary agents in poultry include viral agents like infectious bronchitis virus, Newcastle disease virus, infectious *laryngotracheitis* virus, avian influenza virus and pneumovirus, and bacterial agents like *Mycoplasma gallisepticum, Haemophilus paragallinarum, Pasteurella multocida* and *Ornithobacterium rhinotracheale*. Some of the bacterial agents like *E. coli* may act as both primary and opportunistic invaders depending on the situation. Non-infectious causes are significant contributors to respiratory disease, either by increasing transmission and spread of the pathogens or by creating unfavourable conditions which result in increased stress for the bird or damage to the respiratory tract. Diagnosis and various methods of control that have been used to minimise the economic effects of respiratory disease complex will be discussed.

T2S4I04

LIVESTOCK DISEASE MANAGEMENT IN COASTAL AREAS OF INDIA

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Abstract: Indian livestock sector is progressing over the years and occupied first rank in global scenario. But livestock diseases are potential threats for the developments of this sector. In addition, the coastal areas suffer from tropical cyclones causing extensive damage to the livestock sector. Many endemic diseases are also caused by transboundary infectious pathogens and about 60-70 percent of the infectious diseases are zoonotic in nature. Govt of India has taken initiatives to control important endemic livestock diseases but sufficient awareness and diagnostic facilities are not readily available for many diseases which are causing significant loss to livestock farming. Further, in coastal areas, higher temperatures and greater humidity favours growth of parasites and pathogens that spend part of their life cycle outside the host. It is known that Leptospirosis occurrence is more in coastal areas of India. The are several serovars affecting livestock, causing a variety of diseases like abortion, infertility, mastitis and jaundice resulting in significant loss in livestock farming. Very often diseases are not diagnosed because of insufficient diagnostic facilities. The pathogens are also shed into the environment, infect humans causing serious illness. NCDC has taken initiatives for improving medical diagnostic facilities but veterinary diagnostic facilities are limited and need to be improved. Vaccination, biosecurity measures and disease surveillance and management are very important to control diseases and improve livestock health security, especially in coastal areas.

T2S4POS01

Iron Binding Ability of Exopolysaccharides Producing Lactic Acid Bacteria in Whey, a Dairy By-Product

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Whey is by-product obtained during preparation of chhana and paneer. It is light greenish coloured watery liquid, which is rich in lactose and contain some amount of proteins and minerals. It is produced at both industrial and domestic level but the lack of economic processing interventions forces it to be discarded as a waste, mostly at the domestic level. Recently some industries have launched whey based beverages by flavouring it with spices and condiments. This indicates about the possibility of developing a micro-nutrient supplemented whey based beverage. Iron is an essential micro-nutrient primarily involved in oxygen transport from lungs to the various tissues in our body. Deficiency in iron content in the human beings results either from excessive loss from the body or low dietary intake of iron. Recent reports on increasing the iron bioavailability from food suggests that ingesting iron in complexed form has higher bioavailability as compared to free iron in the product. Therefore, the present investigation was carried out to explore the iron binding ability of exopolysaccharides (EPS) producing lactic acid bacteria (LAB) by their growth in whey as an economic medium to prepare EPS-iron complex. Four iron salts and eight EPS producing cultures were tested for their suitability to prepare iron complex in whey. A non-EPS producing LAB *L. rhamnosus* NCDC24 was considered as control. Samples containing iron complex were evaluated for complexed iron content, colour parameters, acidity, pH, tyrosine value and total lactic count. Complexed iron content of EPS producing *L. rhamnosus* Kar1 was about eight times higher than non-EPS producing *L. rhamnosus* NCDC24. The iron complexing ability of EPS producing LAB strain varied with the iron salt and ranged between 35.01-65.49%, 28.14-59.63%, 21.57-43.6% and 20.11%-41.81% for ferrous sulphate, ferric pyrophosphate soluble, ferric chloride and ferrous ammonium sulphate, respectively. Among the EPS producing LAB strains, *L. rhamnosus* Kar1 had highest iron binding (65.50%) with ferrous sulphate. The EPS from *L. rhamnosus* Kar1 was also extracted from whey and tested for iron binding activity in distilled water. Iron binding of EPS in distilled water was higher (75.29%) than that from whey. In addition, in situ approach had higher iron binding activity in whey than ex situ approach. Considering the obtained results, *L. rhamnosus* Kar1 and ferrous sulphate was selected for further studies to optimize the iron binding in whey by glucose content, iron level and incubation time. The optimized growth conditions such as 11% glucose, 14 h incubation time and 20 ppm iron concentration were found to enhance the iron binding ability of *L. rhamnosus* Kar1 to 81.20%. These finding implies that iron fortified whey beverage with higher bio-available iron content can be developed by suitably spicing the whey containing EPS-iron complex.

T2S4POS02

Livestock-Based Farming Systems in Saline Areas of West Bengal

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Salinity issues constrain both the agricultural and economic development. Salinity causes a hostile environment for the normal crop production throughout the year in the coastal belt of India. Saline soil identified as soil with Electro

conductivity (ECe) of more than 4 dS m^{-1} with the exchangeable sodium percentage (ESP) less than 15 and soil pH less than 8.5 (US laboratory, 1954). It has been estimated that worldwide 20 per cent of total cultivated and 33 per cent of irrigated agricultural lands are afflicted by high salinity (Shrivastava and Kumar, 2015). Furthermore, the salinized area are increasing at a rate of 10 per cent annually for various reasons and 50 per cent of the arable land would be salinized by the year 2050 (Jamil *et al*., 2011). Salinity is one of the most brutal environment factors limiting the productivity of crop plants because most of the crop plants are sensitive to salinity caused by high concentrations of salts in the soil, low organic matter (1-1.5%) and deficiency of micronutrients. Livestock population can also be affected by salinity. Due to high dependence on salinity affected fodder crops, livestock are affected by many negative consequences such as diarrhea, skin diseases, liver fluke, loss of body weight and break down of immune system (Alam *et al*., 2017). Due to water salinity and absence of potable water dairy animal do not achieve optimum growth and health standards result in poor productivity. Tolerance of the saline water varies between livestock species. Pregnant, lactating, and younger classes of livestock are less tolerant than mature dry stock. For optimum production in these classes of livestock, water supplies should not exceed the optimum salinity levels in the food for livestock (Schubert *et al.*, 2009). To understand the impact of salinity on livestock based farming systems, a study was conducted in coastal areas of West Bengal. Most prominent livestock based farming systems in this area were sheep based and goat based farming system. Very little inputs are required to rear these small ruminants and they can easily adapted the harsh environment in coastal saline region. Number of cross breed cattle was less than indigenous one may be due to the same reason of adaptability. Due to rearing of indigenous cattle milk production in this area was much lower than the normal areas. Among the crops mostly rice was cultivated due to low lying area and most of them was consumed with in the household hence very little marketable surplus. Thus, people are mostly dependent on livestock to earn their livelihood.

T2S4POS03

Basic Blood Indices, Serum Biochemical Profiles, Antioxidant and Oxidative Stress Profiles of Andaman Local Buffaloes at Different Stages of Reproduction

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Andaman and Nicobar Islands have non-defined and non-descriptive breed of buffaloes. Andaman local buffaloes are distributed in Andaman group of Islands and few numbers are available in Campbell Bay and Nicobar group of Islands. Andaman local buffaloes are non-descriptive and represent an admixture of different Indian breeds that had been brought to these islands in different phases of inhabitation and rehabilitation of migrated people. It is believed that the Andaman local buffaloes have the inheritance from Murrah, Nagpuri, Bhadawari and Marathwada. It is unique buffalo, well adapted to special type of tropical humid island climatic and environmental condition. The present study was designed to standardise the normal reference haematological and biochemical ranges in different stages of reproduction of Andaman local buffaloes which were maintained in the Andaman Districts of Andaman and Nicobar Islands, India. In this study, haematological parameters, biochemical induces and antioxidant and oxidative stress profiles were estimated in healthy, normal physiological Andaman local buffaloes in different reproductive stages. The present study results clearly indicated that the values of haematological, biochemical and antioxidant profiles were fall under the normal physiological ranges. These results of this study may serve as the reference values in which alterations due to metabolic, nutrient deficiency, physiological and health status can be compared for diagnostic and therapeutic purposes for Andaman local buffaloes in Andaman and Nicobar Islands and its neighboring countries or other parts of the country with similar environmental and climatic conditions.

T2S4POS04

Exploring the Population Diversity and Ancestry of Nicobari Fowl Using Complete D-Loop Sequences of Mitochondrial DNA

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Nicobari fowl (*Takniethyum*) is aborigine of Nicobar group of islands. They are relatively more resistance to common poultry diseases. In this study, the genetic diversity, population structure and ancestry of Nicobari fowl were analyzed using generated D-loop sequences of mitochondrial DNA (MK847522- MK847566 and MT468825-MT468884). In Nicobari fowl, analysis of complete D-loop sequence (1231-1232 bp) shows 46 polymorphic sites result in 26 haplotypes with overall haplotype diversity of 0.895 and nucleotide diversity of 0.0064 using DnaSP. AMOVA analysis of two datasets based on plumage and spatial populations of Nicobari fowl reveals maximum amount of total genetic variation exist within population (i.e) 92.9% in plumage and 77% in spatial datasets rather than among the populations using ARLEQUIN. The Tajima's D test and Fu's FS test indicates no significant deviation from neutrality. Also the multimodal pattern of mismatch distribution in both demographic and spatial expansion suggests that the Nicobari fowl populations are in equilibrium. The Mantel test correlation was non-significant ($r = -0.058624$, $p = 0.6580$) indicating lack of support for isolation by distance process between different spatially isolated Nicobari fowl populations due to human intervention. The Median-Joining (MJ) networks tree constructed using D-loop sequences of Nicobari fowl with reference sequence using PopART reveals the haplogroups A, B, E1, E2, F & I in Nicobari fowl population. The major haplogroup in Nicobari fowls is E (60%), which is found mainly in the Indian sub-continent region. The phylogenetic analysis of D-loop sequences of Nicobari fowl with jungle fowl using ML method of MEGA6 infers that the Indian red jungle fowl, sub species (*G. g. murghi*) as ancestor of Nicobari fowl. This population genetics study will help in breeding and conservation of Nicobari fowl, and also for development of location specific chicken variety using Nicobari fowl as parent line instead of exotic breeds for backyard poultry farming.

T2S4POS05

Flaxseed Oil on Endocrinological Profiles and Scrotal Biometric Attributes in Indigenous Bucks of Andaman and Nicobar Islands

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Teressa and Andaman local goat breeds are indigenous goat germplasm of Andaman and Nicobar Islands. Effect of feed supplementation of Flaxseed oil (FSO) on endocrinological profiles & scrotal and testicular biometrics in different seasons was studied in bucks. The experimental animals were divided into two groups, Gr I: Control (n=6) and Gr II: Treatment (n=6; Flaxseed oil @ 15 mL day^{-1}). FSO was supplemented through oral drench in the morning hours just before concentrate feeding. Endocrinological profiles such as follicle stimulating hormone (FSH),

luteinizing hormone (LH), testosterone, cortisol and thyroxin and scrotal circumference (SC) & testicular biometrics were measured in both groups in different seasons. Blood FSH, LH, testosterone and thyroxin concentration were significantly ($p < 0.05$) increased and cortisol concentration was significantly ($p < 0.05$) decreased in FSO supplemented group than in unsupplemented control group. Similarly, SC and testicular biometrics were increased significantly ($p < 0.05$) in supplemented than unsupplemented group for different seasons and significantly ($p < 0.05$) higher in rainy than in dry summer season in the experimental groups. It can be concluded from the study that supplementation of FSO can effectively be utilized to improve the scrotal and testicular attributes and endocrinological profiles and fertility status of the indigenous goat breeds of Andaman and Nicobar islands.

T2S4POS06

Exogenous Melatonin Effect on Endocrinological and Biochemical Profiles in Post Partum Anestrus Andaman Local Buffaloes in Humid Tropical Island Ecosystem

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Andaman local buffalo (ALB) is distributed in Andaman districts and few numbers in Nicobar group of Islands. It is a unique buffalo, well adapted to special type of tropical humid island climatic and environmental condition. ALB is suffering infertility due to anestrus in dry (summer) season in Andaman and Nicobar islands. Therefore, this present study was conducted to assess the effect of slow release subcutaneous exogenous melatonin (MT) implant on hematological, endocrinological profiles, biochemical and antioxidant & oxidative stress profiles in anestrus buffalo cows during summer season to improve its reproductive efficiency. Buffalo cows (5-7 years of age) were selected and divided into two groups, Gr I: Control (n=6) and Gr II: Treatment (n=6; MT implant @ 18mg/50 kg B.Wt). Hematological profiles, endocrinological profiles [cortisol &prolactin], biochemical profile [total protein, albumin, globulin, glucose and total cholesterol], antioxidant profiles [total antioxidant capacity (TAC), catalase (CAT), glutathione (GSH) and superoxide dismutase (SOD)] and oxidative stress profile [malondialdehyde; MDA] were estimated. Analysis revealed that these experimental profiles differed significantly between treatment and control groups. Blood profiles revealed that the anestrus buffalo suffered severe macrocytic hypochromic anemia with increased leukocytosis and MT has improved the health status of reproductive system and whole body systems. Cortisol and prolactin levels were lower in MT treated than in untreated control. Similarly, antioxidants were higher and oxidative stressor was lower in MT treated than in untreated control group. Biochemical profiles were increased in MT treated than in untreated buffalo cows. It concludes that exogenous slow-release MT had significant beneficial effects in improvement of the antioxidant profiles, minimization of oxidative stress with cascading beneficial effects on endocrinological profiles, biochemical and hematological profiles, which will improve the cyclicity and fertility rate in anestrus buffalo during summer season in humid tropical island ecosystem.

T2S4POS07

Garole - A Promising Sheep Breed in Coastal West Bengal

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Garole is a highly prolific micro-sheep breed of India whose breeding tract falls under the coastal saline zone of Sundarban, located in the North and South 24-Parganas districts of West Bengal. Generally, this sheep breed is mainly reared for mutton production by small, marginal and landless farmers, with average flock size of 3-5. The breed is famous for its high prolificacy rate, resistance to foot rot disease and high mothering instinct for the lambs. Adaptability to hot humid conditions and in saline marshy land of Sundarban, survivability under low-input system and grazing capability in knee-deep water makes it the breed of choice for the poor animal keepers in this coastal region. In spite of harsh climatic condition and lack of established breeding policy, organized farm or improved management system, this sheep breed is proved to be self-sustainable and constant source of income for the animal keepers in the coastal region for decades. The average weights of Garole sheep at birth, 3, 6, 9 and 12 months of age ranged from 0.06-1.00, 4.1-5.8, 6.0-8.68, 7.81-8.01 and 10.4-14.4 kg, respectively. The average daily weight gain (ADG) of this breed at pre-weaning (0-3 months) age was 32.4 g, while ADGs at post-weaning ages, i.e., at 3-6 month, 6-9 month, 9-12 month and 3-12 months of ages were 22.11, 20.41, 21.93 and 21.28g, respectively. On an average, male lambs attain their puberty at the age of 8-9 months. The highest average litter size of this breed is observed as 1.94 in the third lambing. The incidence of twining is highest (66%), followed by singletons (22%), triplets (11%) and quadruplets (<1%). The optimum age of slaughter is 12 months of age with a slaughter weight of 12 kg. The dressing percentage of this sheep is almost 53% at 12 months of age. This breed produces coarse quality fleece with staple length of 4.99 cm and fibre diameter of 53.02 micron. The fleece has felting property and is used for bedding material but not generally sheared for wool purpose. The original source of the FecB gene from Garole sheep is the major gene responsible for increasing the prolificacy rate of Australian Booroola Merino sheep. In India, this breed is also being utilized to improve the prolificacy rate of various non-prolific sheep breeds like Deccani, Bannur, Patanwadi and Sonadi etc. The population of Garole sheep declined from 0.27 to 0.16 million from 2003 to 2013 in its native tract. Realizing the importance of Garole sheep due to its high fecundity rate and severe decline in population size in its home tract, it becomes utmost important to conserve this unique sheep genetic resources in its home tract. Though, some efforts have been made to improve and conserve this breed both at state and country level, but more developmental programmes involving the stake holders and farmers should be undertaken in this direction for upliftment of the livelihood of poor farmers in coastal West Bengal.

T2S4POS08

Evaluation of *β-casein* (CSN2) for Detection of A1 and A2 Genetic Variants in *Shweta Kapila* Cattle of Goa by Allele-Specific PCR (AS-PCR) and Sequencing

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Goa state is situated in west coastal region which is considered as biodiversity hotspot and harbours diverse flora

and fauna. According to latest 19th Livestock Census, the cattle population of Goa is 87, 722 and among this 60,220 is indigenous non-descript cattle. Recently, an indigenous cattle breed called as *Shweta Kapila* has been recognized and registered with National Bureau of Animal Genetic Resources (ICAR-NBGAR), Karnal, Haryana with the accession number of INDIA_CATTLE_3500_SHWETAKAPILA_03048) by ICAR-CCARI, Goa. These cattle are phenotypically characterized by white body coat which extends from muzzle to tail switch. Short to medium statured animal (height 97 -137cm) with straight face, straight and small horns directed upward and outward, and small to medium hump. Udder is bowl shaped and small to medium in size with cylindrical teats. Daily Milk Yield ranged from 1.8 to 3.4kg with an average of 2.8 kg and lactation milk yield from 250 to 650kg. Population size is approximately 22,000. Beta-casein (*β-casein*) is the most polymorphic milk protein gene with 13 known protein variants. Of these the most frequently observed forms of β-casein in dairy cattle breeds are A1 and A2. A1 *β-casein* (CSN1) has been linked to a range of illnesses as it preferentially releases opioid peptide called BCM-7 (*β-casomorphin*-7) upon digestion and is responsible for various disease conditions such as ischaemic heart disease, diabetes, autism and neurodegenerative disorders. Based on several studies, it is now established that, most of the indigenous cattle breeds express A2 *β-casein* (CSN2). Present study was conducted to evaluate A2 β-casein (CSN2) in Shweta kapila breed by employing Allele-Specific PCR (AS-PCR) and sequencing characterization. In this study, the whole blood in EDTA vials was collected from 25 unrelated Shweta kapila cattle. DNA was extracted and quantified using Nanodrop spectrophotometry. Allele-Specific PCR (AS-PCR) was carried out by using CSN2 specific primers and which revealed the presence of A2 *β-casein* in all animals under the study. This breed possessed both the A2A2 and A1A2 genotypes while A1A1 genotype was completely absent. AS-PCR was found to be effective in distinguishing A1 and A2 alleles. Further, these genotypes were confirmed by Sanger's nucleotide sequencing and found the difference between A1 and A2 *β-casein* variants was single amino acid substitution (CCT→CAT) at the 67th residue of 209 amino acid chain. Genotype frequency of A2A2 and A1A2 were 0.82 and 0.18 respectively. The frequency of A2 allele was observed to be 0.93 while that of A1 allele was 0.07. Chi-square analysis revealed that population was in Hardy-Weinberg equilibrium. Being a sturdy and disease resistant breed possessing A2 *β-casein* variant, *Shweta kapila* cattle are a suitable breed for the coastal region particularly to develop climate resilient, hardy and disease resistant breeds with good quality milk. Further studies may be conducted to characterize and improve this breed of cattle.

T2S4POS09

Study on Locally Available Herbal Vaccine Boosters against Newcastle Disease Vaccine in Rural Poultry in A&N Islands

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The work was taken with an objective to control morbidity and mortality of rural poultry through community based scientific health practicesand thereby to improve the livelihood and farmers income. Four villages viz., Mameyo, Sippighat, Chouldhary&Wandoor were adopted for implementation. Preliminary survey was carried out on existing health status of rural poultry. On the basis of preliminary information, vaccination trial in rural poultry was conducted in the selected villages. Three breeds of rural poultry viz., Nicobari fowl, desi birds and Srinithi were vaccinated against RD (F1) through nasal drop in three villages viz., Indiranagar, Wandoor and Manpur. Each breed comprised of four groups. Group 1: No vaccination; Group 2: Vaccination, Group 3: Vaccination plus herbal aqueous extracts; Group 4: Vaccination plus probiotics. Herbal aqueous extract was prepared with composition of neem leaves @100 g, garlic @10 g, ginger @10 g and turmeric @5 g in one litre of water. It was boiled for 20 minutes, cooled, filtered and watered @ 5 ml per bird. Blood collection was done on 0 day, 14th day and 28th day post vacciantion. The

comparative optical density (OD) values were obtained against RD by ELISA method which is indirectly correlated with antibody titres. The average flock size (nos) was 24.26 ± 2.36. Farmers are rearing desi and vanaraja birds. They annual income was of Rs.11000 per year from rural poultry. Farmers do not vaccinate desi birds. The general clinical symptoms of diseased rural poultry observed by farmers are watery discharge from mouth, nose, green and white colourdiarrhea, sudden death, circling, feather flittering, neck hanging, pox like lesions and swelling of eyes with pus formation. Out of 106 respondents, 81 farmers encounter 100% mortality in rural poultry and they do not have knowledge on Ranikhet disease and Infectious bursal disease. Disease outbreak happens during both dry and rainy season. The vaccination trial revealed that protective antibody titre was observed on 14th and 28th day post vaccination in all treatment groups. Among the treatment groups, herbal supplemented groups showed comparatively more immunity followed by probiotics supplementation. Among rural poultry breeds, vaccinated Nicobari fowl showed highest vaccine titres. Supplementation of herbal boosters comprising of neem@100 gm, garlic@10 gm, ginger@10 gm and turmeric @5 gm on wet matter basis boiled in one litre of water for 20 minutes and probiotics along with Newcastle disease vaccination enhanced vaccination antibody titre by 4-8 folds in rural poultry at field level. Farmers are recommended to supplement these ingredients while vaccinating rural poultry to address the issue of vaccination failure at field level by boosting up the vaccination

T2S4POS10

Antibiotic Resistance Characteristics of the Prevalent Coagulase Negative *Staphylococci Species* Isolates from Bovine Subclinical Mastitis

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Mastitis is one of the most expensive diseases of dairy animals in the world and subclinical mastitis occupies the major proportion of mastitis burden. Subclinical mastitis characterised by increase in the somatic cell count of milk can be diagnosed only by laboratory testing of milk samples. When the clinical mastitis is easy to detect and amenable for immediate treatment, subclinical mastitis (SCM), on the other hand, is an invisible malady and it is mostly neglected. The economic loss due to subclinical mastitis is associated with reduction in milk yield and the average milk yield loss reported was 2.58 litres day^{-1} animal^{-1}. Dairy animals (344 nos.) including cattle and buffalo in coastal states Goa, Kerala and Maharashtra were screened for subclinical mastitis by California Mastitis Test and subclinical mastitis prevalence was found to be 63.37% (218/344). The prevalence of Coagulase negative *Staphylococci* (CoNS) was found to be 37.6% in subclinical mastitis milk samples (80/218). Species identification of CoNS were carried out by biochemical identification using commercial kit and confirmed by PCR sequencing of *16srRNA* gene. Nucleotide sequences of 1500bp *16srRNA* gene were analysed by NCBI Blast and compared with published sequences in NCBI and identified as particular species by 100% identity with published sequences. Nine different species were identified among 30 CoNS isolates which were *S. chromogenes, S. cohnii, S. epidermidis, S. sciuri, S. warneri, S. haemolyticus, S. simulans, S. saprophyticus, and S. hominis*. The CoNS isolates were subjected to antibiotic susceptibility testing against 19 antibiotics of veterinary and medical importance. Highest resistance (resistant and intermediate) was found against Ceftazidime/Clavulanic acid 30/10 µg (76.59%) followed by Penicillin G, 10units (40.43%), Amoxycillin/Clavulanic acid 30mcg (23.4%) Streptomycin 10mcg (17.02%), Methicillin (17.02%) and Ampicillin/Cloxacillin 10mcg (14.89%). The veterinary antibiotics found effective against CoNS isolates were Ciprofloxacin 5mcg (97.87% susceptible), Enrofloxacin 5mcg (97.87%), Levofloxacin 5mcg (97.87%), Gentamicin 10 mcg (95.74%), Ceftriaxone (93.62%), Cephalexin 30mcg (93.62%), Cefoperazone/ Sulbactam 50/50 mcg (93.62%), and Ceftriaxone 30mcg (93.62%). Coagulase negative Staphylococci are a group of gram positive bacteria responsible for various tissues infection and a multitude of diseases in humans. Their disease

potency range from mild infection to fatal diseases like pneumonia, endocarditis, osteomyelitis, gastroenteritis, scalded skin syndrome and toxic shock syndrome. Antibiotic resistance in microbes still remains one of the leading concerns in global public health, and several mechanisms involving mobile genetic elements such as plasmids and transposons, have been shown to contribute to the wide spread and distribution of antibiotic resistant genes among bacteria. Earlier studies have proved that Methicillin-resistant coagulase-negative staphylococci (MRCNS), are more frequent carriers of SCC mec gene (responsible for methylene resistance) than Methicillin-resistant S. aureus (MRSA) and can act as reservoir for resistance genes and ability to transfer them into other serious pathogens such as S. aureus. The present study showed a high prevalence of antibiotic resistance against medical and veterinary antibiotics among the CoNS isolates from subclinical mastitis in coastal region which should not be undermined.

T2S4POS11

Studies on Clinico-Pathological and Molecular Diagnosis of Lumpy Skin Disease (LSD) in Dairy Cattle in West Coastal India

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Lumpy skin disease (LSD) is a re-emerging viral disease globally in recent years causing significant economic losses in cattle due to decreased milk production, infertility, abortions, damaged skins and hides, and sometimes death. Additional losses due to trade restrictions, treatment cost, diagnosis and vaccination costs. The disease is caused by poxvirus lumpy skin disease virus (LSDV) and is 96% antigenically related to goat pox and sheep pox viruses. LSD is characterized by high fever (104°F), lacrimation, nasal discharge, anorexia, leg oedema, enlarged superficial lymph nodes and prominent subcutaneous nodules of 0.5-7 cm on all over the body particularly on neck, face, head, scrotum, perineum, udder and oral mucosa. First outbreak of LSD in India was documented in Odisha in August 2019 affecting 182 of 2,539 cattle with morbidity rate of 7.1% and no mortality. Presently there are limited epidemiological and rapid diagnostic assays to assess the disease. The disease is being controlled by goat pox vaccine as there is lack of homologous vaccine against LSD in India. There is urgent need for developing rapid diagnostic assays as well as need to understand the pathogenesis of the disease in order to develop in-house diagnostics and vaccines. In this study, a total of 50 skin nodular biopsy specimens, 40 whole blood and 40 serum samples were collected from clinical LSD cases and processed for diagnosis of LSD by histopathological and molecular diagnosis by gel-based PCR and TaqMan™probe Real time PCR. Skin biopsies were fixed in 10%formalin, processed for histopathology. DNA was extracted from skin biopsies and whole blood and quantified. PCR detection of LSDV was carried out my targeting envelope protein gene (P32), Fusion protein gene (F) and RNA polymerase subunit (P030). TaqMan™probe Real Time PCR was standardised targeting EEV glycoprotein gene (LSDV126) for rapid diagnosis of LSD from subclinical and clinical cases. Out of 50 clinical cases examined, 46 cattle were showed generalized skin nodules and papules of various sizes (1-6 cm) present all over the body particularly, neck, face, nose, tail, perineum and udder. Four cases showed few small patchy nodules at neck region. Histopathological lesions were characterised by diffuse granulomatous reaction in dermis and epidermis (39/50, 78%), vacuolardegeneration of epithelial cells (15/50,30%), hyperkeratosis (46/50, 92%), spongiosis (34/50, 68%), acanthosis (12/50, 24%), proliferation of keratinocytes, histiocytes and inflammatory cells in dermis and epidermis (46/50, 92%). The most prominent finding was focal to diffuse vasculitis and lymphangitis (39/50, 78%). The inflammatory cell types mainly comprised of eosinophils, neutrophils and lymphocytes along with diffuse necrosis in dermis in chronic cases. The eosinophilic intracytoplasmic viral inclusions in keratinocytes and epithelial cells were detected in 23/50 (46%) cases which were pathognomonic feature of LSDV. PCR assay detected LSDV in 41 out of 50 skin biopsies (82%). Whole blood samples were negative by PCR. Whereas TaqMan™probe assay detected LSDV in all 50 skin biopsy samples (100%) which proved that this assay could be very sensitive and rapid in detection of LSDV from field outbreaks.

Theme II:

Technological developments in fisheries, livestock and poultry management, water pollution trends, and ecological security for coral reefs, farming system modules

SESSION V:

Farming system approach: rice-cum-fish culture & homestead production system including social-forestry

T2S5I01

DEVELOPMENT IN RICE-FISH-LIVESTOCK FARMING FOR HIGHER PRODUCTION AND INCOME IN COASTAL AREAS

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Dr. D. P. Sinhababu has about 37 years of research, training, extension and managerial experiences on integrated farming systems (IFS), specifically rice-fish farming systems, fisheries, aquaculture, and fish reproduction. He has developed two rice-fish-horticulture-livestock based integrated and diversified farming system technologies/ models for rainfed water logged lowlands and deepwater areas. These technologies were/are accepted and supported by Indian government and provincial government of Odisha and Uttar Pradesh. These models were/are being adopted in coastal areas of Odisha and West Bengal. He is also working as Consultant, RKVY, Govt. of Odisha funded Rice based Integrated Farming System Project in coastal Odisha, at ICAR- National Rice Research Institute, Cuttack. He has around 100 publications, including research papers book and proceedings chapters and technical bulletins etc.

Abstract: Around 80% of world rice grown, mostly in Asia, under about 80 million (m) hectares(ha) in irrigated and 60 m ha in rainfed lowland conditions, including deepwater and coastal areas offer a suitable environment for growing fish, prawn, ducks and other aquatic organisms. Rice-fish culture, a Globally Important Agricultural Heritage System, was widely practiced in total 28 countries on six continents during mid - 1900s. This culture system got a setback during mid-1960s for a period of more than a decade due to introduction of high yielding cultivars in rice associated with high amount of chemical use. During 1980s, rice-fish culture revived with renewed global interest after the emergence of relatively safe chemicals and introduction of IPM in rice production. Subsequently, this culture system was diversified with the integration of other compatible components like vegetable and fruit crops, duck and other animals. Specifically, rice-fish-/duck farming evolved as an effective and beneficial tool for IPM in rice production in terms of controlling rice pests as well as quality food production and higher income. In the coastal areas of India, Bangladesh and Vietnam, rice fish production remained a more than century-old practice in the form of capture fisheries with the popular indigenous systems viz., Bheri/Bhasabadha, Pokkali and Khazan in India and Bheri/Gher in Bangladesh. The productivity in the traditional systems was less ranging from 0.5-3.0 t of rice and 50-600 kg of fish and prawn/shrimp ha^{-1} y^{-1}. These production systems were improved during 1980s with the introduction of salt tolerant improved rice cultivars and selective stocking and management of freshwater and brackish water fish and prawn/shrimp attaining higher productivity of 2.4-5.7 t ha^{-1} of rice and about 200-2100 kg of fish and prawn/shrimp ha^{-1} y^{-1}, with a net income upto US$ 2263 in one crop cycle. Research at ICAR-National Rice Research Institute, Cuttack, India during 1990s and thereafter, led to development and dissemination of two rice-fish-horticulture-livestock based diversified farming system models in rainfed waterlogged lowland and deepwater situations, including coastal areas. These farming system models have the potential of increasing production by around ten folds and net income by fifteen times (US$1,500-4,000 ha^{-1} y^{-1}) over traditional rice farming. Rice-fish system is a an ecologically sound and climate smart technology as it; i) restricts chemical use, ii) reduces greenhouse gas emission, iii) facilitates multiple use water, including harvested water for crop production,

iv) promotes recycling of farm wastes *per se* and vi) helps conservation of the ecosystem. Adoption of rice-fish-horticulture-livestock based farming systems with policy and institutional supports can greatly contribute to food, nutritional and economic security for coastal farmers.

T2S5I02

COASTAL HOMESTEAD FARMING SYSTEMS FOR ENHANCING INCOME AND NUTRITIONAL SECURITY OF SMALL-HOLDER FARMERS

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Abstract: Homestead farming (HSF) is a production system adjacent to the dwelling house of the farmer. It encompasses diverse crops cultivation, fishery in pond, small-scale livestock rearing and sometimes allied activities such as mushroom cultivation, apiculture etc. By-product of one component often used as input for other, making it a perfect farming system. Crops include vegetables, fruits, ornamental plants, betel vine, medicinal, spices and condiments depending upon the location. Vegetables are generally seasonal/annual crops such as brinjal, chilli, green leafy vegetables, beans, cole crops etc. and ornamental plants are marigold, jasmine, dahlia etc. Unlike in past, the HSF needs to be transformed from subsistence to a sustainable, remunerative enterprise with generation of market driven products. To achieve this, new models of HSF are to be developed, validated and popularised. This paper aims to highlight some of the modern HSF suitable for coastal agro-ecosystem and how these systems enhance the income and nutritional security of resource-poor farmers inhabiting the coastal region. Women participation is an integral component of HSF, owing to which the diversity of crops is higher and there is round the year production. Inclusion of enterprises such as pisciculture, animal husbandry reduces the risk. In some of the coastal HSF, betel

vine cultivation can result in income of Rs. 1.5 lakh year^{-1}. Agroforestry based HSF, involving spices (ginger and turmeric), tuber crops (yam, sweet potato, tapioca and colocasia) grown as intercrops with fruit plants like papaya, pineapple, etc. may result a net benefit of Rs. 60,000 year^{-1} after meeting the household needs. As per Indian Council of Medical Research, for normal male adult, the need of energy, protein, fat, calcium and iron per day are 170 cal, 17 g, 3.5 g, 750 mg and 25 mg, respectively. Therefore, to meet this, HSF should focus on the nutritional aspects of selected crops to address malnutrition and anaemia. For healthy crop production, compost pit should find a place in the design. Cultivation of some of the crops in gunny bags also save space and increase per plant production. Millets such as ragi, sorghum, bajra, high protein maize etc. may be included in hill HSF. Pond based HSF in salt-affected Sundarbans meet the household fish needs and provide scope for growing of aquatic leafy vegetables such as kalmi sag (*Ipomoea aquatica*) in floating beds. This system integrated with duckery further increase the income and nutritional security. Multi-storey HSF are also profitable such as coconut+black pepper in first storey, banana+papaya+guava in second storey and cowpea+turmeric+elephant foot yam in ground storey. Coconut based HSF may also be used for production of fodder crops such as guinea grass (*Panicum maximum*) for dairy cattle. To make HSF as a self-reliant and profitable system, structural and policy support are needed.

T2S5ORAL01

Rice-Fish-Duck: Effect of Co-Culture System on Rice Cultivation under Coastal Lowlands

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Rice-fish-duck integrated farming is a good ecological agricultural practice which has been widely used in China, Japan, and some Southeast Asia countries recently. This system has strong practical significance and promotional value for solving the problems of the world's agricultural ecological environmental deterioration, farmland and water pollution, agricultural products safety and raise in income from rice field. The fish and ducks play an important role in weeding while grazing and trampling, paddling with oxygen supply, fertilization, and feeding on pests in the rice field and enhancement in growth and yield of rice through physical simulation has been reported earlier. It was reported that activities of ducks in the paddy field could bring some positive effects on rice growth, but so far a lot of studies in this area seem to be limited in providing only descriptive findings. States like West Bengal, Orissa, Bihar, Jharkhand, Andhra Pradesh, Assam and North Eastern states, the demand for fish and fish products along with meat and animal products are very high. To meet the demand and supply the integration with fish and livestock is very promising and could bring a significant profitability from a unit area particularly for small holding farmers. The influence of the rice-fish-duck integrated farming on rice growth and yield characteristics was quantitatively studied and determined using a integration of rice-fish-duck in the field plot experiments at National Rice Research Institute, Cuttack Orissa during wet season with the objective to evaluate the performance of rice integrated with fish and the duck over rice alone. Long duration varieties (Varshadhan, CR Dhan 501, CR Dhan 505, Jayanti Dhan and Jalmani) were taken with fish and duck. Fingerlings of major carps were stocked 15 days after transplanting by weighing (8.2 ± 0.9 g) the required number of fish per rice field and thereafter 10 days four months old ducks were allowed to move in the rice plots @ of 200 ducks ha^{-1} under enclosure to protect the ducks from predators. The duck and fish were raised for 150 days in the rice field. Results revealed that among the rice varieties CR Dhan 505 significantly gave higher grain yield of 6.76 t ha^{-1}closely followed by Varshadhan (6.57 t ha^{-1}) and CR Dhan 500 (6.22 t ha^{-1}). The integration of rice-fish-duck gave 35.7 % higher yield over rice alone with higher weed control efficiency and less incidence of pest. The net profit per capita with integration rice- fish-duck farming was 30.6% higher over rice alone.

T2S5ORAL02

Water Budgeting and Enhancing Water Productivity in Lowland Rice-Fish Farming System

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Twin problems in lowland rice field include low and uncertain agricultural productivity and under-utilization of surplus water. The low productivity is due to excess and deficit water stress in wet and dry season, respectively. However, water quality is mostly suitable for agriculture unlike grey water and problematic ground water. Taking advantage of good quality water and heavy textured soil, rice-fish based farming system is often suggested and practiced to some extent. Per capita water availability in India has declined from 8192 m^3 for the year 1900 to 1704 m^3 in 2010. The projected figure is 1144 m^3 in 2050 which is much below the stress level of 1700 m^3 $year^{-1}$. Thus, it is important to conserve and utilize the surplus fresh water for increased water productivity with suitable technologies such as rice-fish farming system. For increasing water productivity of such system, study on water budgeting is important. We reviewed this aspect for a deep lowland (ponding depth >1 m) in coastal Odisha, intermediate lowland in Brahmaputra river valley (30 to 60 cm ponded water depth and shallow lowland (up to 30 cm ponded water depth). For the deep lowland area with high clay content (52 to 55%) and wet swelling property, seepage percolation loss (water balance method) was low (0.47 to 1.93 mm d^{-1} during November to April). Water harvesting up to potential level in wet season and growing of water loving crops (water chestnut, deep water rice) is suggested (Rautaray, 2020). Emphasis was given for high yielding dry season rice with irrigation requirement of 572 mm (dry season rainfall not considered). Dry season rice occupying 6000 m^2 area in 1 ha rice-fish system area required 3434 m^3 water considering residual harvested water (200 mm). A supporting farm pond (45 m x 40 m x 3 m) may provide this demand including pisciculture and dyke crops. An improved rice-fish farming system is suggested with water harvesting in 700 m^2 pond refuge (2 m deep), 1000 m^2 two side trenches (0.75 to 1.5 m deep) and 1800 m^2 supporting pond (3 m deep). Potential water harvesting for two rice crops and round the year water availability is expected to favour fish size and yield. For the intermediate lowland in Brahmaputra valley (Rautaray *et al*., 2005, Rautaray, 2011), harvested water with the rice-fish system helped in cultivation of dry season rice also. In combination with the residual harvested water (160 mm), dry season rainfall (155 mm during November-March, and also a part of 461 mm in April-May), dry season rice cultivation in rice-fish system required only 2 irrigations (250 mm) for 2002-03 receiving significant late season rainfall. In normal years, 4 irrigations (500 mm) were required. The system helped in growing 2 rice crops. For shallow lowlands, two-stage rain water harvesting was suggested (Mishra *et al*., 2014) with fish cultivation in refuge pond receiving surplus water from rice field over the weir height of 15 cm. Similar concept was replicated with a self-reliant farming system (Rautaray et al., 2016).

T2S5POS01

Multilevel Integrated Farming Model in Pokkali lands of Kerala

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The marshy Pokkali tracts typify a unique ecosystem, having a rich biodiversity and capacity to produce rotational rice and shrimp in an organic way. Salinity, acidity and submergence are the major hindrances for crop production in pokkali lands. People grow saline tolerant rice varieties in the low-lying marshes and swamps situated near the estuaries of streams and rivers not far from the sea along with traditional capture based aquaculture in many places

over many centuries Integration within farming systems, enhanced farmers' socio-ecological capacities to sustain livelihoods. Hence the study was conducted to evaluate the multilevel integrated farming system with rice-prawn-crab-duck-goat in pokkali lands for maximum productivity in a farmer's field at Thathappilli, Ernakulum district, Kerala. The rice cultivation starts with south west monsoon, in the low saline phase till October. During monsoon fresh water from the rivers enter the field, salinity is diluted and partially washed off. From November onwards salinity builds up and the field is unsuitable for paddy cultivation. Fish farming or prawn cultivation is followed in this high saline phase. Tidal flows make the field fertile. Farming system involved integration of prawn, duck, goat and poultry along with pokkali cultivation. The fields are allowed to dry by preventing entry of water in the fields for rice cultivation. Raking starts with specialized spades and mounds were prepared, and on this sprouted Pokkali seeds were sown on 04/05/2017. Rice seedlings were dismantled after 30 days of sowing by cutting the mound into pieces and transplanting. The cultivation is exclusively naturally organic without any external inputs/ intercultural operations. By mid-October, the rice is harvested by cutting only the panicle at a height of 30 to 35 cm from the top and the remaining biomass is left in the field. The grain yield recorded was 2.38 t ha^{-1}. Ducks (35 no.) were released into these harvested fields, in which paddy wastes acts as feed for them. They were released as pest control in standing crop fields too. After the harvest of pokkali rice, prawn seeds (Penaeus monodon) were stocked in the field @ 30,000 per ha along with small crab seeds. They subsist on the organic matter from decayed stubbles, drying water weeds etc. and in turn, the field is enriched with manure. The harvest was after 100 days of culture by pumping out the water from entire field by using cast netting and ring nets for prawns and crabs respectively. Prawn yield and crab yield were 300 kg ha^{-1} was 250 no ha^{-1} respectively. Along with this, goat farming with 12 no. of goats supports farmer by providing a steady income. Fodders and other local feeds like jack leaves were available in plenty and free of cost. Returns from the goat farming were sales of kids and manures. A multilevel integrated farming system model suitable for acid saline soils of Pokkali lands with paddy-prawn-crab in low lands vegetables and other crops in the uplands with duck and goat farming with a benefit cost ratio of 1.85 improved the economic status, livelihood opportunities and human nutrition. The study revealed that multilevel integrated farming is found to enhance the soil properties, cost effective and reducing input requirement, which makes it ecologically stable and economically sustainable.

T2S5POS02

Sustainable Nutritional and Income Security Through Integrated Farming in Coastal Saline Pokkali Ecosystem of Kerala

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Pokkali system of cultivation, unique in the world, produces naturally organic rice in coastal saline soils of Kerala. Rice-fish/prawn is the traditional system followed, wherein rice is cultivated during June- October when salinity is partially washed out by monsoon and prawn is cultivated in the high saline phase (November to May). Fish culture forms an integral part of pokkali cultivation. Less attention is given for rice cultivation and this makes the system less sustainable. *Pokkali* farming, which was acclaimed as a sustainable model turned into a loss-making venture due to widespread attack of white spot symptom on shrimps in many years. Labour shortage, high wages, lack of proper machinery and lack of branding of pokkali products aggravated the crisis. Most of the *pokkali* fields that produced lots of organic paddy and shrimp in the past are left barren now. Ensuring more income per unit area from pokkali fields is the only way to attract farmers back to pokkali cultivation and to bring back the glory of the traditional farming system. With the aim to develop and demonstrate profitable new enterprises in the Pokkali ecosystem, the project was taken up including various integrating components. Different farming systems compared were rice

alone(low saline phase), rice+ fish (additional) in the low saline phase , rice- fish rotational system and rice-fish+ poultry system. A new model-floating duck cage which can carry 50 ducks was developed and installed over field of one acre. Duck droppings favoured fish culture (Tilapia) and the average size of fish increased by 250g without any external feed as duck droppings provided the same to fish. Production of eggs and meat by poultry increased farm income and contributed to the nutritional security of the neighbourhood. Duck release to paddy fields after harvest of rice reduced duck feed to a great extent. Ducks fed on the weeds and pests like snails in the field. Increasing the income from rice fields by year round utilization of the farm land by judiciously mixing fish +poultry with rice reduced the negative trend in the rice production front. The study proved that duck rearing is a viable component for integration in the rice-fish pokkali ecosystem having a BC ratio of 2.34. Besides, rice-fish+duck farming system formed an important strategy for climate moderation by an additional transfer of C (addition of 1.5-2 kg organic matter per day by 50 ducks per acre) to the soil and enhancing other ecosystem services.

T2S5POS03

On Farm Diversification of Existing Farming Systems under Marginal Household Conditions in South Konkan Coastal Zone of Maharashtra

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Appropriate combination of farm enterprises through farming system approach to ensure reasonable standers for living and efficient management of natural resources would certainly boost the socio-economic standers of the farmers. Topography of the konkan region is having fragmented land holding and has limited scope for the extension of the cultivable area. So as to boost the agriculture production and to ensure the financial security diversification in existing farming system is one of the important step. The current study was conducted on randomly selected 60 farmer's field of the Ratnagiri district in six villages of Lanja and Rajapur block. After characterization of the farm enterprises three type of the farming system were identified. These were Crop + Dairy, Crop + Dairy + Horticulture and Crop + Dairy + Goat. Maximum percentage of the Farmers (50%) adopted Crop + Dairy, followed by Crop + Dairy + Horticulture adopted by 47% farmers and Crop + Dairy + Goat was followed by 3% farm house holds. The benchmark survey was undertaken during 2018 under the aegis of AICRP-IFS. Before diversification benchmark income recorded in respect of Crop + Dairy, Crop + Dairy + Horticulture and Crop + Dairy + Goat was Rs. 43338, 64754 & 46470 respectively. Interventions in existing crop component including sowing recommended crop varieties, recommended fertilization, proper weed control & diversification with inclusion of pulses & vegetable crops during Rabi season increased the net income of individual households. Similarly, interventions in livestock components viz., supply of improved breed of poultry (Giriraj), Vaccination and deworming, Supply of improved variety of Forage crops seed (Maize-African tall), mineral mixture supplementation increased net income of per households. After that regarding the capacity building module further resulted in increased technical know-how of participating households & proved helpful for better management of production techniques on farm. After one year of diversification and due to the implementation of interventions in existed crop component, livestock component, product diversification& capacity buildings, average net income Crop + Dairy, Crop + Dairy + Horticulture and Crop + Dairy + Goat was Rs. 54236, 82580 & 60812 respectively and it was 25.1 %, 27.5 % and 30.9% higher as compared to benchmark status.

T2S5POS04

Integrated Organic Farming System Involving Turmeric for Livelihood Security

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The present situation of soil quality and environmental security warrants to go for an organic nutrient management in farming system. Integrated Organic Farming System (IOFS) is an innovative concept of on-farm resource management strategy to achieve economic and sustained agricultural production to meet the diverse requirement of the farm household while preserving the resource base and maintaining high environmental quality. The coconut (*Cocos nucifera* L) palm, a crop of small and marginal farmers in India, may not support enough to sustain the livelihood of small farm families. Coconut as a monocrop is a poor resource user and the growth habit and offers immense scope for raising compatible crops in the inter and intra spaces and integrating animal husbandry and subsidiary income generating enterprises. The share of marginal and small holdings in the total spice holdings tends to be more than 90% reflecting the potential interventions in benefitting small holders giving livelihood security. Hence an integrated organic farming system model (0.40) was established during 2016-2019 at ICAR-IISR Kozhikode with cropping system components such as coconut, turmeric, tapioca, horticultural components viz, banana, vegetable cowpea, livestock component 2 cows and calves, raising fodder and provision for nutrient recycling. The crop -livestock model had 3 parts cropping systems, horticulture crops and live stocks maintained in dairy unit in an acre area. Cropping system included coconut trees, fodder crops and turmeric. Inter spaces of coconut trees were used for planting fodder crops such as Hybrid Napier grass Co3 and Co4 (15 cents) and turmeric (10 cents). Fodder grasses were planted at a spacing of 50 x 30 cm by leaving 2 meter radius of coconut. Coconut slurry and Jeevamrutham were fed to grasses at fortnightly interval. First harvest of fodder was made after 90 days and subsequently harvested on day to day basis for feeding the cows. Coconut trees were manured with farmyard manure and compost prepared from Dairy waste (Paddy straw and fodder grass left over by animals from the feed and weeds). Regarding horticultural part, tapioca, banana and vegetable cowpea were the main crops. Stem cuttings of tapioca (variety Sreejaya) was planted at a spacing 1x1 m during May and maintained by organic package and harvested at the 10 months. Tissue culture plants of the banana variety Grand naine was planted at a spacing 2x2 m in the inter spaces of coconut during May and harvested after 10 months. Vegetable cow pea was planted in an area of 2.5 cents as inter crop during the month of January and manured as per organic POP and harvested after 2 months and subsequent harvest after attaining maturity of the pods. Two cows + 2 calves were maintained (2 Holstein fresien) in the diary unit. The farmyard manure and dairy waste compost used for manuring the crops in the IFS plot including coconut palm. The milk and excess cowdung produced are sold. In this model cropping system contributed 90% share, horticultural crops 7.5% and live stock by 2.5 % share to total area. Among the crops maximum income was received from coconut (Rs. 22653 year^{-1}) followed by turmeric (Rs 4825). Regarding horticultural crops banana recorded maximum income (Rs. 2088 year^{-1}) followed by vegetable cowpea. Green fodder produced 13.88t per annum was enough to meet the fodder requirement of two cows and calves for 365 days. Annually 4320 l milk was produced and income obtained was Rs. 243495 year^{-1}. Annual production of dry cowdung was 4380 kg, out of this 3265 was used as manure for the crops and Rs. 4787 was received as income by selling cowdung (1115 kg year^{-1}). An average net income received from IOFS model was1.35 lakhs year^{-1}. Maximum net income shared by livestock component (90.1%) followed by horticultural component (6.3%) and by cropping system (3.6%). The benefit cost ratio of the IOFS model was 1.55 with an annual employment generation of 359 days. The IOFS models can not only bring significant change in crop diversification by way of inter/mixed cropping, but also improve the average income derived from such farming system there by sustaining the livelihood security.

T2S5POS05

Integrated Farming System Model for Sustainable Production, Livelihood Security, Income and Employment Generation to Farmers under North Konkan Coastal Zone of Maharashtra

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Food security, employment, income generation, resource conservation and environment protection have emerged as major world concerns. The integrated farming systems (IFS) are vulnerable to climate change and must adapt to maintain and improve productivity and its stability. IFS are a powerful tool; it holds the key for ensuring income, employment, livelihood and nutritional security in a sustainable mode for small and marginal farmers. IFS approach is a judicious mix of two or more components while minimizing competition and maximizing complementarities with advance agronomic management tools aimed at sustainable and environment friendly improvement of farm income and family nutrition. Konkan region of Maharashtra comes under high rainfall zone receiving on an average 3000 to 3500 mm rainfall in 95 to 110 rainy days during *kharif* season. Considering the Agro-climatic conditions, natural resources, land holding of farmers and farmer's needs of Konkan region, an ideal integrated farming system model for small and marginal farmers has been developed on an area of 1.00 ha for family having 3 males and 3 females (6 persons) at Regional Agricultural Research Station, Karjat, Dist. Raigad under All India Co-ordinated Research Project on Integrated Farming Systems. The objectives of this study are to assess the impact of Integrated Farming System model in respect of employment generation, recycling of farm produce and increasing profit per unit area per unit time and to demonstrate efficient use of available farm resources. The IFS model comprised of different enterprises viz., crops and cropping systems on an area of 0.50 ha, horticulture component (fruit crops + nursery) 0.40 ha, livestock components namely, dairy, goatary and poultry on area of 35.75 m^2 each (107.25 m^2), vermicompost unit on 18.00 m^2 and rest of the land (874.75 m^2) is used for operational and other purposes. This region is dominated by rice based cropping systems due to high rainfall. Therefore, the total production of the model is converted in terms of Rice Equivalent Yield (REY). The average of six years data revealed that the total production of 47.09 t REY was obtained from 1.00 ha area. In terms of economic returns, the gross and net returns were Rs. 7,15,957 and Rs. 2,10,553, respectively. IFS have created more number of working days in the system due to involvement of more enterprises than cropping systems alone. Six years average employment generation through present IFS model was found to be 1085 man days and its value was Rs. 2,04,819 which contributed 40.53% in the total cost of production. This has provided employment opportunity almost throughout the year. The average total cost of production of the IFS model was Rs. 5,05,404 ha^{-1}, which included outside purchase for Rs. 1,93,250 ha^{-1} (38.24 %), value of recycled material within the system of Rs. 1,07,336 ha^{-1} (21.24%) and for farm labours costing Rs. 2,04,819 ha^{-1} (40.53 %). On an average of six year study, the benefit: cost ratio was 1.42 by inclusion of different modules in the model. Farmers can increase their net returns by saving the expenditure on farm labours through employment of family labours. The six years compiled data of IFS model showed that as far as the demand of essential foods for a family of 6 members per annum is considered, the annual production in this model was surplus for cereals, oilseeds, milk, fruits and vegetables commodities.

T2S5POS06

Integrated Multi-Trophic Aquaculture (IMTA): A Potential Farming System to Enhance Production of the Red Seaweed *Gracilaria tenuistipitata* (Chang and Xia) in Brackishwater

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Globally, intensification in aquaculture leads to concern on both environmental and economic sustainability. In this context, integrated multi-trophic aquaculture (IMTA) is one of the best solutions to bring in sustainability in aquaculture. Earlier studies suggest that raising the ecosystem capacity i.e. increasing the succession of trophic levels may enhance the biomass production of seaweed. Therefore, IMTA may impact positively for the production of seaweed biomass, which will help to meet up the immense industrial requirement of raw material. Thus, the present study focused to evaluate the production performance of red alga *Gracilaria tenuistipitata* in an IMTA (milkfish-oyster-seaweed) system in comparison to monoculture (only seaweed) in brackishwater tide-fed ponds in Sundarban. Water salinity ranged between 5 – 7.5 g L^{-1} during the 80-day study period. It was observed that the biomass production increased as time progressed in both systems, but biomass and specific growth rate were significantly higher in IMTA (1657.98 ± 65.905 g and 2.64 ± 0.049 % d^{-1}) compared to monoculture (1287.74 ± 86.003 g and 2.32 ± 0.085 % d^{-1}) throughout the culture period. Analysis of tissue C and N contents of *G. tenuistipitata* revealed significantly higher percentage of deposition in IMTA seaweed than in monocultured one. In addition, an average final body weight of milkfish was 214.89 ±1.665 g from initial 14.57 ± 1.66 g in the IMTA system. An average 10% weight gain of edible oyster was obtained from the IMTA during the culture period. It could be concluded that along with higher growth performance, seaweed utilized a significant amount of carbon and nitrogen which maintained the environmental sustainability. Moreover, higher biomass production and diversification of species in IMTA will certainly provide an economic sustainability to farmers through intensive farming.

T2S5POS07

Exploring Possibilities of Income Generation through Fish Culture in Polythene Lined Farm Ponds in Ratnagiri District, Maharashtra

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India's primary source of livelihood and income security is agriculture and allied sectors. Aquaculture is one of the fastest growing food production systems in the world which are likely to witness an increase in demand. Pond farming can play a significant role in increasing manifold production, income, nutrition and employment opportunities of rural populations. Ponds add value to other farming activities such as it can be used for the supply of domestic and livestock water and for irrigation of high-value crops and vegetables. Arid and semi-arid regions of India, limited irrigation is one of the most important critical constraints found. The Department of Agriculture, Government of India has launched a 'National Horticulture Mission' to solve irrigation problems as well as to improve agricultural production. Construction of polythene lined farm ponds has been promoted under this mission, where rainwater can be harvested and managed for agricultural and horticultural crop irrigation. The area covered by such farm ponds varies between 0.2 to 0.6 ha with an average depth of 4.0 m, where water is available for approximately 8-10 months

and offers a good potential for fish culture. In fact, many of these water bodies are used solely for the conservation of water and are not used for fish farming. The farmers can get an additional income from polythene lined farm ponds and generate employment as well as livelihood security through fish farming. At present, total 147 farm ponds are established in Ratnagiri district which is having potential for freshwater fish culture. Considering this, present study has been undertaken for exploring possibilities of income generation through fish culture in polythene lined farm ponds. Several field trials of fish culture in farm ponds were carried out at six farmer's pond site (approximate area of pond 0.04 ha). Farmers of Ratnagiri district were demonstrated fish culture techniques in polythene lined farm ponds. Around 1000 nos. of monosex tilapia seed of 10 gm size were stock in pond. Pond was fertilized quarterly and supplemental feed mixture of groundnut oil cake and rice bran at a ratio of 1:1 by weight was fed daily @ 2-3% of body weight. After 8 months fish harvested with yield of 450 kg. Several awareness/trainings/demonstration programmes were organized by Krishi Vigyan Kendra, Ratnagiri for dissemination of this technology for farmers and fishers. Results revealed that improved production method and better management practices can increase the fish production from small farm ponds. It is suggested that polythene lining can not only ensure water availability throughout the year, but can also increase farmers' revenue several times by providing the market to the table size fish.

T2S5POS08

Fish Farming: A Promising Source for Income and Employment Generation under Sodic Soil

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Fish farming in saline-sodic soil plays an important role in human nutrition and also in the rural economy of the country. For the management of waterlogged saline and sodic soil, a comprehensive ecological approach and a development of new system is essential. The fish culture is flourishing in saline and sodic area and act as a profitable enterprise for farmers. Inland aquaculture makes greatest contribution of (60 %) to total aquaculture. Mr. Fedrick Nickson is a progressive farmer adopting inland fish farming for their sustainable livelihood under sodic soil and started fish farming in a very small scale (0.2 ha) during 1993 with the technical guidance of Krishi Vigyan Kendra, Tiruchirappalli and became a successful producer for quality fish. Mr. Fedrick Nickson got motivated and on an average 2 t ha^{-1} $year^{-1}$ of fish was harvested, which is quiet a better yield. Further he started a fingerlings production unit in 0.8 ha and harvested 2 lakh nos. $year^{-1}$ ha^{-1} from 2014 onwards. The scientific validation of study revealed that Mr. Fedrick Nickson was yearning a net annual income of Rs. 2 lakh ac^{-1} $year^{-1}$ through the sale of fish and quality fingerlings. Thereby he generates an additional employment of 1099 man-days per year. Moreover, he is encouraging interested farmers (200 rural youth) through training to start fish farming on their own farms so that farming community can be benefitted in normal soil and also in sodic soil. The results of the current study revealed that benefit cost ratio (2.0:1) of fish farming was significantly higher than in agriculture (1.6:1) and can boost-up Indian economy which is today's essential need besides serving as an eco-friendly venture for rural populace.

T2S5POS09

Coconut Farming in Lakshadweep Islands: Strategies for Enhancing Sustainability

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Lakshadweep, India's smallest Union Territory located in Arabian sea, comprises of 36 tiny coral islands with 32 sq km in area and a population of 64429 (2011 census) in the ten inhabited islands. Besides fishing and tourism, coconut cultivation and production and marketing of copra constitute the major livelihood option of people of Lakshadweep islands. Farming activities in Lakshadweep islands are essentially coconut centered and efforts to improve farm sector in the islands need to primarily focus on coconut-based income generating activities. Cultivation of vegetables and fruits is very meagre and the islanders mostly depend on the supply from mainland to meet their requirement for vegetable and fruits. Farming activities in Lakshadweep islands are essentially coconut based and efforts to improve farm sector in the islands need to primarily focus on coconut-based income generating activities. Cultivation of vegetables and fruits is very meagre and the islanders mostly depend on the supply from mainland to meet their requirement for vegetable and fruits. Efforts for popularization of kitchen garden concept in all the islands have been initiated by the Govt. With the objective of exploring the scope of horticultural crops with emphasis on coconut on the island ecosystem, a survey was made in six major islands of Lakshadweep including Kavaratti, Androth, Agatti, Kadmat, Amini and Kiltan. The investigation describes coconut farming scenario in the Lakshadweep islands and suggests strategies for conservation and sustainable utilization of coconut genetic resources, production of quality planting material, agro-techniques for sustainable coconut production and coconut based multiple cropping and integrated farming, production and marketing of value-added products besides capacity building programmes for youth, farmers and extension personnel. Role of farmer producer organizations (FPOs) and coordination between various agencies in improving the situation for sustainable coconut-based industry are also flagged by the authors.

Theme III:

Natural resources and carbon flow dynamics vis-à-vis soil quality, water use trends, and integrated water management including ground water and farm machinery developments

SESSION I:

Natural resources: assessment and degradation, management

T3S1I01

ASSESSMENT AND MANAGEMENT OF MONOSULFIDIC BLACK OOZE ACCUMULATIONS IN COASTAL WATERWAYS AND WETLANDS

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Professor Leigh Sullivan FSSA CPSS has an international reputation in geochemistry especially on acid sulfate soils and carbon biosequestration in crops. He was the Chair of the International Union of Soil Sciences' Acid Sulfate Soil Working Group (2002-10 and 2014-18). He has been Deputy Chair, Physics, Chemistry and Environment Panel for the Australian Research Council's College of Experts (2012-14). Professor Sullivan is Deputy Vice-Chancellor, Research and Innovation, University of Canberra, Australia. He was lead author on a range of acid sulfate soil assessment and management guidance manuals published in 2018 for and by the Australian Government.

Abstract: Monosulfidic black oozes (MBOs) have only been recognised in the waterways and wetlands of our coastal landscapes in the past two decades. During this time our understanding of the potential of these sediments that contain monosulfides (predominantly iron monosulfides, but also consisting of other compounds including H_2S) to pose environmental hazards has rapidly increased. One of these hazards is for MBOs to accumulate and be mobilised by floodwaters in drainage channels causing severe deoxygenation. Other hazards include severe acidification, and the release of toxicants (e.g. heavy metals, metalloids such as arsenic, and high levels of nutrients) from MBOs subsequent to disturbance of these materials (Sullivan *et al.*, 2012).

MBOs are typically black gel-like materials, high in organic matter (typically >10% organic carbon) and can form thick (i.e. >1 m) accumulations that characteristically form in very low-energy flow waterways within coastal landscapes. Contents of ≥ 0.01% acid volatile sulfide (AVS) are sufficient for these materials to be classified as 'monosulfidic'. Undisturbed, MBO typically has a near neutral pH (i.e. pH 7–8), and a low redox potential required for its formation. The main conditions that promote MBO accumulation are: a ready supply of soluble sulfate (i.e. >10 mg SO_4 L^{-1}); a supply of easily decomposable organic matter; anaerobic conditions as a consequence of inundation; an adequate supply of iron (usually abundant in sediments), and; low-flow conditions to prevent removal of these ooze-like accumulations. These conditions are met in a wide range of coastal environmental settings including lakes, rivers, estuaries, drainage channels, tidal swamps and salt marshes.

MBO accumulations are prone to mobilisation during high-energy events such as floods, drain cleaning etc and prior to mobilisation pose a range of hazards including: accelerated nutrient mobilisation and consequent algal blooms; choked hydraulic functioning of waterways; smothering of benthic communities, and; emission of noxious gases. Post mobilisation during high flow events, MBO accumulations pose hazards including: deoxygenation and acidification of waterways; release of contaminants such as metals, metalloids and nutrients, and; smothering.

Approaches for the management of MBOs in waterways include; minimisation of organic material accumulation; flushing regimes that eliminate MBO accumulation by regular scouring; establishing transience in drains that are only required to function as waterways only irregularly, and; re-introducing wet/dry cycling in managed waterways and wetlands.

T3S1I02

CUTTING-EDGE REMOTE SENSING TO UNDERPIN WATER RESOURCES ASSESSMENTS

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Dr. Jorge Peña-Arancibia was awarded a Ph.D. in geography and hydrology from King's College at the University of London in 2013, supported by a grant of Microsoft Research. He is currently a Senior Research Scientist in CSIRO Land and Water in Australia. Jorge is a hydrologist with more than 10 years of experience in Australia and abroad. His research within CSIRO has focused on the biophysical impacts of climate, land use and the development of water resources through hydrological modelling and remote sensing. He has contributed to relevant multi-institutional projects in Australia and internationally including the Murray-Darling Basin Sustainable Yields (MDBSY); Water Information Research And Development Alliance (WIRADA); Bioregional Assessments (BA); and Northern Australia Water Resource Assessment (NAWRA). More recently, Jorge led the river system modelling in BA, remote sensing for flood inundation modelling in NAWRA and the modelling in the Tacna Drought Management Plan project in Peru, Jorge currently leads the DFAT-funded Sustainable Development Investment Program (SDIP) remote sensing cropping analysis and water use projects in Bangladesh and Pakistan (Indus). These projects use innovative remote sensing and machine learning approaches developed by Jorge to map irrigated crops and their water use. Dr Peña-Arancibia is the author of more than 50 publications, including 20 in refereed international journals (more than 1000 Google Scholar citations and h-index of 18). Jorge is a member of the Asia Oceania Geosciences Society and the Modelling and Simulation Society of Australia and New Zealand

Abstract: Water resources are on an unsustainable trajectory in many parts of the world due to the increased reliance on surface and groundwater used in irrigation to meet the demand for food and other agricultural products. The impact of irrigation on surface and groundwater resources has been difficult to quantify at policy-relevant scales. Satellite Remote Sensing (RS) provides an opportunity to assess irrigation dynamics and water use at resolutions amenable for detailed modelling and decision making. Crop types and associated water use can be quantified by mining RS data and using machine learning techniques. This talk showcases recent work which used Landsat (30 m) and MODIS (500 m) reflectance data to estimate water use and crop types in northwest Bangladesh and the Indus Basin in Pakistan. The large amount of data and processing required computational power which was harnessed through cloud-based geospatial processing and peta-bite repositories of analysis ready data. Common issues and potential solutions related to the use of reflectance data in this cloud-affected region are discussed, as well as possibilities of implementing scalable monitoring tools like CSIRO's Earth Analytics Science and Innovation

platform (EASI), which enhance the capacity to process and integrate big RS data with other geospatial information and models using a friendly interface through Jupyter Notebooks.

T3S1I03

CROP GROWTH IN SALINE SOILS IS NOT (MOSTLY) ADVERSELY AFFECTED BY THE ECe

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Prof. Ed. Barrett-Lennard works in the Department of Primary Industries and Regional Development (DPIRD) of Western Australia, Murdoch University and The University of Western Australia. For more than 35 years Ed. has been a passionate researcher and advocate of the need to develop saline agricultural farming systems in response to landscape salinization and climate change. His interests lie at the intersection between practical agriculture, agronomy, soil science and ecophysiology. He is the author/editor of five books, more than 70 papers and numerous other publications. Ed. has overseas experience of having worked in Pakistan, Bangladesh, India, Iraq and Vietnam.

Abstract: Anyone who has examined crop responses to salinity in a hydroponic experiment will immediately recognize a simple truth: the stress on plants is caused by the salt concentration of the solution, that is the ratio of the amount of salt divided by the amount of water. It is not therefore much of a stretch to propose that the stress for crops growing in salinized soils should be the same: stress is caused by the amount of salt divided by the amount of water. Despite this essential truth, there is a huge volume of literature that relates crop yield to the soil's ECe or related measures like the $EC_{1:5}$. It needs to be stressed that these variables are not measures of the salinity of the soil water but are rather measures of the salt concentration of the soil.

If crop growth is more affected by the salinity of the soil solution than the soil then we should be able to observe stronger statistical relationships between yield and the salinity of the soil solution compared with the soil. This paper will document several examples showing that this is true based on recent studies with sunflower and barley. The paper will conclude with some thoughts about how existing relative yield–ECe response curves might be adapted to take account of both salt and water concentrations in soils.

T3S1I04

SALINE SOILS OF COASTAL ECOSYSTEM: SPATIAL AND TEMPORAL VARIATION OF SOIL PROPERTIES, CLASSIFICATION, FERTILITY STATUS AND MANAGEMENT FOR SUSTAINED PRODUCTION

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Abstract: Coastal ecosystem, one of the ecosystems on the earth is a land ecosystem which is adjacent to a marine ecosystem. Coastal plain is the landward extension of the continental shelf or the sea used for agriculture and allied activities. 'Coastal' has a significant role in agriculture or food production, since the agricultural productivity in this ecosystem is generally lower than the country's average, although overall about 50-70% of the global population live within 100 km of the coastline covering only about 4% of earth's land and within 200 km of coastal area shares less than 15% of the earth surface area. Agriculture in this ecosystem is constrained by a number of technological, anthropological and climatic factors limiting the productivity. The coastal saline soils, their spatio-temporal variation, characteristics, classification, distribution, fertility status and their management options have been discussed. The primary causes of salinity in coastal soils are ingression of sea water in coastal plain, deposition of salts in deltaic plain, linkage of drainage channels with saline sea water and salty parent materials, presence of poor-quality/ brackish ground water, periodic inundation of sea water. Soil salinization is a continuous and repetitive process occurring in complex physiographic regions in coastal area viz, alluvial, aeofluvial, coastal, deltaic and mud flats/ mangrove swamps. Spatial and temporal variability of soil salinity in coastal area have been one of the key focus of soil science research. The large spatio-temporal variability is due to various factors like climate, topography/ physiography, texture of soils and groundwater dynamic and degree of spatial and temporal variation are strongly influenced by seasonal changes during one annual cycle. Two-dimensional salt distribution pattern i.e. horizontal and vertical is attributed to landscape position/ soil texture and ground water salinity, respectively. Salinity problems are

caused from the accumulation of soluble salts in the root zone. These excess salts reduce plant growth and vigour by altering water uptake and causing ion-specific toxicities or imbalances. High salt concentrations can induce osmotic stress in plants and lead to the toxic accumulation of ions, such as Cl^- and Na^+ particularly in the surface soil horizons. Most of the coastal saline soils are having the texture like silty loam to sandy clay loam. Taxonomically, the majority of these soils are classified in soil orders like Aridisols, Alfisols, Inceptisols and Vertisols based on the saline soils developed in coastal ecosystem under prevailing soil forming factors and processes. Coastal saline soils are also categorized in to saline, saline-sodic and sodic soils based on the nature and types of salts present. Fertility status of these coastal saline soils showed great variability in the nutrient content. These soils are, in general low in available nitrogen and phosphorus content. Micronutrient content and availability depend on the soil properties like pH of soils and antagonistic effect of other ions present. Integrated nutrient management has been imperative for sustainable crop production and it has been necessary to view the nutrient elements and their interaction with the salt components together instead of considering each of them in isolation. Some of the management options for sustainable crop production in coastal saline soils have been discussed.

T3S1I05

A REMOTE SENSING ASSESSMENT OF SPATIO-TEMPORAL DYNAMICS OF COASTAL ECOSYSTEM: EVIDENCE FROM INDIAN SUNDARBANS

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Abstract: The Sundarbans is the largest contiguous mangrove ecosystem in the world located in the southern part of West Bengal, India and Bangladesh, and lies on the delta of the Ganges, Brahmaputra and Meghna rivers in the Bay of Bengal. Owing to its unique geographical location this world heritage site is highly vulnerable to climate change. Despite the value and vulnerability of the coastal delta, very little data exist on the spatiotemporal dynamics of the land and the impacts of anthropogenic and natural disturbances of the ecosystem. Under the global climate change and the related sea level rise we explore the spatiotemporal dynamics of the changing coastline and assess the vulnerability of the region. Multi-temporal landsat imagery was used for studying land-use/land cover dynamics and shoreline changes in Sundarbans. Out of total 7300 km^2 study area of Indian Sundarbans total erosion and

accretion was 163 km^2 and 149 km^2 during 1975 to 2015, net change was erosion of 14 km^2. The land use land cover dynamics indicated that in Sundarbans mangrove forest remained more or less stable since 1975, whereas, the aquaculture and cropped area during rabi season increased considerably and fallow area decreased. Salinity map indicated that there was shifting in soil salinity from west to east during 1973 to 2015 because of increased rabi cultivation in western part of Sundarbans whereas increased brackish water aquaculture in eastern part increased salinity in the region. The village level climate change vulnerability in agricultural sector of Indian Sundarbans region were estimated using spatially aggregated biophysical and socio-economic parameters by applying equal weight method. There are 1074 villages in the islands ecosystem which are distributed among 191 gram panchayats. We selected the indicators for each category of exposure, sensitivity ad adaptive capacity. Exposure is represented as changes in the long-term climatic conditions and the projected changes in the climate variables which can impact the agrarian ecosystem. For the present analysis we extracted spatially interpolated long period (1970-2000) climate data from 'WorldClim' database (http://www.worldclim.org). The data was prepared for global climate surfaces on monthly precipitation, minimum, mean and maximum temperature. We used HadGEM2 AO model output by the year 2050 under representative concentration pathways (RCP) 8.5. The cropping (mono and double cropped) area were extracted by landsat data. We aggregated agricultural, socio-economic as well as population data from Census 2011. Data were normalized during their integration into aggregate vulnerability index within a dimensionless range 0-1 based on directly and inversely related indicators to component of vulnerability. We assigned equal weights to all variables considering their functional relationship with vulnerability. Higher the value of exposure and sensitivity, higher was the vulnerability while for adaptive capacity it was reversed. Finally, from the arithmetic sum of the two indices of exposure and sensitivity minus the adaptive capacity we obtained the final value of the climate change vulnerability index. From the integration of outputs and based on the severity of vulnerability, explicit vulnerable zones were demarcated spatially. The results indicated that the villages in Sandeshkhali-I & II and Minakhan of North 24 Parganas was under highly vulnerable zone. Out of 1074 No. villages in Sundarbans 139 villages covering an area of 587 km^2 with a population of 5.64 lakhs are under highly vulnerable to climate change.

T3S1ORAL01

Coastal Saline Soils of West Bengal and their Management for Augmenting Productivity

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In West Bengal the coastal saline soils are distributed in the four coastal districts of North and South 24 Parganas, East Midnapore and Howrah. The soils of the region have developed on alluvial and deltaic deposits of recent to sub-recent origin. Thesoils are generally heavy textured (silty loam to silty clay) and have have hyperthermic temperature and aquic moisture regimes. The soils are saline in nature mainly due to upward capillary movement of saline water from brackish ground water located at shallow depth, sea water ingress, tidal flooding, etc. Chlorides and sulphates of Na, Mg, Ca and K are the predominant salts. There is wide spatial and temporal variation in salinity and it is highest during the summer and lowest during the monsoon season. The soils are generally low in available N, low to high in available P and high in available K contents. Except zinc, the soils are found to have adequate amounts of micronutrients. In addition, acid-sulphate soils having very low pH (<4.0) are found to occur in the Sundarbans delta. These soils have high water-soluble Fe, Al, and Mn leading to toxicities of these elements in plants. The region being low lying with flat topography and impeded drainage face prolonged water logging during the monsoon season.Crop productivity in the coastal region is severely constrained due to soil degradation arising out of high soil salinity, acidity found in acid sulphate soils, toxicities of iron and aluminum, low N, P and Zn availability and water logging. Besides the region is also vulnerable to the threats of climate change. Therefore, improving

agricultural productivity for achieving the food and livelihood of the resource poor farmers of the coastal region is the biggest challenge. In spite of these constraints, there are opportunities for enhancing agricultural productivity in the coastal degraded saline soils through adoption of improved land and water management practices such as land shaping technologies including crop diversification, nutrient management, conservation agricultural practices, etc.

T3S1ORAL02

Soil Fertility and Productivity of Rice-Groundnut Cropping System in North Konkan Coastal Zone as Influenced by Organic Nutrient Management

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Rice - Groundnut is a predominant cropping system grown by farmers in Konkan region of Maharashtra. Therefore, a field experiment was conducted under Network Project on Organic Farming, being operated at Regional Agricultural Research Station, Karjat, Dist Raigad, (M.S.) to study the response of varied quality and duration varieties of rice and groundnut to organic production system during 2018-2019.Total 15 rice varieties were grown during *Kharif* season and 15 varieties of groundnut were grown during Rabi-hot weather season after harvest of *Kharif* rice varieties. The experiment was conducted in a Randomized block design with three replications. Results revealed that the rice hybrid Sahyadri-5 produced maximum and significantly higher grain yield (66.97 q ha^{-1}), straw yield (73.78 q ha^{-1}), grain Rice Equivalent Yield (REY) (82.16 q ha^{-1}), straw REY (11.39 q ha^{-1}) and total REY (93.55 q ha^{-1}) as compared to rest of the varieties except hybrids Sahyadri-3 and Sahyadri-4. During Rabi-hot weather season, groundnut variety TG 26 remained at par with Konkan Gaurav and recorded significantly higher dry pod yield (31.10 q ha^{-1}), haulm yield (40.49 q ha^{-1}), REY of dry pods (191.97 q ha^{-1}), haulm REY (6.25 q ha^{-1}) and total REY (198.22 q ha^{-1}) as compared to rest of the groundnut varieties except Phule-6021, TAG-24, JL-776, and TG-37A in respect of haulm yield and haulm REY. Rice variety Karjat 3 grown during *Kharif* and groundnut variety TG 26 grown after harvest of Karjat 3 recorded maximum and significantly higher total system REY (276.93 q ha^{-1}), net returns (Rs. 2,84,895 ha^{-1}) and B: C ratio (2.74) except 'Karjat 5 – TAG 24' and 'Jaya-Konkan Gaurav'. Organic carbon, available N, P and K were notably increased under all the rice-groundnut varietal sequences as compared to their initial levels. Significantly the highest organic carbon content (1.30) was observed due to Jaya-Konkan Gaurav varietal sequence which was identical to Ratnagiri 3 - JL 776 over rest of the sequences with few exceptions. Jaya - Konkan Gaurav varietal sequence recorded maximum and significantly higher available N (285.08 kg ha^{-1}), P (9.69 kg ha^{-1}) and K (345.7 kg ha^{-1}) status of soil over rest of the varietal sequences except Ratnagiri 3 - JL 776, Sahyadri 5 - TG 37A, Karjat 3-*TG* 26 and Karjat 2 - RHRG 6083.

T3S1ORAL03

STCR – a Tool for Fertilizer Recommendation for Rice (ADT 43) in UT of Puducherry

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Rice (*Oryza sativa* L.) is central to the lives of billions of people around the world. At the global level, rice is the most widely grown crop which occupies an area of about 161.8 million hectares, of which Asia covers about 143.2 million hectares. Similarly, out of the total world rice production of 701 million tons, Asia contributes approximately 633.7 million tons (FAO Statistical year book, 2013). In India, more than 44 million hectares area is occupied by rice under three major ecosystems, rainfed uplands (16% area), irrigated medium lands (45%) and rainfed lowland (39%), with a productivity of 0.87, 2.24 and 1.55 tons per hectare, respectively (Tiwari *et al.*, 2013). The blanket fertilizer recommendation are based on crop responses without taking into account the spatial and temporal variability of the soils and the results is over / under use entailing economic / yield losses. This can be offset only by adopting soil testing and applying integrated plant nutrient supply as has been enunciated as "The Law of Optimum", which has been demonstrated and validated in numerous farmer's field for obtaining targeted yield of crops under the All India Co-ordinated Research Project on Soil Test Crop Response (AICRP-STCR) project annual reports (Ramamoorthy and Velayutham, 2011, Tandan 2014 and Velayutham *et al.*, (2016). A field experiment was conducted with rice as test crop on alluvial soil *Typic Ustropept* (Inceptisol) of farmer's field at Arachikuppam village, Puducherry to develop targeted yield equation following the procedure of Ramamoorthy *et al.* (1967). The various levels of FYM (0.6.25 and 12.5 t ha^{-1}) and fertilizer [four levels of N (0, 60, 120 and 180 kg ha^{-1}), four levels of P_2O_5 (0, 25, 50 and 75 kg ha^{-1}) and four levels of K_2O (0, 25, 50 and 75 kg ha^{-1})] were used. Plot-wise soil test data, fertilizer doses, yield and uptake were used for obtaining NR (nutrient required to produce one tone of rice grain), %CS (per cent contribution of nutrients from soil) %CF (per cent contribution of nutrients from fertilizers) and %Cfym (percent contribution of nutrients from organic matter), as per method described by Ramamoorthy *et al.* (1967). The results revealed that, the nutrient requirement for producing 1 quintal of rice grain was 1.44 kg of N, 0.73 kg of P_2O_5 and 1.13 kg of K_2O, respectively. The percent nutrient contribution from soil was 11.83, 21.03 and 19.27, from fertilizer 42.71, 57.18 and 68.50 and from organic manure 20.67, 19.01 and 33.85 for N, P_2O_5 and K_2O respectively. By using the basic parameters, the soil test based fertilizer adjustment equations for specific targets of rice grain yield of 7.0 and 8.0 t ha^{-1} have been calibrated based on the targeted yield concept. These fertilizer prescription equations developed for Rice (var.) ADT 43 can be used to estimate fertilizer doses formulated for the range of soil test values and desired yield targets under NPK alone and IPNS (NPK plus FYM).

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T3S1ORAL04

Effect of Inorganic and Organic Manure on Biological Properties of soil and Yield of Yam bean (*Pachyrrhizus erosus* L.) in lateritic soil of Konkan

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A field experiment was carried out during Kharif, 2019 to evaluate the effect of inorganic and organic manure on

biological properties of soil and yield of yam bean (*Pachyrrhizus erosus*) in lateritic soils of Konkan region at research Farm of All India Co-ordinated Research Project on tuber crops, Central Experiment Station, Wakawali under the jurisdiction of Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri with thirteen treatments comprised with three levels of nitrogen (80,100,120 kg ha^{-1}), phosphorus (40, 60, 80 kg ha^{-1}), FYM (10, 15, 20 kg ha^{-1}) with a constant dose of potassium (100 kg ha^{-1}) and an absolute control replicated thrice in randomized block design. The results of the experiment showed that the application of different levels of inorganic and organic manure noted significant increase in the biological properties of soil namely bacteria, fungi and actinomycetes population and highest microbial activities were recorded at 60 DAS compared to 30 DAS and at harvest stage. However, increasing level of inorganic and organic manure increased the enzyme activities and significantly highest enzyme activities were recorded in T13 treatment comprising 120:80:100 $N:P_2O_5:K_2O$ kg ha^{-1} + 20 t FYM ha^{-1} as compared to other treatments. The growth and yield contributing character, the plant height, number of leaves per plant, length of tuber and total tuber yield were recorded significantly maximum in T13 treatment comprising 120:80:100 $N:P_2O_5:K_2O$ kg ha^{-1} + 20 t FYM ha^{-1} application. However, significantly highest weight of tuber and the marketable tuber yield was obtained in T8 treatment comprising 80:40:100 $N:P_2O_5:K_2O$ kg ha^{-1} + 15 t FYM ha^{-1} application.

T3S1ORAL05

Effect of Saline Water Irrigation through Drip System on Okra in Salt Affected Soils of West Bengal

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The confluence of river Ganges and sea Bay of Bengal have resulted in formation of the coastal West Bengal. Topographically the coastal area consists of low lands which are flat with little or no slope and often suffer from inadequate drainage and waterlogging during the rainy season (June-Sept.). The region is the mixing zone of inland fresh water, rain and brackish water of the sea. Agriculture in the lean period of eight months suffers from acute fresh water scarcity and salinity. Ground water in this region varies spatially and temporally and often carries threats for water table depletion and sea water intrusion. The upper aquifer is available at shallow depth but saline. Somewhere ground water salinity is too high and not usable for agriculture. Less saline water may be available at more depths. In this scenario, cultivating more with little available water propels the idea of using highly efficient drip irrigation system. Experiments conducted at ICAR-CSSRI, RRS, Canning Town farm during 2014-2018, water of different salinities were prepared by mixing the saline groundwater with fresh water for the four treatments such as T1: 2 dSm^{-1}, T2:6 dSm^{-1}, T3: 10 dSm^{-1} and T4:14 dSm^{-1}. Only one quality of water was applied through the drip irrigation system at a time. The treatments were imposed after 20-25 days of fresh water irrigation when the crop is established. The highest yield of okra was obtained for the treatment T1, i.e. 14 t ha^{-1}. The irrigation water applied was in the range 36~48 cm during the cropping periods depending upon the unseasonal rainfall received time to time. There was about 50 % less yield in case of T4 in comparison to T1. The NDVI value was higher for the irrigation water of lower salinity (T1>T2>T3>T4) throughout the experimental period. There was little mortality of okra plants due to application of saline water even in case of T4. The water use efficiency was highest for treatment T1 whereas lowest for T4. The salinity build up was highest for T4 during the experimental period, but the salts were leached out by the runoff during rainy season.

T3S1POS01

Assessment of Soil Nutrient Index in the Post Flood Scenario in Pokkali Soils

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In recent year's world has been facing extreme weather events due to climate change in the form of different havocs like flood. In August 2018, Kerala witnessed large scale devastating flooding due to excess rainfall, as per India Meteorological Department (IMD) data, Kerala received 36 per cent excess rainfall than normal. One of the most affected districts was Ernakulam, especially AEU 5 i.e, *Pokkali* lands. *Pokkali* lands represent the lowlands, often below sea level, in coastal areas of Ernakulam district and extending to parts of Thrissur and Alappuzha districts. The soils are hydromorphic, often underlain by potential acid-sulphate sediments with unique hydrological conditions. The origin, genesis and development of *Pokkali* soils are under peculiar climatic and environmental conditions. These soils comprise low lying marshes and swamps situated near streams and rivers and are not far from the sea. They are water logged and ill drained and are subjected to tidal action throughout the year. Representative geo-referenced composite soil samples were collected randomly from 5 selected panchayats i.e, Kuzhuppilly, Nayarambalam, Elamkunnapuzha, Kottuvally and Edavanakkad. From each sampling site, soil samples were collected to a depth of 0-15 cm using soil auger. A total of 60 soil samples were collected and were analysed for organic carbon and macro nutrients. Standard procedures were followed for the estimation of nutrients. Organic carbon content of the soil sample was estimated by Walkley and Black method or wet digestion method (Walkley and Black, 1934). Available nitrogen was estimated using alkaline potassium permanganate method using Kelplus distillation system (Subbiah and Asija, 1956). Available phosphorus in soil samples was determined by Bray method. Available potassium in soil samples was determined by flame photometer using neutral normal ammonium acetate as an extractant (Jackson, 1958). The nutrient index of the *Pokkali* soils was calculated using the formula given by Ravikumar and Somashekar, (2013). Fertility status based on organic carbon, available nitrogen, available phosphorus and available potassium came under high category (NI >2.33) in Kuzhuppilly, Nayarambalam, Elamkunnapuzha, Kottuvally and Edavanakkad panchayats. Higher organic carbon content is the reason for the high nitrogen status in the soil. Due to the submergence of the soil, the pH of acidic soil increased to near neutral pH and resulted in higher availability of phosphorus. Tidal action on the *Pokkali* soils contributed to the increased available potassium. Joseph (2014) reported that nutrient indices of organic carbon, available phosphorus and available potassium came under high category (NI >2.33) and available nitrogen in medium fertility status (NI 1.67-2.33). Fertility status of Kuzhuppilly, Kottuvally and Edavanakkad panchayats based on organic carbon was rated as medium category. Fertility status of Nayarambalam and Elamkunnapuzha based on organic carbon came under high category. Fertility status of Kuzhuppilly, Nayarambalam, Elamkunnapuzha, Kottuvally and Edavanakkad panchayats based on available nitrogen came under medium category. Fertility status of Kuzhuppilly, Nayarambalam, Elamkunnapuzha, Kottuvally and Edavanakkad panchayats based on available phosphorus and potassium came under high category (Joseph, 2014). In comparison with pre-flood data nutrient indices of organic carbon, available phosphorus and available potassium recorded no wide variation after flood but there is slight deviation in available nitrogen after floods. The pre-flood data showed that nutrient index of available nitrogen was recorded medium fertility status but the results of the present study revealed that the available nitrogen is under high category. Nitrogen status is mainly governed by organic carbon content in the soil. This might be due to the deposition of organic debris after the floods. Soil fertility varies within the soil, in each growing season in each year due to the deposition and depletion of nutrients and also by tidal action in the soil. Hence soil testing and computation of nutrient index will determine the fertility status and provide information regarding nutrient availability in the soils.

T3S1POS02

Time Series Analysis of Climate Variables for Baitarini River Basin of Odisha

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The major river basins of the world play a big role in supporting more than 70% of the global population. Global warming is likely to accelerate the water cycle of the earth system, which consequently leads to changes in precipitation and evapotranspiration rate that will directly affect the sustainability of water resources. The dynamic structure of climate is mainly governed by changes in rainfall and temperature. Rainfall is the most important source of water on earth, supports majority of existence of living beings. Changes in rainfall pattern directly affect the water budget and agricultural production of an area. Hence basin wise planning is made as per the water availability from different sources and the demand from domestic, livestock, industrial sectors. Assessment is carried out based on present scenario and then future projections are proposed for the area depending upon trend analysis. Time series analysis, modelling, forecasting is necessarily becoming the part of management strategies. Baitarini River is one of the east flowing rivers of India, which has the drainage area of 14,218 km^2 in two States of Jharkhand and Odisha. Major portion i.e., nearly 13,482 km^2 areas lies in Odisha covering 42 blocks of 8 districts i.e., Balasore, Bhadrak, Jajpur, Kendrapada, Angul, Keonjhar, Mayurbhanj and Sundergarh. Water stress during post monsoon and summer season is the major issue in this river basin. Most of the upper catchment areas suffers with this condition for which the cropped area is low. But in the lower part of the basin, near to the coastal area, waterlogging and flooding is the main problem. In this paper, rainfall analysis was carried out for all the districts. Time series rainfall analysis for 119 years (1901-2020) were carried out for daily, monthly, seasonal, and annual scales. The average annual, monsoon, post monsoon, winter and summer season rainfall were 1416.7 mm, 1093.95 mm, 152.53 mm, 37.95 mm and 132.26 mm respectively for the basin. Statistical parameters (minimum, maximum, mean, standard deviation, coefficient of variation, skewness, and kurtosis) for annual, monsoon, post monsoon, winter and summer season rainfall were calculated for each of the location. As temperature is also dependent factor for agricultural system, hence trend analysis (1901-2002) of maximum, minimum, mean temperature was carried out for the basin. Temperature variation during monsoon, post monsoon, winter, and summer season for all districts were analysed. Potential evapotranspiration varied from 5 to 7.63 mm day^{-1} during August and May respectively for the entire area. The non-parametric Mann–Kendall and Sen's methods were used to determine whether there was a positive or negative trend in rainfall, temperature data with their statistical significance. For the study area, positive trend was observed in annual, monsoon and post monsoon rainfall. But no significant trends were detected in summer and winter rainfall series for all the stations. Hydrological analysis of the river basin was carried out by using remote sensing and GIS. This would be helpful to decide appropriate water management strategies for sustainable use of water resources.

T3S1POS03

Nano-Potassium Intercalated Composted Coir Pith: A Slow Releasing Fertilizer for Laterite Soils of Humid Tropics of India

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High potassium demanding plantation crops such as coconut, arecanut, cocoa and rubber are being grown in the laterite soils of humid tropics of India having low to medium level of potassium and low Cation Exchange Capacity (CEC). Poor potassium nutrition in plantation crops is a limiting factor for their higher and sustained productivity. Nano-fertilizers offer an excellent option as they release nutrients slowly for longer period, thereby increasing its use efficiency. With this background, nano-zeolite based potassium fertilizer (NZK) was synthesized and characterized. The sorption of potassium on nano-zeolite was found to increase with increase in equilibrium concentration (r^2=0.988). The synthesized nano-potassium was intercalated into raw coir pith (CNZK) and composted coir pith (CCNZK). The potassium content in CNZK and CCNZK was 27.2% and 31.6%, respectively, and the later was characterized using X-ray diffraction and Scanning Electron Microscope, and confirmed the intercalation of NZK. The release pattern of potassium was studied in laterite soils collected from arecanut-cocoa cropping system of coastal Karnataka. The desorption study indicated that nano-potassium fertilizer as such and when intercalated into composted coir pith was found to release the nutrients slowly for longer period (> 432 h) in the laterite soils of humid tropics. Our study suggests that nano-potassium fertilizer can be developed using nano-zeolite as a carrier which can be intercalated into the composted coir pith which releases potassium slowly and make the application easier and safer as inhalation is the important route of nanoparticle exposure in humans and livestock.

T3S1POS04

Soil Quality and Productivity Assessment for Bridging the Yield Gap in Farmer's fields of Coastal Cauvery Deltaic Region of Karaikal

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Yield and technology gap is a major problem in increasing paddy production in the diverse rice agro ecosystems in India. Farm yields and farmers income swing widely in irrigated ecosystems of the states. The marginality is a dynamic process - a land unsuitable for poor rice growers due to low level of inputs/technologies adoption, lack of irrigation, could be made highly productive for the same farmers by utilizing all the resources and technological interventions. A study was, therefore, conducted in *Kharif* 2019, in farmer's field locations representing major rice growing coastal Cauvery deltaic region of Karaikal to assess the nutritional status and productivity of the crop under farmer's current management practices for further improvement in rice productivity. Participatory rural appraisal, group discussion and transect walk were followed to explore the detail information of study area. The questioner-based survey was conducted in twenty-four farmer's field spread across five villages of Karaikal at the end of the harvest season rabi (Samba), 2019-20 cultivating CR1009, BPT5204, ADT46, White Ponni, Kichadi Samba, TKM 13 and applying varying levels of NPK as -80:58:19, 80:58:10, 80:58:00,80:58:37,120:80:57,40:29:00,90:58:37,

90:53:75, 40:58:37, 90:10:29, 160:44:60. The initial, post-harvest soil samples along with grain and straw samples were collected and analyzed for their soil characteristics and nutrient content, respectively. The co-ordinates of the farmer's field selected for the study were also recorded. For grouping the data for yield, two categories were formed as low yielders having below 4tonnes per ha productivity and high yielders having more than 4 tonnes per ha productivity. The grain yields recorded varied from 3.59 t ha^{-1} among low yielders to 4.67 t ha^{-1} among high yielders at Karaikal. Soil Parameters data were pooled in different categories and the resulting soil quality index generated showed variations in the quality and health of the soil across different farmer's categories and for nutrient uptake between low yielders and high yielders across the locations. At all locations, wide variations in grain yields and nutrient uptake were recorded while soil test values did not match with rice yield and nutrient uptake, suggesting less suitability of current soil testing methods for flooded soils. Nutrient requirement calculation was a useful tool to know how the responses were for fertilizers applied per ton of the grain yield obtained and the recommendation given for low yielders from the study was 13.7: 13.17: 27.54 kg NPK per tonne grain yield. In the scenario of ever-changing fertilizer management practices followed across rice fields in India, there cannot be a single blanket fertilizer formulation followed for diverse soil ecosystems with less importance given to management induced site variations which mainly cause nutrient imbalances and unsustainability. Fertilizer nutrient management not matching with the variability in soil fertility of the farmer fields is one of the important factors responsible for low rice productivity. Variability in nutrient acquisition and its utilization by genotypes for yield expression is coupled with nutrient application in right proportions to meet the growth requirements of a genotype is vital for realizing the yield potential in any given farming situation. The study thus indicated ample scope for improvement in nutrient use efficiency, precise assessment of nutrient requirements of such varieties under each farmer's condition for arriving at the fertilizer prescriptions to ensure harvestable yield potential on sustainable basis besides optimizing input use.

T3S1POS05

Phosphorus Fixation and Release Studies in Major Rice Growing Soil Series at Coastal Deltaic Region of Karaikal

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The fixation studies elucidate the amount of nutrients fixed in the soil, while the release pattern indicates the amount of nutrients that can be released for the plants from the soil. Nowadays, the farming sector are planning to perform their fertilizer recommendations based on the soil test values; but on prescribing the soil test values, there was less concern about the fixation and release pattern studies. In case of high nutrient fixing capacity soils, the prescribed rate of nutrients may not be absolutely made available to the crops for which they are meant unless the soil equilibrium is maintained to satisfy the fixation complex. The release and supplying power of the soil that are used synonymously is the key thing to have an idea about capacities of soil to supply nutrients to the plants all along its growth. Therefore, fixation properties, residual value of nutrients and their release patterns should be evaluated for fertilizer recommendation to have positive and practical impact on the crop grown. A laboratory experiment was thus carried out at Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal, to estimate the P-fixing and releasing capacity of soil collected from the major rice growing soil series (Thirunallar, Karaikal and Pattinam soil series) of Karaikal region. Phosphorus fixing and release capacity of three soil series was calculated by adding different levels of P as KH_2PO_4 *viz*. 0, 25, 50, 75, 100, 125, 250, 375, 400, 425 and 500 ppm and extracting successively in each of the levels until constant value is reached. Irrespective of soil series, the P fixation and release increased with increasing P levels and the per cent P fixation did not vary much among the soil series. The maximum P fixation of 100 to 99 per cent, 99 per cent and 99 to 98 per cent were achieved in Karaikal, Thirunallar and Pattinam soil series, respectively which would serve as evidence for the saturation of fixation complex of soils. Among the

soil series, the cumulative release increases slowly and steadily with added P levels in Thirunallar and Karaikal soil series which might be due to higher clay per cent and organic carbon status in the soil. Whereas in Pattinam soil series, the cumulative release was slowly increasing up to 250 ppm and thereafter a sudden significant increase was registered from 375 to 500 ppm level of P. This lesser release at lower levels indicates that medium textured soils require more P to satisfy the adsorption complex than heavy textured soil in order to release P in solution. Even though there exist significant variation in the successive release of P in all the soil series, the cumulative release of P fits well into the 4th order polynomial equation of the form $Y = aX^4 + bX^3+cX^2+dX+e$, where, Y is the Cumulative P release, X is the number of extractions and a, b, c, d are constants varying with the soil indicating the slope of the curve on successive extractions and constant "e" is the instant releasing power of the soil. The 4th order polynomial equation that fits to P release in different soil series are given below:

Soil Series	4th order polynomial equation	R^2
Thirunallar soil series	$Y = -0.0007x^4 + 0.0225x^3 - 0.2155x^2 + 0.9285x + 0.8911$	0.99
Karaikal soil series	$Y = -0.0001x^4 + 0.0022x^3 + 0.0024x^2 - 0.0365x + 3.4567$	0.99
Pattinam soil series	$Y = -0.0004x^4 + 0.0152x^3 - 0.1712x^2 + 0.7932x - 0.2388$	0.99

From the above equation, it could be concluded that with higher "e" value in Karaikal, the instant release of P would be greater followed by Thirunallar and Pattinam, respectively. Similarly, the lower negative co-efficient value of 4th order indicates that the decreasing release in the successive extractions was shallow or flat as experienced in Karaikal and Pattinam soil series. On the other hand, higher negative co-efficient value of 4th order in Thirunallar indicates that the decreasing release in the subsequent extractions was steeper. Similarly, the higher positive co-efficient value of 3rd order indicates the steep rise in the release on successive extractions as evidenced in Thirunallar soil series and vice versa in Karaikal and Pattinam soil series.

T3S1POS06

Validation of Soil Test Crop Response Based Integrated Plant Nutrition System (STCR-IPNS) Recommendations for Hybrid Bhendiin U.T. of Puducherry

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Bhendi (*Abelmoschus esculentus* L.) is one of the important fruit vegetables in India. It is an excellent source of proteins, carbohydrates and vitamin C (Gopalan *et al*., 2007) and plays a vital role in human diet (Kahlon *et al.*, 2007). In India, bhendi is cultivated in 12,780 hectares with a production of 88,070 tonnes (Horticultural statistics, 2016-17), while in puducherry it is grown in 80 ha, producing 760 tonnes in a year (Horticultural statistics, 2016-17). The present consumption of vegetables per capita per day is 135 g against the requirement of 285 g per capita per day emphasizing the necessity to enhance production of vegetables which can be achieved by bringing more land under vegetables cultivation and increasing the productivity of the vegetables as well. To mitigate these issues, adoption of appropriate site and situation specific nutrientprescriptions will become one of the technological interventions for boosting the yield bhendi. In conventional method, blanket recommendation is made which leads to either over or underuse of fertilizer nutrients. Therefore, to enhance the efficiency and economy of fertilizer use, the current option is to adopt economically and ecologically sound management strategies like Soil Test Crop Response based Integrated Plant Nutrition System (STCR-IPNS) for ensuring balanced nutrition, sustained crop productivity

and soil fertility in intensive cropping sequences over long run. Further it could form an important component of "Precision Agriculture" for maximizing the productivity of crops. Soil Test Crop Response based Integrated Plant Nutrition (STCR-IPNS) recommendations developed for hybrid bhendi on *Typic Ustropept* soils of Puducherry was validated at farmer's holding at Karikalampakkam, Puducherry district. The experiment consisted of ten treatments viz., blanket recommendation, STCR-NPK alone for 160, 170 and 180 q ha^{-1} yield targets, STCR-IPNS for 160, 170 and 180 q ha^{-1} yield targets,farmer's practice , FYM alone and absolute control in RBD with three replication. The findings emanated from the test verification trials clearly revealed that the per cent achievement of the aimed yield target was within +10 per cent variation confirming the validity of the STCR-IPNS recommendations. The STCR treatments recorded significantly higher yield, Response Ratio (RR) and BCR over blanket while STCR - IPNS treatments recorded relatively higher yield, RR and BCR over STCR-NPK alone treatments. The yield targets of STCR-IPNS for 180 q ha^{-1} of bhendi proved their superiority over all other treatments in terms of yield (179.50 q ha^{-1}), BCR (3.00) and quality parameters viz., mucilage (4.54%), starch (4.95), protein (1.84%), crude fibre (10.36%) and ascorbic content (13.99 mg per100 g). These treatments had recorded a yield increase of 11.35 and 32.96 per cent respectively over blanket and farmer's practice for maize. The post-harvest soil test values of test verification trials revealed that, soil test based fertilization resulted in either build up or maintenance of soil fertility and the magnitude of build up was higher with STCR-IPNS as compared to STCR-NPK alone, blanket and farmer's practice. Therefore, soil test based fertilizer prescription can be recommended to Typic Ustropept soils of puducherry for achieving 180 q ha^{-1} of bhendi yield.

T3S1POS07

Effect of Inorganic and Organic Manure on Yield and Quality Parameters of Yam bean (*Pachyrrhizus erosus* L.) in Lateritic Soil of Konkan

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A field experiment was conducted to study the effect of inorganic and organic manure on biological properties of soil and yield of yam bean (*Pachyrrhizus erosus*) in lateritic soils of Konkan region during Kharif, 2019 at Research Farm of All India Co-ordinated Research Project on tuber crops, Central Experiment Station Wakawali, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri with thirteen treatments consisted three levels of nitrogen (80,100,120 kg ha^{-1}), phosphorus (40, 60, 80 kg ha^{-1}), FYM (10, 15, 20 kg ha^{-1}), a constant dose of potassium (100 kg ha^{-1}) and an absolute control replicated thrice in a randomized block design. The study revealed that the growth and yield contributing characters, the plant height, number of leaves per plant, length of tuber and total tuber yield were recorded significantly maximum in T13 treatment comprising 120:80:100 $N:P_2O_5:K_2O$ kg ha^{-1} + 20t FYM ha^{-1} application. Further, it was observed that reducing sugar (1.45%), non-reducing sugar (4.26%) and crude fibre (1.80%) in the treatments T13 however, Starch (11.74%) and Ascorbic acid (13.19%) were observed in the treatments T12. However, significantly highest weight of tuber (254.33 g) and the marketable tuber yield (21.67 t ha^{-1}) in T8 treatment comprising 80:40:100 $N:P_2O_5:K_2O$ kg ha^{-1} + 15t FYM ha^{-1} application. Moreover, the significantly higher total tuber yield (22.96 t ha^{-1}) was obtained in the treatment T13 receiving 120:80:100 $N:P_2O_5:K_2O$ kg ha^{-1} + 20t FYM ha^{-1} application. The quality of yam bean tuber was found superior in treatment T13 consisting of 120:80:100 $N:P_2O_5:K_2O$ kg ha^{-1} + 20t FYM ha^{-1} significantly increased the reducing, non-reducing sugar, starch content and crude fibre content of yam bean tubers.

T3S1POS08

Zinc Enrichment in Cereals with Proper Scheduling of Zn Application Protocol and Cultivar Choice

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Saline soil having pH more than 7.0 poses a risk for cationic micronutrient deficiency in plants in coastal region. Cationic micronutrients exist principally as insoluble hyroxide form when soil pH is more than 6.0. Zinc deficiency in crops may be obvious in this type of soil. Zinc enrichment in grains may be a possible option through agronomic biofortification of Zn in cereals to overcome the problem. We assessed the effect of agronomic biofortification of Zn in grains and foods processed from rice and wheat with the potential of different Zn application protocols and cultivars. Six protocols of Zn application through soil, foliar or both at critical phenological stages of the cereals were evaluated, each with ten cultivars, analysing both the harvested grains and processed foods for Zn and phytic acid contents. Zinc enrichment was more acute in rice (58-70% over control) than in wheat (40-50% over control) and varied significantly among the cultivars and Zn application protocols. Application of Zinc at later growth stages of crop produced more Zn dense grains. Such enrichment in grains ended up with addition of 1.0 and 3.0 mg of Zn in 300 g of cooked rice and flat breads of wheat prepared from those Zn fortified grains, respectively. Application of Zinc significantly reduced phytic acid content in grains and foods processed from Zn biofortified cereal grains. Such a decrease in phytic acid content improved Zn bioavailability in grains and processed foods of different rice and wheat cultivars.

Theme III:

Natural resources and carbon flow dynamics vis-à-vis soil quality, water use trends, and integrated water management including ground water and farm machinery developments

SESSION II:

River flow dynamics, bank erosion, surface & underground water flow modelling vis-à-vis climate change

T3S2I01

DYNAMIC BEHAVIOURS OF THE ESTUARIES IN RESPONSE TO THE PHENOMENON OF GLOBAL WARMING IN THE COASTAL ECOSYSTEMS OF WEST BENGAL AND ODISHA, INDIA

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Dr. Ashis Kumar Paul had completed his Ph.D. degree in Geography from the University of Calcutta on "Coastal Geomorphology and Ecology in parts of West Bengal" during 1992. He had also carried out two research projects on the topic "Morpho-ecological dynamics of the Sundarban coastal tract", and on the "Coastal tourism prospects in West Bengal and Odisha" funded by the UGC during 1993 to 1996 in the Dept. of Geography, Ashutosh College, Kolkata. He has authored reference books on "Coastal Geomorphology and Environment" and on "Tsunami-the disaster in Indian Ocean nations". He has also done various consultation works on Environmental Auditing during 2006-2008 at Vidyasagar University under a group of Environmental scientists. He has worked on research projects related to "Hydro-geomorphology" and on "Water quality of river basin wetlands" funded by PHE, Govt. of West Bengal and Central Pollution Control Board carried out at Vidyasagar University during 2012-2015. He has supervised 30 Ph.D. research scholars in Department of Geography and Department of Remote Sensing & GIS at Vidyasagar University on the aspects of Coastal Geomorphology, Coastal Agriculture, Land Degradation, Forest Degradation, Coastal Hazards and Disasters, Livelihood Security of Coastal people, Geospatial techniques in Coastal studies, Coastal Tourism Environments, Coastal Morpho-dynamics and Integrated River Basin Management. He has published about 150 research papers in the National and International journals and as book chapters of edited volumes. He is engaged in teaching Physical Geography, Oceanography and Coastal Management in the Department of Geography at Vidyasagar University since 2006 to till date. Currently, He is doing research on the Coastal Habitats, Coastal Geomorphology and Coastal Hazards in Indian Coastal Zones and in Island systems. He is associated with the committee of Quality Assessment of CRZ maps in West Bengal under the Dept. of Environment. He has received the international award from CERF, JCR, USA in 2017 and also elected as the President of Indian Institute of Geomorphologists (IGI) for the year 2020.

Abstract: The coastal plain estuaries are sediment sink and they try to adjust with the changing environment of hydrodynamics and sediment input systems but never achieve the equilibrium. Odisha and West Bengal coasts represent number of estuaries such as the Hugli R., Ichamati-Raimangal R., Subarnarekha R., Brahmani-Baitarani R., Mahanadi R., Daya and Bhargav R. and Rushikulya R. along the shore fringes of the Bay of Bengal. A disturbance regime is generated in the tropical coastal system at present due to the impacts of global warming phenomenon and for which the estuaries are affected by bank line shifting, shoreline retreats, sediment encroachments, thalweg shifting and widening of estuary fringe tidal flats. The study also reveals that the erosion-accretion processes induced by dynamic behaviors of estuaries on the other hand producing damages to the sensitive coastal habitats of the region at alarming rate. The high rate of SST, high magnitude cyclone landfalls, warming induced sea level

rise, delta land subsidence process and human interventions into the coastal systems have created the disturbance regimes of episodic energy inputs. Mangrove ecosystems and dune ecosystems of the coastal fringes are largely affected by such dynamic behaviors of estuary channels, episodic energy inputs, shifting sands, ephemeral rise of sea waters, and tidal drainage loss into the higher tidal flats of the coast.

Remote Sensing techniques, other attribute data from different sources, and multi temporal field survey methods helped to identify the geomorphological signatures, the status of degraded coastal habitats and the nature of changes of the coastal systems in the present study. Such critical factors and their functions of the coastal systems should be understood for management potentials of the coast.

T3S2I02

POTENTIAL OF RIVER BANK FILTRATION (RBF) FOR SAFE WATER SUPPLIES FROM SALINE COASTAL AQUIFERS

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Dr. Y. R. Satyaji Rao had joined as Scientist at National Institute of Hydrology, Roorkee in the year 1992 and having 28 years research experience in the field of Hydrology especially on catchment water balance models, Hydrological monitoring network design, Rainfall-runoff modeling, ground water quality evaluation and modeling. He is having hands-on experience on application of Remote Sensing, GIS, and Artificial Neural Network tools. Important research projects completed are: East flowing river catchment water balances, establishment rainfall recharge coefficients in Mahandhi, Godavari, Krishna and Pennar deltas, nitrate transport modeling in coastal aquifers due to faulty septic tanks, hydrological time series modeling, estimation of reservoir sedimentation rate using Remote Sensing technique and storm water management in Chennai and Hyderabad etc. Worked as adjunct faculty at San Diego State University, USA under UNDP project and warded junior fellowship of IWMI, Srilanka. Published 125 technical papers in Journals and Conferences and 25 in-house projects completed on various facets of Hydrology.

Abstract: Soil and groundwater salinity is one of the major environmental factors lowering the agricultural production in the coastal part of Andhra Pradesh State, India. The mixing of high amounts of various salts with fresh water (in a few parts of the coastal zone in the State) renders groundwater unsuitable for agriculture and drinking purpose which may be due to various factors such as the Paleo-marine environment, aquaculture and low coastal topography etc. To achieve food security, there is a need to focus on crop productivity in the saline coastal areas. Even though the paddy and other high water dependent crops are being cultivated largely in the fertile lands, some of the inland parts are less cultivated (or converted into commercial crops) commonly due to the high soil salinity/ saline groundwater in the coastal districts. Such a problem encountered in the downstream of the Varaha river basin, Visakhapatnam district, A.P., which is mainly due to the saline soils or saline groundwater (Groundwater EC varied between 1500-7000 $\mu S\ cm^{-1}$) resulted the land degradation. The downstream area of Varaha river basin is

underlain by saline coastal aquifer and has no canal irrigation. Due to degraded lands, the possibility of agriculture area (paddy) is very less and therefore palm oil cultivation other salt tolerant crops are main cultivable crops in the coastal tracts. The identification of low saline zones in the subsurface for improving the water quality in this coastal environment is a challenging task. The natural River Bank Filtration (RBF) technique on Varaha river bank is a strategy to obtain low saline induced (filtrated) water from the bank filtrate well for sustainable domestic as well as agriculture/horticulture practices. The extent and exact depth range of low saline river-aquifer interaction (riverbed-aquifer connection) zone is identified using an integrated approach which include hydrogeochemical studies, geophysical (VES and ERT) surveys, pumping tests and groundwater flow modelling techniques. Based on resistivity surveys, a suitable RBF well has been drilled on Varaha river bank and the lithologs are collected at every 1m depth interval. The pumping rates have proved that the aquifer is productive and the EC values (720–850 $\mu S\ cm^{-1}$) of induced water from RBF well are within the domestic and irrigation limits throughout the pumping time (5 hr) and hence it is found that the extracted water (induced water from bank filtrate) is suitable for drinking and irrigation supplies. The RBF well is yielding nearly 520 lpm with suitable quality during 5 hr pumping period. Further increase of pumping time may lead to the cone of depression around RBF well resulting to the water quality deterioration. The particle tracking analysis using MODFLOW and MODPATH estimated to be higher migration of induced bank filtrate (74%) and the more capture zone (river water influenced zone) than surrounding production wells. The optimum pumping rate of 150 $m^3\ day^{-1}$ within recommended pumping time (5 hr) is crucial to tap high quality induced water from RBF well. As reduced contaminants (heavy metals and other chemical contaminants) by this natural treatment of pumping process, the high-quality RBF well water could be viable option for drip/sprinkler irrigation in order to increase the productivity of horticulture crops in any similar saline coastal regions.

T3S2I03

GROUNDWATER MODELLING FOR SUSTAINABLE MANAGEMENT OF COASTAL AQUIFERS OF IRRIGATED REGIONS UNDER CLIMATE CHANGE

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Dept of Atomic Energy, PWD, MECON, Larson and Toubro, HPCC, Gammon India, Gimpex etc. He has travelled under academic and research assignments to Australia, Austria, Brazil, Canada, Czech Republic, Denmark, France, Finland, Germany, Hong Kong, Hungary, Italy, Japan, Netherlands, Russia, Spain, Switzerland, Singapore, Sweden, South Korea, South Africa, Thailand, Tunisia, UK and USA. He has published over 175 research papers and 25 scholars have completed their PhD under his guidance until the year 2020.

Abstract: Climate change and increase of agricultural production will affect coastal aquifers around the world. Groundwater is the major source for irrigation in most of the coastal parts of India. The region just north of Chennai city is no exception and is being affected by seawater intrusion due to over extraction of groundwater for agriculture and drinking water supply to Chennai city. The objective of this study is to evaluate the impact of climate change for identifying measures for sustainable management of groundwater resources in the coastal aquifer by groundwater modelling. Density-dependent model was used to predict the changes in hydrological stresses on the groundwater head until this year. The study indicates that 10% increase in rainfall recharge with an additional check dams and 1 m increase in crest level of all the existing check dams scenario increased the groundwater head of about 3 m in the upper and 5.5 m in the lower aquifers. Thus, the construction of Managed Aquifer Recharge structures will decrease the chloride concentration and restore in this seawater intruded aquifer. Thus, the groundwater modelling tool was used to identify measures to manage the coastal groundwater resources in an intensively cultivated region.

T3S2I04

WATER SENSITIVE AGRICULTURE - THE USE OF INNOVATIVE MODELS TO HELP INCREASE LAND AND WATER PRODUCTIVITY AND WATER QUALITY PROTECTION IN COASTAL ECOSYSTEMS

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Dr. Ranvir Singh is an environmental hydrologist, with specific research expertise and teaching experience in catchment hydrology, irrigation and agricultural drainage systems, water quality, farm nutrient flow pathways and their potential attenuation options, and water productivity and foot printing sciences in agricultural landscapes. He holds a Masters in Soil and Water Conservation Engineering (1999) from CCS Haryana Agricultural University, Hisar (India) and a PhD in Environmental Sciences (2005) from Wageningen University in The Netherlands. He did his post-doctoral at Iowa State University, Ames (USA) and a research fellowship at Western Sydney University (Australia). Ranvir is currently working as an Associate Professor in Environmental Hydrology and Soil Science at Massey University in New Zealand. He is also affiliated as a Visiting Professor, Facultad de Ciencias Agronomicas, Universidad de Chile, Santiago, Chile. He has been a member of the Water Footprint Network (WFN) and participated and contributed to the FAO Water Technical Advisory Group (2016-18) for development of the LEAP guidelines for water use assessment of livestock production systems and supply chains. He has published over 75 research articles in scientific journals or conference/workshop proceedings and serves as Associate Editor for Agricultural Water Management journal. He has gained significant research knowledge and experience while working on different

projects related to water management in rural and peri-urban landscapes in India, USA, Australia, Indonesia, China, Chile and New Zealand.

Abstract: Agriculture and its associated industries play a key role in a nation's food security and social and economic wellbeing, particularly in rural areas. However, increasing population, urbanisation and industrialisation are putting enormous pressure on the limited land and freshwater resources available in both inland and coastal environments. A robust development of water sensitive agriculture practices offers opportunities to increase resource use efficiency while reducing negative environmental impacts. Reflecting on the challenges faced this paper will present recent advances in the development and application of innovative methods and models to help develop water sensitive agriculture focused on improving land and water productivity and water quality protection in farmed landscapes. Concepts of water productivity and land use suitability will be defined to help assess and improve the efficiency of water use and reduce the impacts of agriculture on water quality. Case study examples will be presented on (i) the modelling of water productivity and sustainability of irrigation systems in northern India and (ii) the use and mapping of the concept of 'land use suitability' and 'edge-of-field' mitigation options to reduce nutrients (nitrate) losses from agricultural lands in New Zealand.

T3S2POS01

Assessment of Long Term Trends in stream flow of River Basins flowing in the West Coast of India

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Coastal region of India is one of the most fragile ecosystems, as it is highly vulnerable and exposed to several natural and anthropogenic activities. The coastal ecosystem is the integral part of the river basins as they form a major link between the land and sea. A study was carried out to assess the long term trends in seasonal and annual stream flow of rivers flowing in the west coast of India. The stream flow gauging stations time series data from 1986-2015 (30 years) was used to analyse the temporal trends of these west flowing rivers. A total of 29 stream flow gauging stations were selected i.e 10 stations from Tapi to Tadri basin and 19 stations from Tadri to Kanyakumari basin for the analysis based on the data availability. The different statistical tests such as Mann-Kendall test, Spearman's rho test and linear regression were used to analyse the trend in time series and sen's slope was used to estimate the rate of change. All the tests were considered statistically significant at 1% and 5% significance level. The results revealed that during monsoon season (JJAS), out of 29 stations, 16 showed increasing trends and 13 showed decreasing trends in streamflow, but only 5 stations exhibited significant increasing trend and 2 stations (Collem and Pattazhy) exhibited significant decreasing trends. The trend analysis of streamflow during pre-monsoon season (MAM) revealed that 15 out of 29 stations showed increasing trend and 14 stations showed decreasing trend in which only 4 stations exhibited significant increasing trend and 4 stations exhibited significant decreasing trend. In the post-monsoon season (OND), only 2 stations (Durvesh and Nanipalson) showed significant increase in stream flow whereas the trends in the other 27 stations were not significant. During winter season (JF), only 3 stations exhibited significant increasing trend whereas 4 stations exhibited significant decreasing trend. The annual stream flow followed the trend similar to monsoon stream flow. The decreasing trends in the seasonal and annual stream flow in some of the river basins indicates decrease in water resources, resulting in less water available for irrigation of pulses and vegetable crops during post-monsoon season, as well as for the perinneal crops like Cashew, Coconut, Arecanut and Mango which are predominantly cultivated in the west coast region of India. The results of the present study will be useful for planning proper water resource management strategies in the river basins. Water conservation measures like check dams, farm ponds and percolation ponds needs to be adopted for storing rain water and improving the ground water table in the river basins showing decreasing stream flow trends

for utilizing water during post-monsoon season for irrigating Rabi crops, and strategies like enhancing the capacity of reservoirs and creating additional storage facilities for storing excess flow in the river basins showing increasing stream flow trend needs to be adopted for utilizing stored rain water for irrigating the crops during post-monsoon and summer seasons.

T3S2POS02

Design of a Sand Based Storm-Water Filtration Unit for Groundwater Recharge

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Groundwater use is being increasing at an alarming rate, which aggravates the cause of groundwater depletion in many parts of India. The exhausting groundwater table can be tackled through recharge which is mainly achieved by natural or artificial methods. Generally artificial groundwater recharge methods, percolation pond, recharge shaft, recharge pit are the common techniques, though clogging being one of the major issues which affects the recharge structures. Filtration unit present in recharge structures can enhance the recharge rate only if designed properly to counteract the sediment formation. There are no fixed criteria for designing the thickness of different layers of the filtration material of the recharge structures in India. There is uncertainty in achieving adequate recharge rate due to this reason. Among different filtering materials coarse Sand (CS), gravel and pebbles are commonly used in different sizes. A laboratory experiment was carried to observe the removal efficiency, recharge rate of a filtration system which was made of PVC pipe with 150 cm height and 25 cm diameter. CS of different particle size ranging from 0.25 to 1 mm, gravels (8 to 20 mm) and pebbles (20 to 40 mm) bed were arranged and outlet was given at the bottom of the system. Coarse sand being the finest material which was exposed to storm water first, thus higher amount of suspended particulates retained in it. The experiment also showed that more than 70 % of suspended particles were entrapped in first 20 cm of CS bed with larger particle size and as thickness of CS bed increased, simultaneously the removal efficiency was also enhanced. Therefore, the particle size of CS plays a significant role in designing the recharge structures and improves the quantity and quality of recharged water.

Theme III:

Natural resources and carbon flow dynamics vis-à-vis soil quality, water use trends, and integrated water management including ground water and farm machinery developments

SESSION III:

Jute geo-textiles and its applications in coastal ecosystems

T3S3I01

APPLICATION OF SYNTHETIC GEOTEXTLES FOR PROTECTION AGAINST COASTAL EROSION

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Er. Tapobrata Sanyal graduated in civil engineering from Calcutta University (Bengal Engineering College—now IIEST) in 1961. He had his in-service training in the Netherlands as a government nominee in river engineering in the specialized field of geo-synthetic applications. He headed the river-research wing of Kolkata Port Trust as the Chief Hydraulic Engineer (1992-2000). He was a member of West Bengal Senior Service of Engineers prior to joining the port-service. He also served as the Chief Consultant to National Jute Board, Ministry of Textiles, Govt of India for some time. He is acknowledged as a leading expert in river engineering in the country and a pioneer in the field of Jute Geotextiles. He is the first to author a book on application of Jute Geotextiles titled "*Application of Jute Geotextiles* in Civil Engineering" (published by Springer). His book on the river Hugli in Bengali is a pioneering work ('*Hugli Nadir Gati O Prakriti*'). He is a fellow of the Institution of Engineers (India) and member of several academic bodies in India and abroad. He was also the recipient of the Cambridge Certificate for outstanding Engineering Achievement. His name figured in Marquis' Who's who in Asia' (2012- 2nd edition). He was awarded Life Time Achievement Certification from the International Geosynthetics Society (IS) for his outstanding role in the field of geosynthetics in 2006. He has contributed more than 60 technical and research papers in national and international journals and has received a number of awards for his achievement.

Abstract: Protection of coast against erosion is an important component of coast-land management. Dynamic oceanic environment punctuated by waves, strong currents especially littoral drift, storm surges, sea-level rise coupled with anthropogenic activities such as dredging are main causes of coastal erosion. Geotextiles made from thermoplastics (synthetic) belong to the group of planar textile fabrics used usually in or on soil to improve its engineering performance. Synthetic Geotextiles have been in use to protect coasts for the last 5/6 decades effectively in the developed countries. The USP of polymerized geotextiles is its long-term durability, high tensile strength that can withstand the erosive forces of Nature, flexibility of construction according to design, easy availability and economy. For geotextiles to perform efficiently, they must satisfy the site-specific mechanical, hydraulic and durability criteria. The long-term behavior of geotextiles against mechanical stresses in a site-specific hydraulic environment is pre-assessed in laboratory. Geotextiles singly may not however protect a coast subject to severe erosion for which off-shore structural intervention in addition to robust on-coast geotextile protection may be necessary. Selection of the right product for a specific application and quality control are critical. Innovative forms of geotextiles such as geo-tubes/geo-containers are also used in appropriate cases. Eco-concordance of polymer-based geotextiles is not however without question. But effectiveness and economical advantages of synthetic geotextiles score over their environmental limitations.

T3S3I02

EFFICACY OF JUTE GEOTEXTILES IN MITIGATING SOIL RELATED PROBLEMS ALONG WITH A FEW CASE STUDIES

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Pradip Choudhury did post graduate course in Jute Technology from the University of Calcutta in 1974 and later on became the Fellow of the Institution of Engineers (IEI). He worked in Jute Industry for five years and thereafter joined Indian Jute Industries' Research Association (IJIRA) as Technologist in the year 1979 and worked there till March, 2016 as Principal Technologist. In April 2016 he joined National Jute Board (NJB), and has been pursuing the research and application of different types of jute geotextiles/agro textiles. Some of his research achievements are (1) Unique method of jute bag manufacturing (2) development and successful field application of JGTs of width up to 200 cm and tensile strength up to 40 kN m^{-1}, (3) Development and application of lighter, simplified plain weave JGT of tensile strength of 25 kN m^{-1} & 20 kN m^{-1}, (4) Development and application of jute sapling bags (JAT) for growth of sapling in the nurseries. He has published more than 130 papers in National and International journals / proceedings of conferences. He has also 5 patents in his credit. More than 800 technical presentations have been given by him in different seminar/conference/engineering colleges / academic institution (as guest faculty) within and outside the country. He was awarded UNDP Research Fellowship and undertook advanced R&D work on jute composite at FPL, Wisconsin University, USA. He has been honored with "Dr. Triguna Sen Award" in 2007 and also has been felicitated as an "Eminent Engineering Personality" in 2015 for his outstanding contribution in the field of Geotextile Engineering by the Institution of Engineers (India).

Abstract: The environment around the globe is governed by three main basic elements viz., soil, water and air. The natural environment is progressively transformed by human beings with indiscriminate deforestation, ever-expanding urbanization, building large industrial projects, setting up nuclear plants etc. The restoration of environmental eco-system through application of bio-engineering approach is a proven cost-effective method and can conveniently be adopted as remedial measures. With the growing awareness for the protection of environment the scientists and technologists have developed new products which are eco-compatible and bio-degradable. In this respect application of jute geotextile (JGT), made out of 100 % natural fibers of jute, has been found to be more effective for protection of surface soil erosion, stabilization of earthen slope & overburden dumps, road construction, river bank protection including growth of seedling / sapling in forest nurseries and many more. The products have been standardized by BIS and application guidelines have also been published by the competent authorities of state and central Govt. depts. Total number of successful field applications as of date is more than 800 in India. The products were found to be highly effective in normal soil and climatic condition. Interesting, JGT was also found equally effective in difficult soil in and around Sunderban area where the materials were used for construction of Aila affected flood embankment, road construction in Patharpratima and elsewhere, river bank protection in Kakdweep, growth of mangrove sapling at Kulpi and elsewhere, construction of rainwater harvesting tank at Sagar Island etc. JGT is one of the low-cost technologies for protection of environment in mitigating soil related problems. Its method of application along with effect has been discussed in this paper substantiated with some case studies.

T3S3I03

PROTECTION OF SOIL EROSION OF EARTH EMBANKMENT USING NATURAL FIBRE-BASED COMPOSITE-STRUCTURED GEOTEXTILES

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Abstract: Jute-HDPE composite structured geotextiles was developed to improve the performance of earthen structure of embankment, through soft revetment. The optimized geotextiles (430 g m^{-2}) containing 86% natural component (on weight) having better physical, mechanical (tensile strength, 10 kN m^{-1} (machine direction) and 18 kN m^{-1} (cross direction), index puncture (163 kN) and CBR (1.5 kN), hydraulic (AOS 178 μ) and endurance properties than 100% HDPE geotextiles. Coconut fibre geotextile net was placed over jute-polyolefin geotextiles to resist washing off of loose cover soil till the establishment of vegetation. Placing of continuous seamless geotextile tube (weight 196.2 kg m^{-1}) filled with moist river sand at the anchor trench- cum-toe guard. Initially closed structure of geotextile assisted in efficient filtration leading to soil stabilization through compactness of soil layer (14 cm thick). The uniqueness of work lies in conversion of closed structure of geotextiles to open-mesh of HDPE slit film on degradation of jute, remained beneath the cover-soil, through which grass root penetrated the geotextiles sheet and riveted both the layers of soil, the cover and the compacted back layers. The remnant synthetic part thus acts as durable reinforcing element and its increased porosity provides breathability for growth of soil flora and fauna. Bermuda grass turf provided very high nailing strength (658.8 kN m^{-1}) with the soil through intertwining of grass roots with durable synthetic network.

Theme III:

Natural resources and carbon flow dynamics vis-à-vis soil quality, water use trends, and integrated water management including ground water and farm machinery developments

SESSION IV:

Carbon dynamics and C sequestration in coastal ecosystems vis-à-vis soil quality

T3S4I01

CARBON SEQUESTRATION AND QUALITY OF COASTAL SOILS

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Abstract: Most of the coastal areas have problematic soils affected with salinity, alkalinity and acidity. Some other location-specific problems include sea-water intrusion, iron toxicity, impeded drainage, high permeability, nutrient leaching and erosion. Nutrient, particularly nitrogen use efficiency in these soils is low. Climate change and discharge of pollutants are further degrading quality of coastal soils. Climate change affects soil quality due to ingression of saline water with sea-level rise, erosion with extreme rainfall events, loss of carbon with increased temperature and drought stress and salinity with increased evaporation. Majority of the industries in several countries are located in the coastal region. They discharge their waste into the coastal region. Municipal, industrial and sewage wastes discharged in the rivers of the upper terrestrial lands also find their way into the coastal region affecting soil quality. Coastal ecosystem such as mangroves, tidal marshes and sea grass meadows store and sequester more carbon per unit area than terrestrial forests. Often referred to as blue carbon, it plays a significant role in mitigating climate change. Unfortunately, these ecosystems are getting lost or damaged and their carbon sink capacity is reduced. Carbon stored in it is getting released as carbon dioxide contributing to climate change. Thus, coastal soil, a major sink of carbon is converted into a source of greenhouse gases. The concept of climate-smart coast management with sustainable food production, resilience and mitigation should be promoted to maintain and improve the coastal soils.

T3S4I02

SOIL QUALITY ASSESSMENT FOR COASTAL AGRO-ECOSYSTEM: PROBLEMS AND PERSPECTIVES

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Professor Biswapati Mandal is presently working with a big group of young researchers for rehabilitating degraded natural resources including contaminated ecology. He did some innovative works on carbon sequestration, soil quality, and rehabilitation of acid, salt affected and micronutrient deficient soils with a large number of research projects funded by national and international agencies. Professor Mandal's laboratory is the breeding ground of quality human resources. During the last 35 years, he mentored a big number (>60) of researchers across India, who are now providing stewardship for upkeeping natural resources of the country. He published in almost all the high-ended professional journals of the world. He has in his credit a few national and international recognitions for his seminal contributions.

Abstract: Coastal region is the home of forty per cent of the global population, and continuous anthropogenic exploitation impaired the health and ecosystem services of coastal soils. Inherent ecological constrains like intrusion and seepage of brackish water, congestion of ingress saline water, flat and low topography, impeded drainage, waterlogging, shortage of fresh irrigation water, occurrence of acid sulphate soils etc. of the region further aggravated the problem and are responsible for its poor soil quality. Global warming and associated sea level rise is making things even worse. Assessment of quality of coastal soils is, however, a function of numbers of soil attributes like inherent electrolytes concentration, pH, relative distribution of different ions (Na^+, Mg^{2+}, Ca^{2+}, K^+, and SO_4^{2-}, Cl^-, HCO_3^- etc.) in soil solution, soil aggregation-dispersion, hydraulic conductivity, metabolic activities and abundance of useful soil microbial populations. The rhythmic changes in electrolytes concentrations in *kharif* and *rabi* season because of intrusion of brackish water damages coastal soil physical structure, imbalances soil nutrients dynamics, decreases bioavailability of nutrients, increases osmotic effect onto plant roots, and retards proliferation of soil microbiomes. Accordingly, a periodic assessment for identifying key soil quality indicators is essential for capturing the stressor(s) and health of soil. Since the productivity of principal agricultural crops in the coastal areas is low, an assessment of critical values (optimum and threshold) of key soil quality indicators might be helpful for capturing the soil born constrains and their possible solution for achieving profitable yield and sustainable utilization of soil and water resources of the region. Adoption of land modification, surface or underground drainage, surface water harvesting for rabi crops, need based calcium supplementation for acidity neutralization, adoption of conservation agricultural practices, and integrated nutrient management with locally available organic amendments (farmyard manure, green manure, vermicompost, smart city waste compost etc.) are advocated for restoring soil quality and improving livelihood security of coastal farm community.

T3S4I03

CARBON DYNAMICS AND GREENHOUSE GASES EMISSIONS IN COASTAL AGRICULTURE: MANGROVE-RICE ECOLOGY IN SUNDARBAN, INDIA

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Abstract: Highly productive mangroves in coastal ecosystem have huge potential to carbon (C) sequestration and climate change mitigation. However, it is under threat due to anthropogenic activities. Mangrove ecosystems cover about 60-70% of the world's tropical and subtropical coastlines that provides huge ecological services. The highest area of mangrove is found in Asia (42%) followed by Africa, North and Central America, Oceania and South America (20, 15, 12 and 11%, respectively). The Sundarban is the world's largest contiguous mangrove covers an area of approximately 10,000 km^2 in which 38% is in India. In the last century, we lost around 40% of tropical mangroves and a significant area in coastal agriculture has been ecologically degraded. India also has lost 10.5% mangrove during the period 1930 to 2013 in Sundarban alone. Further, climate change induced sea-level rise, burgeoning coastal population, non-scientific human activities (in agriculture and aquaculture) are aggravating the land degradation in coastal system. Therefore, restoration, conservation, regeneration and protection of mangrove ecologies along with coastal agriculture are necessary.

Mangroves act as a huge C sink (882,200 and 102,300 Mg C km^{-2}) and sequester higher amount of CO_2 (around 100 Mg of CO_2 per hector (ha)) than any other forest; control erosion and conserve soil health. This is the most C-rich forests in the tropics. Another estimate elucidated that coastal and estuarine mangrove forests retains 1023 Mg C per ha. Specifically, high organic C in this ecosystem is present at 0.5-3m soil depth that accounted for 49- 98% of C storage. However, mangrove deforestation causing emission of 0.02 - 0.12 Pg C $year^{-1}$, accounted for 10% of global emissions. Another prevalent ecology in coastal agriculture, lowland rice also could act as C-sink (@ 0.93 t ha^{-1} $year^{-1}$) if managed properly. The C-dynamic in undisturbed mangroves in coastal area is more or less stabilize and maintain its own cycle naturally. But the mangrove-agriculture (rice/aquaculture) interphases are zones which are directly and indirectly affected by human activities and impacted the agriculture and climate change and vice-versa.

Therefore, mangrove-agriculture ecology is a typical ecology that has unique soil C dynamics, GHGs emissions pattern and biodiversity. We specifically discuss that interphases/ ecology here.

A considerable part of the atmospheric C comes from terrestrial ecosystem of which soil is a major component. The soil organic matter (SOM) is considered as the key factor which controls the soil C dynamics. The accumulation and turnover of SOC is a major factor in soil fertility and ecosystem functioning and determines whether soils act as sinks or sources of C in the global C cycle. The carbon stocks of mangrove-rice systems in Sundarban varied with species (*Sonneratia apetala* > *Avicennia alba* > *Excoecaria agallocha*) and also spatially (western region vs. central region) and temporarily (premonsoon, monsoon, and post-monsoon). Soil labile C pools, namely readily mineralizable C (RMC), microbial biomass C (MBC) and potassium permanganenet oxidizable C ($KMnO_4$-C) are sensitive indicators of soil quality in the mangrove sediments as well as rice rhizosphere. The percentage distribution of soil labile C pools in the order of $KMnO_4$-C > RMC > MBC.

The production and emission of GHGs (carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O)) are microbial mediated and directly depends on C substrate availability in soils. Methane is released during the terminal step of mineralization of C (through methanogenesis), while N_2O is produced during nitrification-denitrification process. The high C storage in mangrove system is facilitates higher GHGs emissions as it provides readily available food to microorganisms. Further, mangrove and rice provide passages to GHGs emission from soil to the atmosphere through pneumatophore and rice-aerenchyma columns, respectively. Apart from these another two modes of transport contributes to GHGs emissions from soil to atmosphere in mangrove-rice systems are ebullition (through the bubble) and air-water interphase. The primary drivers of C-dynamics and GHGs emissions in these systems are tidal movement, water stagnation, alternate anoxic-oxic-environment, seasonal temperature variation, higher salinity and decreasing rate of SOC decomposition. Salinity plays the key role in C-dynamics and GHG emission. Relatively lower CH_4 flux in the system due to the abundance of SO_4^{-2} in seawater that preferred the sulfate reduction process over methanogenesis. Apart from methanogenesis the denitrification process responsible for N_2O emission is dominant in mangrove-rice interphases. Further, the agricultural and aquacultural runoff carries nutrients; contain more nitrogenous compounds that accelerate the N_2O production in the degraded mangrove system near to habitat and agriculture system.

T3S4ORAL01

Carbon Dynamics in Plantation Crops under Different Cropping Systems in Ultisols of Coastal Belt of Karnataka

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Ultisols are the predominant soil order in Dakshina Kannada district ie the coastal belt wherein plantation crops are grown extensively. In Dakshina Kannada arecanut is the main plantation crop that supports the rural youth and provides high net return per rupee invested. Arecanut was grown conventionally as a monocrop by farmers. Later on wider spacing with mixed cropping of cocoa was highly practiced. Recently farmers are adopting high density multi species cropping system integrating pepper, cocoa and banana in the interspaces. Soil is the major source of carbon, than atmosphere. The soil carbon affects the nutrient dynamics, production, productivity and overall global biodiversity and food security. The soil carbon pools are highly dynamic that depends upon the climate, soil, cropping system and management practices adopted. The management practices and cropping systems followed can turn the soil into net sink or net source of greenhouse gases. The present study was conducted in experimental plots

of ICAR -CPCRI, Regional station, Vittal, Karnataka to find out the carbon dynamics of the soils under different cropping systems in areca plantations. The gardens selected were above 12 years of planting with arecanut variety Mohithnagar. The plantations were maintained uniformly by giving the recommended dose fertilizers and following the all management practices. Three cropping systems widely adopted by farmers were studied. The first cropping system T1-Arecanut mono cropping, T2- Arecanut + cocoa and T3- Arecanut + banana+ pepper (HDMSC- high density multi species cropping system). Thirty soil samples were collected from each cropping system randomly and analysed for total carbon, soil organic carbon, labile carbon and microbial biomass carbon. The results showed that the Total carbon (3.2 % + 0.6) and soil organic carbon (2.61 % + 0.04) was high in Arecanut + Cocoa cropping system when compared to the arecanut mono cropping and HDMSC in arecanut. The soil labile carbon pool (334.17 ppm + 0.36) was highest in arecanut HDMSC system. Soil microbial biomass carbon was about 30.2 to 48.6% higher in the arecanut HDMSC system when compared to T1 and T2. The highest non labile carbon pool was 52 to 63.2 % higher in arecanut monocropping when compared to the mixed cropping with cocoa or HDMSC. The higher total carbon content in the soils with areca cocoa intercropping evidently marks the system as an efficient sink for soil carbon storage. The high density cropping system (HDMCS) with arecanut cocoa and pepper is efficient system for better productivity and nutrient cycling since the system shows high soil labile carbon pools and liability index. The study reveals the importance of high density multispecies cropping system in arecanut grown in coastal belts of Karnataka that can ensure better soil health, nutrient cycling and high system productivity. The adoption of HDMSCs ensures higher economic returns to farmers in environmentally sustainable manner.

T3S4ORAL02

Influence of Ameliorants on Soil Physico-Chemical Parameters and Salinity Studied in a Coastal Soil of West Bengal, India

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Field experiment was conducted in an inceptisol of Coastal West Bengal, India to study the effect of ameliorants on different soil physico-chemical parameters and salinity. Four ameliorants namely poultry manure, farm yard manure (F.Y.M.), Acacia leaf and tank silt were used. The doses were 2, 4, 6, 8, 10 and 12 t ha^{-1} (T1, T2, T3, T4, T5 and T6 respectively) on the basis of moist weight. The experiment was carried out in split plot designs with three replications where in the ameliorants were put in the main plots and their doses in the subplots. Soil samples were collected from $0^{-1}5$ cm depth after one year of decomposition and were processed. Saturated hydraulic conductivity, bulk density, organic carbon and non capillary pore spaces were determined. Soil hydraulic conductivity was also measured using Kozeny-Carman (Chapuis and Aubertin, 2003) and Shepherd's (1989) equations. Results showed that the soil bulk density decreased with increase in amount of doses, 1.24 Mgm^{-3} for 12 t ha^{-1} amendments (T6). The value is 1.40 for 2 t ha^{-1} amendment (T1) used. The saturated hydraulic conductivities were also dependent on the treatment and doses. The values were higher for Tank silt and green leaf manure treatment (2.0-3.5 cmh^{-1}) compared to Poultry manure and farm yard manure (F.Y.M.) treatments (0.10-1.0 cmh^{-1}). With increase in the dose of ameliorants in general, there was a decrease in salinity (3.1 dS m^{-1} for T1 and 2.3 dS m^{-1} for T6 treatments using F.Y.M.) in the studied soil. The relation between measured and calculated hydraulic conductivity using Kozeny- Carman equation was significant (r^2= 0.97; $p<0.01$). The calculated values were slightly higher than the measured values. Hydraulic conductivity determined from Shepherd's equation were relatively higher than those were measured in laboratory and using Kozeny- Carman equation. Effect of different ameliorant doses was significant in bringing differences in soil parameters like saturated hydraulic conductivity and bulk density.

T3S4ORAL03

Soil Quality Assessment of Integrated Rice-Based Farming System in Bramhagiri Block of Puri District

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Integrated rice-based farming exploits land and water resources providing food and livelihood security worldwide. Integrated farming is very beneficial for farmers as well as sustainable for environment. Five Integrated Farming System (IFS) models have been developed at Brahmagiri in Puri district of Odisha. The models include cropping systems based on rice, rice-fish, rice-agroforestry, rice-vegetable, rice-coconut integrated with poultry and duckery. Macronutrients supplied by mineral fertilizers such as nitrogen, phosphorus, potassium and sulfur are essential for crop production. Simultaneously, agricultural microbes may also contribute nutrients directly or indirectly to the crop which improve the fertilizer efficiency. Crop productivity and nutrient cycles are essential parts of soil health. But continuous exploitation of soil has led to soil degradation through nutrient depletion and erosion.So, long-term strategies are important to discourage the use of chemical fertilizers without affecting the crop productivity adversely. In the cropping systems, the use of organic manures, composts and biofertilizers has gained increased attention. The study was conducted at rice-based integrated farming system model at Bramhagiri, Puri, Odisha, India. The soil samples were collected before and after development of the IFS. In order to determine the pH, organic carbon, N, P and K content, various chemical analysis was performed with three replications. Results showed that soil pH ranged between 5.4 and 6.49 and electrical conductivity of the entire study area held between 2.8 to 9.12dSm^{-1}. Soil organic carbon (SOC) content the carbon percentage ranged between 0.9 to 1.48. Available nitrogen content in these soils was found to be varying between 39.72 to 60.63 kg ha^{-1}. The total content of soil potassium ranged widely from 0.157 to 0.177 percent and the amount of phosphorus ranged from 0.0588 to 0.0653 percent. The study depicted the quality of soil which was found fertile with water logging. IFS is not only the ideal and most promising solution for small and marginal farmers, but also improves the nutritional and economic status of farm families increasing opportunities for employment and making optimal use of farm resources.

T3S4POS01

Carbon:Nitrogen Ratio Based Nitrogen Prescription in Acid Sulphate Rice Soils of Kerala

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Kole lands of Kerala located 1-2 m below mean sea level are potentially acid sulphate soil with high acidity and high organic matter content with or without seawater inundation. Being low-lying estuarine lands, these areas are subjected to floods during the two monsoons and salinity intrusion during post-monsoon periods. In soil test based fertiliser recommendation, nitrogen is applied based on the organic carbon status assuming that the C: N ratio stabilises at 10:1. The organic carbon based nitrogen recommendation is relied on for fertiliser recommendation because more than 95 per cent of nitrogen in the soil exists in the organic form associated with organic matter. As per recommendations, for such soils with high organic matter under submergence nitrogen rates are to be reduced since the organic carbon content is very high. But if the nitrogen doses are reduced, the crop is found to be suffering

from N deficiency. This is due to the slow decomposition of organic matter under a flooded environment resulting in broader C: N ratio at equilibrium (John, 2014). Hence, it becomes necessary to study the chemistry and pattern of decomposition of organic matter as well as the Carbon: Nitrogen relations in these soils under flooded conditions. This, in turn will help to have a meaningful organic carbon based nitrogen recommendations exclusively for these acid sulphate soils which ultimately modify the present recommendation. A field experiment was conducted to investigate the response of rice to different levels of nitrogen in Adattu Kole in Thrissur district of Kerala with an initial C: N ratio of 20:1 on wet basis.The treatments with increased levels of nitrogen based on C: N ratio (treatments T5-T10) produced significant effect on plant height, number of productive tillers, number of grains per panicle, straw yield and grain yield. The total nitrogen content both in soil and plant were significantly influenced by higher doses of nitrogen fertilisers prescribed as per the C: N ratio. Among the carbon fractions, hot water extractable carbon contributed more to the mineralisable pool than water-soluble carbon. The direct effect of total hydrolysable nitrogen on total and available nitrogen was very high. Ammoniacal nitrogen being a dynamic and time-dependent variable, though contributing significantly to available N content, its effect on total nitrogen was negligible. The maximum grain yield of 8.22 Mg ha^{-1} was recorded in the treatment where nitrogen was applied based on C: N ratio (wet analysis). An increase of 1.15 Mg ha^{-1} of grain yield was recorded over the treatment where soil test based fertiliser recommendation was applied. The highest straw yield of 17.47 Mg ha^{-1} was recorded in treatment where nitrogen applied was double that of C: N ratio based recommendation. The highest net return was obtained in treatment where nitrogen was applied as per the C: N ratio in the soil.

T3S4POS02

Carbon Dynamics as Influenced by Biochar Application in Ultisols (Typic Plinthustults) of Kerala

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Continuous application of organic manures and amendments is highly essential in tropical soils, because of soil compaction and high rate of mineralization associated with tropical situation. It is in this context that 'biochar, a carbonized biomass' which is an amendment highly resistant to decomposition serves as a viable proposition. The carbon contained in biochar is by and large stable and aromatic which makes it unavailable to the microbes. But it is revealed that the metabolisable fraction of carbon present even in minute quantities would alter nutrient transformation process which necessitates studying the C dynamics in soils added with biochar. To study the dynamics of C in soil, an incubation experiment was conducted in a surface soil (Agricultural Research Station, Mannuthy, Kerala), belonging to Velappaya series and Fine loamy kaolinitic, isohyperthermic, Typic plinthustults as per USDA classification. Three levels of biochar (5, 7.5, 10 t ha^{-1}), FYM 10 t ha^{-1}, soil test based POP + biochar 10 t ha^{-1} and soil test based POP were the treatments. Soil test based POP consisted of NPK recommendation for Chinese potato and FYM 10 t ha^{-1}. The treatments were imposed in the soil (1 kg) contained in plastic pots and mixed thoroughly. Distilled water was added to bring the gravimetric water content of the soil to field capacity. The soil samples with different treatments in triplicate were maintained separately for 15 months. The soil was incubated at field capacity for 15 months and distilled water was added once in two days to the container to maintain a uniform moisture content throughout the incubation period. Sampling was done at fixed intervals viz., 0, 3, 6, 9, 12 and 15 months after incubation and analyzed for carbon fractions. Results of incubation experiment revealed that, the content of water soluble carbon (WSC) and microbial biomass carbon (MBC) increased up to 6 months of incubation and decreased thereafter. With the advancement of incubation period, there was a decline in the organic carbon content. In the case of permanganate oxidizable carbon (POXC) and hot water soluble carbon (HWSC),

a decreasing trend was noticed. While the highest value of WSC and HWSC were recorded in FYM 10 t ha^{-1}, all other C fractions were higher in the treatments viz. soil test based POP + biochar 10 t ha^{-1} and biochar 10 t ha^{-1}. With an increase in levels of biochar, the labile C fractions viz. POXC and MBC increased. The labile C fractions in soil were in the order POXC > HWSC > MBC = WSC. Rate of decrease in organic carbon was computed using simple regression analysis and found to be highest in soil test based POP (4.177 mg kg^{-1} day^{-1}). With an increase in the biochar levels, sharp reduction was noticed in the rate of decrease. Applying biochar together with inorganic fertilizer sources further aggravated the reduction.

Theme III:

Natural resources and carbon flow dynamics vis-à-vis soil quality, water use trends, and integrated water management including ground water and farm machinery developments

SESSION V:

Coastal water use trends - sources and availabilities, integrated strategies for irrigation & drainage, and other location-specific irrigation practices including poor quality water use

T3S5I01

ADAPTIVE MEASURES IN WATER MANAGEMENT FOR HIGHER WATER PRODUCTIVITY AND INCREASED EFFICIENCY

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Dr. Kaluvai Yella Reddy is the Dean (Faculty of Agril. Engg. & Technology) of ANGR Agricultural University, Andhra Pradesh, India. He has more than 35 years of experience in teaching, research, project management and administration. He obtained B.Tech. (Agril. Engg.) from Dr PDKV, Akola, M.Tech. and Ph.D. degrees from IIT, Kharagpur and PG Diploma from University of Arizona, USA. The salient achievements include development of Solar Powered Micro Irrigation System in 2002 with the financial support of Govt of India; as Project Manager, he successfully completed $ 3.5 million FAO-funded AP Water Management Project; as Technical Advisor to Andhra Pradesh Micro Irrigation Project (APMIP), strengthened and supported the $570 million project in achieving 1.1 million ha under MI systems in 10 years; and as Director of WALAMTARI, Hyderabad (2012-2018) contributed for the growth of the Institute as one of the best in India. Besides, organized over 25 national and international conferences and workshops and published over 120 scientific papers. He received 'International Commission on Irrigation and Drainage ICID WATSAVE Technology Award' in the 20th Congress of ICID held in Lahore (2008); and elected as Vice-President of (ICID) in the 68th International Executive Committee meeting held in Mexico City in Oct 2017. He also obtained 'World Heritage Irrigation Structures (WHIS) Awards' for 6 projects of India (2 in 2018 and 4 in 2020). He got the approval of International Executive Committee (IEC) of ICID for hosting ICID Congress in Vizag, AP, India in 2023. (This event last held in India in 1966). Visited more than 20 countries on official and technical assignments.

Abstract: Water, as the key natural resource, is fundamental to all economic, social and environmental development processes. Thus, efficient water resources management is essential for achieving poverty reduction through inclusive growth; maintaining public health and food security; providing livelihoods for a life of dignity for all; and sustaining long-lasting harmony with the Earth's essential ecosystems. Globally, rising temperatures will translate into increased crop water demand. Therefore, special impetus should be given towards mitigation at farm-level by enhancing the capabilities of community adopted climate resilient technological options. This, together with an approach at a catchment level will help to increase the overall efficiency of water use. Given the rapid changes taking place within the global development scenario due to demographics, climate change and degradation of natural resources, AWM also needs to change in order to ensure water security, food security and sustainable rural development. In view of this dynamic development scenario International Commission on Irrigation and Drainage (ICID) as a network of AWM professionals decided to give itself a reality check and reorient its vision and strategies to achieve its stated objectives. "A water secure World free of poverty and hunger through sustainable rural development," a road map to ICID vision 2030, presents the strategies to convert this vision into actions. The Road Map is aligned with the SDG targets and takes into consideration the ICID's overall mandate as well as specific goals and issues related to agriculture water. The relative quantities of water being lost at the different

levels in an irrigation system needs to be considered carefully and measures should be taken to reduce the losses and manage the water resources efficiently. The largest volume of water lost is normally at the field level, where, both the irrigated surface area and percolation losses below the root zone are high. The second major loss of water happens at during the distribution of water from field-to-field in the field channels. Increasing water use efficiency should be one of the top priorities of countries where irrigation demands are high in order to cope with increased climate variability, droughts and water scarcity. This requires emphasis on water measurement and quantification, participatory irrigation water management, capacity building of farmers, scientists and government agencies, large-scale promotion of water saving crop production technologies and expansion of micro irrigation into canal-irrigated areas. The ClimaAdapt Project (funded by the Ministry of Foreign Affairs, Norway and coordinated by NIBIO, Norway), AP Micro Irrigation Project (funded by NABARD, India), Base line studies on Water Use Efficiencies of Irrigation Projects (Funded by Govt. of India) have made significant contributions to capacity building, design and implementation of various measures to improve water use efficiency in the states of Andhra Pradesh and Telangana in India. The outcomes from these projects have helped in developing policy guidelines and wider adaptation of efficiency measures in the two states.

T3S5I02

WATER RESOURCES AND IRRIGATION MANAGEMENT IN SOUTHERN ITALY COASTAL ECOSYSTEMS: THE BASILICATA REGION

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Dr. Marco arcieri was born in potenza, in 1967. He's a Technical Officer of the Southern Italy Hydrographic District Authority, MINISTRY OF ENVIRONMENT, where he works since 2006 as a technical officer. Earlier to that, he has been working for the *National Institute of Agriculture*, a research institute of the ministry of agriculture, as a researcher. He graduated from the faculty of agricultural sciences of basilicata, where he gained his international PhD on "crop systems, FORESTRY AND ENVIRONMENTAL SCIENCES". During his professional experience he visited more than 40 countries worldwide, in order to implement international research projects and attend various workshops and meetings, both as a key note speaker and an invited guest. During his scientific activity, more than 25 years now, he has produced several papers for peer reviewed journals, dealing with issues related to water resources management and irrigation planning/design, with a particular research interest focused on atmosphere-soil-water-plant interactions, aimed at the proper assessment of crop water requirements, the achievement of a sustainable agriculture and of water saving in agriculture. He's currently the senior Vice President of ICID, as well as the secretary general of ital-ICID, the national committee of italy. Also, he's a member of icid task force to guide the partnership process (tf-gpp) – support to the high level advisory group (hlag) on "partnership for agriculture water management; member of icid panel of judges for evaluations of nominations (pojs) invited under the "scheme for recognition of heritage irrigation structures"; head of the ICID regional node for the mediterranean area – irpid program; chair of the icid permanent finance committee; member of icid working groups "water & crop", "european" and "history"; member of the steering committee of un fao program wasag - global framework on water scarcity and is a permanent observer to un agencies fao, ifad and wmo.

Abstract: Management of water resources and irrigation in Southern Italy coastal ecosystems are of extreme importance, both for its economy and for the overall asset of the territory. Basilicata region, placed in Southern Italy peninsula, enjoys typical Mediterranean conditions and a varied climate depending on latitude and altitude.

Figure 1. Location of Basilicata Region in Southern Italy.

The region is rich in water resources, collected by means of several dams, barrages and weirs, conceived for water storage and conveyed through a complex system of aqueducts and infrastructures network to farmers and final users.

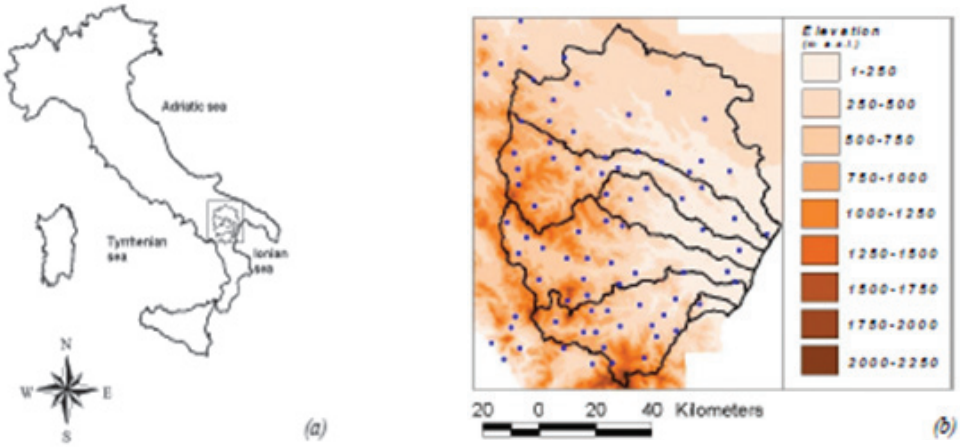

Figure 2. a) Location of Basilicata Region in Southern Italy). b) Rain gauge network (•) and digital elevation model; watersheds of the five main rivers are depicted in black (from top to bottom: Bradano, Basento, Cavone, Agri and Sinni river).

Nevertheless, the region has been affected several times by drought, especially in recent years when increasingly alarming processes of land degradation and desertification have also been witnessed. The uncontrolled exploitation of ground water, the adoption of non-environment friendly farming techniques, unregulated human activities and subsequent continuous loss of forests and of green cover, lack of maintenance and of basic soil erosion protection measures, besides the intensive exploitation of quarries and unauthorized withdrawal of inert material from river

beds, have certainly triggered such disorders and further highlighted the fragility of the coastal ecosystem, also leading to costal erosion dynamics.

The increasing incidence of such problems has led, on the one hand, to risk management policies dealing with these issues on a permanent basis, rather than during emergencies. On the other hand, these drought events and the subsequent water crises occurred have been raising great awareness in policy makers, demanding fora new approach in the management of water and soil resources. At the national level, Italian legislative framework has thus been shifting from a basic set of laws focused on repairing the damage and delivering provisions, to an actual system of forecasting and preventing events at different levels, aimed at evaluating risk conditions and adopting interventions in order to minimize the impact of the events. At the local lever, Basilicata Province has conceived, developed and enforced a new Governance system, in order to achieve a proper management of water resources and to prevent situations of water deficit, encompassing when needed trans boundary region cooperation.

First step in this new approach has been the modernization of hydraulic networks, in order to achieve a more efficient transfer of water resources. Also, new criteria such as the adoption of environmental tariffs for water pricing have been introduced, in order to compensate indirect effects to communities living in areas affected by large hydraulic infrastructures (storage and transfer works), besides of course the deprivation of resources required to the social and economic development of the bordering territories. Another major objective of this newly conceived approach has foreseen a thorough quantitative and qualitative assessment of the resource, carried out by means of an accurate monitoring of consumption and a continuous control of the structural features of hydraulic infrastructures plus, last but not least, the use of advanced technologies to control use and to prevent waste.

It is certainly possible to state that the water resources management system developed in Basilicata region represents an outstanding case of Governance. It has proven to be of great help as it enabled full exploitation of the resources in a complex and fragile eco system, characterized by different physical, social and economic features, often put under pressure by recurrent water crises due to repeated droughts. It can well be considered a "best practice", which might be transferred to other countries of the MENA region, or even in other developing countries suffering situations of water crisis, either that is because of severe meteorological conditions or of harsh situations of conflict in sharing of the resource, not only among different stake holders within the Country but also amongst different and bordering countries.

T3S5I03

USE OF GEOINFORMATICS FOR DRAINAGE PLANNING OF EASTERN COAST

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Abstract: High intensity of rainfall combined with saucer shaped physiography and flat land near the coastal area in deltaic alluvial region is the most important reason for water logging. Drainage is one of the measures to control waterlogging provided proper outfall is there. Drainage planning was made for Mahanadi delta in eastern coast of India using geoinformatics. Indian remote sensing satellite images were used for generation of land use/ land cover including surface waterbodies of the Bhargabi-Daya doab of Mahanadi delta. The digital elevation data of ASTER (Advanced space borne Thermal Emission and Reflection radiometer) Global DEM (digital elevation model) was obtained from United State Geological Survey (USGS) Earth Explorer data base. The contour maps with different elevation interval were prepared separately for the study area. The existing topographic and geomorphologic drainage parameters were estimated to assess the drainage capacity of the existing streams present in the study area. The drainage coefficient from historical rainfall data was also estimated. The remedial measures which could mitigate the problem is improvement of drainage conditions in the area by constructing artificial drains, which could manage the drainage congestion problems by effectively channeling the excess surface water as well as the rejected recharge to the sea. For enhancing drainage density, stream length to be desilted or excavated is at least 180.6 km which would help in enhancing drainage density from 0.235 to 0.341 km km^{-2}. Removal of silt and weeds from water bodies of 125.39 km^2 is required for enhancing the storage capacity of the pond which will help in improving drainage congestion. Layout and location of proposed drainage map was prepared in this study. A comprehensive drainage planning using geoinformatics was prepared for the Bhargabi-Daya doab in the Mahanadi delta which can be adopted in solving drainage problems of eastern coast of India.

T3S5I04

MANAGEMENT OF PROBLEM SOILS, RAINWATER HARVESTING AND JUDICIOUS WATER UTILIZATION FOR AGRICULTURE IN COASTAL ECOSYSTEM

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Abstract: Konkan region of coastal Maharashtra is characterized with high rainfall, hilly topography. The region has varied types of soils including laterite and lateritic, red loamy, red sandy, medium and deep black, coastal alluvium and acid sulphate. Maximum part of rainfall received during monsoon season meets sea either through surface or sub-surface runoff, and thus the water scarce situation is formed during post-monsoon seasons. Rainwater harvesting coupled with judicious water utilization through drip irrigation is found very effective in two ways i.e. heavy precipitation could be used very judiciously for agriculture lessening burden on groundwater and recharging groundwater aquifers in the region. DBSKKV, Dapoli has taken the initiatives on rainwater harvesting, water conservation, management of coastal saline lands and judicious water application thereby increasing the cropping intensity. The innovative works on management of coastal saline soils, water conservation and its application for growing second and third crops undertaken by the university and certain challenges for promotion of these

techniques and ways of adaption of these techniques in the region are discussed in this paper. The university has developed, recommended and promoted the cost-effective off-line rainwater harvesting techniques like Konkan Jalkund, large ponds as well as online techniques like Konkan Vijay Bandhara, tyre bandhara and modified vanrai bandhara. The university standardized the modified norms for permanent water conservation structures like RCC nala bandh particularly for hilly regions and accordingly these norms are being followed for the region under GoM watershed development programs. The university also advocated the adaption of micro-irrigation for water saving and recommended irrigation and fertigation schedules for different crops in the region with the proof of water saving as well as enhancement of crop yield as compared to conventional irrigation methods. These techniques are found very effective in uplifting the socio-economic status of the farmers in the region. Gravity drip irrigation is also one of the ways for utilizing irrigation water for agriculture by taking advantage of hilly topography. Research on irrigation water management revealed that use of micro-irrigation and fertigation has the potential to save the water in the range of 20 to 80 per cent and its increases the crop yield also to the tune of 5 to 116 per cent as compared to the conventional irrigation method. Significant area in the region measuring about 65000 ha suffers from salinity and acidity causing the reduction in yield by 30 to 50 per cent. The soil salinity is mainly attributed to the inundation of land with sea water during high tide and ingress of sea water along the estuaries, creeks, drains and rivers. Entire area is being cultivated with only rice during monsoon season and remains fallow due to high soil salinity and water scarcity. Salinity menace is aggravated due to waterlogging by high rainfall and impeded drainage during monsoon season. The university has recommended drainage and land management techniques for reclamation of these coastal saline soils. Embankment with 2:1 slope on creek side and 1:1 slope on inner side with sluice gate opening one way is recommended for ingress control by high tides. The flexi-head wall dam (Rubber dam) technology could be very effective in water harvesting and controlling the soil salinity due to high tides. Open drains with depth of 1.5 to 2.0 m depth and 100 m spacing are found very effective to drain the excess water and control soil salinity. Dug-out farm ponds also found effective to control soil salinity and land management practices like Ulkatni is effective as compared to shallow ploughing and rice planting technique, locally called as Awatani is economic and superior over transplanting. Many techniques are being adapted by the farmers in the region individually or through peoples' participatory approach. GoM is also promoting these techniques through different schemes and subsidies to the farmers.

T3S5I05

METHODS OF DRAINAGE AND IRRIGATION FOR ENHANCING PRODUCTIVITY IN COASTAL ECOSYSTEMS

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for reclamation of waterlogged and salt-affected lands, bioengineering approaches to drainage of irrigated lands and modern tools. He contributed as member secretary of committee for developing national drainage guidelines of subsurface drainage which were published and circulated to 12 states. He is currently working with HOPP, Haryana, WRD, Rajasthan and a consultancy firm, M/s Astral Pipes for subsurface drainage in heavy soils of five states. He developed proximal sensing, and RS and GIS protocols for mapping of 3-D soil salinity, low productivity, waterlogged and salt-affected lands, and Windows based DSS programs for enhancing productivity in saline environments. He collaborated to national and international institutes including ICARDA and UNSW, Australia for salinity research and travelled to Texas, USA for understanding Irrigation District DSS; Sydney, Australia for salinity management in Murray-Darling basin; and Jordan, Amman for water and salinity management in arid agriculture. He has co-guided six M Tech and one PhD students and published 31 peer-reviewed national and international articles, 2 symposia proceedings and 24 popular articles and book chapters.

Abstract: Drainage and salinity problems are the most serious in coastal ecosystems of India and worldwide, particularly in coastal lowlands which are further aggravated by tides, cyclones, sea water ingression and climate change. The coastal ecosystems comprising deltaic and estuarian areas of major rivers and coastal lowlands including mangrove forest areas are spread in nine states and three union territories of the country and overseas. Drainage problems are caused by heavy rain storms, flooding from discharge of inland river basins and the sea, congestion and inadequacy of drainage network etc. In such situations, rice crop is only grown and supplementary irrigation is needed in case of long dry spells during the monsoon season whereas good amount of irrigation water is required to grow winter crops. Saline soils and acid sulphate soils originated from marine environments are prevalent in coastal ecosystems. In the older areas especially where well or tubewell drainage method is practised, the salts have mostly been leached from the upper soil layers and the upper groundwater has become rather of good quality. In the younger soils as well as in some poorly drained older soils, the saline groundwater is still found at shallow depth. Rain water storage pond or tubewell with micro-irrigation method provides a feasible and cost-effective solution for growing winter crops. Since most of coastal lowlands remain waterlogged, climate adaptive surface drainage and vertical drainage methods can be adopted for timely planting of crops. In acid sulphate soils, controlled sub surface drainage has been found to be effective in alleviating the deleterious effects of acidity and salinity to enhance the rice productivity with a condition not to expose sub-soil layers of sulphur compounds for oxidation. Water efficient irrigation practices with good mulch cover need to be promoted to winter crops for enhancing productivity as well as avoiding water and salinity stresses. Therefore, climate smart drainage and irrigation methods hold the key in coastal ecosystems for enhancing crop productivity.

T3S5I06

GROUNDWATER SALINITY- IMPACTS AND POSSIBLE REMEDIAL MEASURES AND MANAGEMENT SOLUTIONS

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Abstract: Groundwater is the largest freshwater resource used for public drinking water supply, irrigation and industrial uses worldwide. Ever increasing demands have accelerated the consumption of groundwater resources leading to it's over exploitation which has undesirable effects such as declining water levels, land degradation and water pollution. In coastal, arid and semi-arid areas groundwater salinization has been observed at local or regional scales due to salt water intrusion as well as caused by geological formations and anthropogenic activities where its occurrence is controlled by factors such as hydraulic aquifer characteristics, distribution and rate of groundwater recharge, residence time, flow velocities, and nature of discharge areas etc. Therefore, for its remediation and management solutions understanding of aquifers and groundwater movements are very crucial.

T3S5I07

GROUNDWATER SALINITY DISTRIBUTION IN THE COASTAL AQUIFERS OF THE BENGAL DELTA AND SUITABILITY ASSESSMENT FOR IRRIGATION USE

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Abstract: The coastal population of Bangladesh has already been suffering from the salinity encroachment both in groundwater and surface water regime. Reduced river discharge, coastal surges, shrimp farming, lowering of groundwater table due to dry season irrigation in a large part of the country accelerate the rate of saline water

distribution. In addition, sea level rise, due to the impact of climate change, may contribute to salinity encroachment on coastal freshwater resources, particularly in the shallow alluvial aquifers. In many countries like Bangladesh, present trend of water use is often not sustainable. Problems are mainly due to unplanned development and management, wasteful use and inadequate governance actions. This also hampers socio-economic and agricultural development, causes widespread public health problems and disturbs a wide range of ecosystems. In the coastal areas of Bangladesh where availability of fresh and safe water is a big problem due to arsenic contamination and saline water encroachment in upper aquifers, delineation of fresh water zones and assessment of development stresses and probable impact of sea-level rise on existing fresh water regime is required. Anticipated sea-level rise due to global warming is considered a major threat on coastal fresh water resources of the country. The irrigation water evaluation indices (EC, SAR, TDS, TH, RSBC, KR, SSP, and MAR) indicates moderate to poor irrigation water quality in the coastal area for both wet- and dry-monsoon periods. The coastal surface water is overall suitable for irrigation during wet period, while it needs treatment for irrigation use during dry period. Groundwater of the area is generally moderately suitable for irrigation with very high EC and SSP values. To sustain groundwater use in stressed aquifers, interventions need to be developed. An integrated plan should be taken to increase the water storing capacity in the coastal area to harvest water during wet period. This will slow down or even mitigate aquifer depletion including the management of groundwater demand and the conjunctive use with surface water. Formulation and upgrading of appropriate national and regional acts, policies and plans, review and strengthening of existing institutions can help to guide acceptable use of this resource.

T3S5ORAL01

Water Governance in Coastal Polder Ecosystems of Bangladesh: Are the Water Management Organizations Positioned to Accept the Responsibility?

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The coastal zone, consisting of one-third country's area, is the most climate-vulnerable region of Bangladesh. The country has invested significantly in coastal zone management through the construction and rehabilitation of polders. Both irrigation and drainage can be achieved by gravity operating the sluice gates/regulators capitalizing on the tidal dynamics in the coastal region. Despite vast opportunities, land productivity in the polders is very low due to poor water governance and management. To improve in-polder water management, the responsibility of operation and maintenance of the polder water infrastructure has been transferred to Water Management Organizations (WMOs) since 2001. WMOs are voluntary organizations but very important for micro-level agricultural water management, particularly for drainage management during the monsoon when the lands often get flooded due to heavy rain and tidal surge. The major focus of the study was on organizational behaviour: the hierarchy in decision-making, transparency, financial accountability, leadership, internal communication, and motivational incentives of WMOs in Polder 30 of southwest region of Bangladesh. Field level data were collected through a structured questionnaire from 192 respondents of randomly selected eight Water Management Groups (WMGs – the lowest tier of WMOs), out of 40 WMGs in the polder. Data were collected from three management levels: officials of the executive committee (EC) (M1), general members of the EC (M2), and the farmers/members of the general committee (M3). The decisions on the operation of sluice gates (87% respondents), maintenance of sluice gates and drainage canals (66% respondents), and terminal drainage from the agricultural lands (57% respondents) are taken at M1 level, who seldom consult with members of the M2 level. Although destitute women, landless, and fishers are involved in

the EC of the WMGs, their participation in decision-making is neglected. In the case of transparency, it was found that information sharing by the M1 level was not satisfactory. The respondents at the M3 level (70th percentile) mentioned that no participatory discussion occurred between the general members and the EC of WMGs, while the respondents at the M1 level disagreed with the opinion. Financial accountability is also an important factor in organizational sustainability. The survey result reveals that record-keeping on income and expenditure and maintaining savings documents were not satisfactorily mentioned by M3 level respondents. This may be due to the lack of skills and capacity of the EC members. A strong disagreement was observed within the community (M3 level) on leadership in handling social and political influences. The survey revealed that internal communication through regular meetings, field visits, phone calls within the members of the EC were satisfactory. But, internal communication between EC and general members, and between WMG and Local Government Institutions was not satisfactory. The survey revealed that a significant number of respondents (81%) want motivational incentives like training, input supports to join the WMGs. Knowledge gap among the three management levels is a significant concern. It is therefore concluded that capacity building is needed to strengthen the WMOs. Moreover, information sharing, better linkages, and communication development among the stakeholders are also essential.

T3S5POS01

The Combination of Shallow Surface and Subsurface Drains Alleviates Waterlogging and Salinity in a Clay-Textured Soil and Improves Sunflower (*Helianthus annuus L.*) Yield in the Ganges Delta

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Waterlogging and salinity can occur together in salinized landscapes and restrict crop production. Drainage can alleviate waterlogging and, at the same time, increase crop growth under conditions of salt stress. However, the relative effectiveness of shallow surface and subsurface drains for alleviating waterlogging and increasing the yield of sunflower has not been assessed on clay-textured soils with a shallow water table. Over consecutive dry (rabi) seasons during 2018–19 and 2019–20, we tested the usefulness of shallow drains in mitigating the waterlogging and salt stress on sunflower on a clay-textured in the saline coastal zone of the Ganges Delta in Bangladesh. Experimental treatments were: slotted pipe subsoil drains (SSD; 0.5 m deep, 4.5 m apart), open surface drains (SD; 0.1 m deep, 1.8 m apart), SSD+SD, and control. All plots were inundated (2–3 cm above the soil surface) for 24 hours after sunflower emergence and then at 8-leaf stage: after this the drains were opened. Relative to undrained controls, the SSD+SD, SSD and SD treatments substantially increased yields relative to the controls (95, 42 and 34% increase, respectively in 2018–19, and 92, 61 and 66%, respectively in 2019–20). Simple correlations across all plots showed that the increases in yield due to drainage were associated with decreases in waterlogging (Sum of excess water above 30 cm depth) after inundation events, increases in soil water content (SWC) late in the growing season, and decreases in EC1:5 throughout the growing season. Our results indicate that shallow surface and subsurface drainage together decrease the risk of waterlogging damage to crops early in their growth on the saline clay soils in the Ganges Delta, but later in the season enhance SWC while reducing salinity levels in the root zone.

Theme III:

Natural resources and carbon flow dynamics vis-à-vis soil quality, water use trends, and integrated water management including ground water and farm machinery developments

SESSION VI:

Farm machinery development compatible with small land holdings and for women-friendly use

T3S6I01

MECHANIZATION OF SMALL FARMS TO REDUCE DRUDGERY OF WOMEN WORKERS

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Abstract: Indian agriculture employs about 45% of total work force and contributes only 16% to GDP of our country which makes farming in India less remunerative. The average farm size in India is small (1.08 ha) and small and marginal land holdings (less than 2.0 ha) account for more than 86% of land holdings. Mechanizing small and non-contiguous group of small farms is against 'economies of scale' for individual ownership of farm machinery. The share of agricultural workers to total workers has reduced from 58% in 2001 to 55% in 2011. The labour availability in agriculture is expected to go down to 26% of total workforce in 2050. With no possibility of increase in net cultivated area and diminishing farm labour availability, intensive agriculture with higher input use efficiency is essential for the growth of Indian agriculture in near future. Mechanization of Indian agriculture has increased considerably and reached to an overall level of 45% during the recent past. Large number of manual, animal drawn, self-propelled, power tiller and tractor operated equipment and machinery have been developed and are commercially available for carrying out different farm operations in major crops. Presently, the participation of women workforce in agriculture is expected around 45% and demand more emphasis on development of gender-friendly tools, equipment as well as work places. There is a need to empower women workers through use of modern farm tools and machines. It also highlights the need to organize demonstrations and trainings for farm women on proper operation of various modern tools/equipment. The widely fragmented and scattered land holdings in many parts of the country as in coastal ecosystems need to be consolidated to reap benefits of agricultural mechanization. There is a need to innovate custom service or a rental model by institutionalization for high cost farm machinery such as combine harvester, paddy transplanter, laser guided land leveller, rotavator, threshers (multi-crop and paddy) etc. to reduce the cost of operation on small farms and can be adopted by private players or state or central organizations in major production hubs. Precision agriculture using GIS/GPS techniques for region specific crop planning, controlled precision application of inputs (seeds, fertilisers, chemicals, water, etc), conservation

agriculture for carbon sequestration, multi-functional farm equipment to conserve energy and to reduce turnaround time, farm machinery management, application of drones in agriculture, application of sensors, micro-processor and computer in agriculture are some of the areas that need more attention in India for sustainable agriculture. In future, agriculture is expected to be dominated by precision and cloud data and supported by advanced infrastructure like smart small tractors, unmanned aerial vehicles and wireless technology. There is a need to simplify these technologies to rudimentary levels and made them cost-efficient for maximum acceptance.

T3S6ORAL01

Development and Performance Evaluation of Finger Millet Cleaning System

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Traditionally, the finger millet cleaning operation is performed by manually. It characterized as labor-intensive, drudgery prone, time-consuming, and skillful. Therefore, to overcome these problems a cleaning system was designed and developed for finger millet. The designed cleaning system is a part of finger millet thresher-cum-pearler. The capacity of finger millet thresher-cum-pearler is 36 kg h^{-1}. The performance of the cleaning system depends on its operational parameters viz. sieve slope (2 to 5°), stroke length (10 to 30 mm), and frequency of stroke (300 to 500 strokes min^{-1}). Therefore, the study aims to optimize the operational parameters of the cleaning system to achieve maximum cleaning efficiency and minimum spilled grain. The analysis was carried out using the Response Surface Method (RSM) along with the 'User Defined Design (UDD)' statistical tool. The optimum operational parameters of the cleaning system were found as stroke length of 20 mm, frequency of stroke 400 strokes min^{-1}, and sieve slope of 3.5° that predicts maximum cleaning efficiency of 96.53% and spilled grain of 1.26%. In the end, the performance of the cleaning system was validated by setting optimum conditions. It results, the maximum cleaning efficiency of 97.5% along with 1.3% spilled grain. The validated performance evaluation of the cleaning system was better than the predicted. The designed cleaning system overcomes the problems associated with finger millet cleaning system. As per standard prescribed by BIS (CE > 96 % and SG < 1.5 %), the cleaning system was accepted for finger millet thresher-cum-pearler.

T3S6ORAL02

Machinery Development for Improved Sowing and Weeding for Small and Marginal Farmers

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Method of sowing and timely weeding operations in farming system has always closely associated with the yield and profit. Jute is an important cash crop mostly grown in the Eastern part of India. Poor economic conditions, small land holdings and shortage of labours are major problem in jute mechanization resulting in delayed planting of jute in rural eastern India. Broadcast sowing of small seeded crop requires higher seed rate. Due to scattered and higher planting density, reduces the yield. The scattered germination and higher planting density in broadcast sowing,

increases the cost of production and reduces the yield and profit. Because of labour costs, time and tedium, manual weeding is unfavourable and involves 40% of total expenditure. On the other hand, line sowing of small seeds like jute, mustard and sesame etc. is very much desirable to save seed, maintain plant population, weeding and thinning. The weeding and thinning are the most labour intensive and tedious operations in jute farming. Mechanical weed control is mainly associated with cultivating tillage (e.g. tertiary tillage), but also primary and secondary tillage influence the weeds. The present study relates to development of a simple, light weight and low cost manual seeder for sowing of jute and similar small seeded crops and a manual driven weeder for upland weeding operation. The field evaluation of seeder shows the seed rate of 2.8-3.0 kg ha^{-1} and 60-70% uniformity of seed distribution along the rows with seed spacing of 30-50 mm. The effective field capacity (EFC) found to be 0.18 to 0.20 ha h^{-1} with field efficiency of 90-95 per cent. The field evaluation of the weeder was found to be the most suitable for jute and similar line sown upland crops with regards to its field capacity (0.026 ha h^{-1}), weeding index (81.65%), performance index (2021.42) and less plant damage (4.78 %). It was easy to operate and involved less human drudgery during its operation among all the weeding devices.

Theme IV:

Forestry & biodiversity and spatio-temporal changes, integrated forest management policy for ecological sustenance and eco-tourism for livelihood

SESSION I:

Coastal forestry: mangrove dynamics and temporal changes, biodiversity including algal species

T4S1I01

SPATIAL AND TEMPORAL DYNAMICS OF THE MANGROVES OF INDIAN COAST

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Dr. K. S. Murali has over three decades of work as a researcher and program manager in water, climate change adaptation, biodiversity conservation, forestry and the development sector. He recently managed a successful project on glacier-fed river basins of Hindu Kush Himalayan Region (India, Bangladesh, Pakistan and Nepal) as a part of his assignment in International Development Research Centre (IDRC) in the last 6 years. He has worked in the United Nations systems for 5 years and in addition worked as a researcher in various institutions such as The Energy and Resources Institute (TERI), Indian Institute of Science and the French Institute at Pondicherry. He has the experience of working as a researcher and research manager at various international NGOs, Governmental Institutions and Academic institutions. He has published nearly 130 articles in international and national peer reviewed journals, besides books and newspaper articles. Over the last 13 years he has been working in the developmental sector managing various programs in UN organizations, International NGOs, Governments and donor agencies. With Bachelor's and Master's degrees in agriculture and PhD in Ecology apart from other short-term certificate courses in project management, project facilitation, monitoring & evaluation, he has worked on the forestry sector, community forestry, biomass estimation modelling, forest degradation, conservation of biodiversity, marine biodiversity, climate change adaptation, social aspects of watershed management, gender and climate change, water conservation and on interdisciplinary water studies including gender, governance and policy. His work has encompassed the geographies of South Asia, Africa and Southeast Asia particularly in biodiversity conservation and climate adaptation. He served on the editorial boards of several peer reviewed journals, trust boards and is member to various professional organizations including American Association for Advancement of Science (AAAS) and Association of Tropical Biology while being recognized as a South Asia regional biodiversity expert for USAID and Asia regional expert at IUCN for NTFPs. His major achievements include supporting the Government of India to submit the Reports to CBD, CBD and UNCCD, supporting the Government to successfully getting the GEF projects based on the priorities set by GEF, successfully managing biodiversity programs in South Asia and India, and programs of Climate change across the continents of Asia and Africa.

Abstract: India has substantive amount of coastline nearly 8000 km. However, the mangroves in this vast area are very limited to some places. Over the last century and more, the mangrove area has changed substantially due to management and also due to natural disasters such as persistent cyclones in the region apart from the impending climate change. We provide here a brief summary on the extent of qualitative and quantitative changes in the mangroves area and species changes over these years. Mangroves also provide livelihoods of millions of people along the coast, apart from sheltering them from severe cyclonic storms. Usage of mangroves and industrialization along the coast also has influenced the mangroves in many ways. This is primarily a collation of various studies and our own observations across India and an assessment of such management regimes and linking them to the current situation.

T4S1I02

MANGROVES VEGETATIVE DYNAMICS VIS-À-VIS MANGROVES DIVERSITY IN THE ECOLOGICAL PERSPECTIVE

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Dr. R. N. Mandal is working as a Principal Scientist in the discipline of Economic Botany & Plant genetic Resources at the Regional Research Station, ICAR-Central Institute of Freshwater Aquaculture, Rahara, Kolkata 700 118. He did his B.Sc.(H), M.Sc. and Ph.D. in Botany from University of Calcutta. He received a Young Scientist Award for his outstanding work on mangroves ecology and biodiversity in 2001 from the Indian Science and Environmental Program, Science Academy, Gorakhpur, India. He has also been selected as a Life Member by the National Environmental Science Academy, New Delhi for his work on mangroves ecology and biodiversity. He has published around 100 scientific articles including research papers, review papers, book chapters, and popular & technical papers in the refereed journals. All these articles cover a diverse spectrum of wetlands vegetation including mangroves, in the field of aquaculture management and in the mangroves ecosystem in view of changing climate. He also authored jointly four books such as 'Ecology and Biodiversity of Indian mangroves' (Vol. I & II), Daya Publishing House, New Delhi; Mangroves for Building Resilience to Climate change, Apple Academic Press, CRC press, Taylor & Francis group, USA; Wastewater Management through Aquaculture, Springer; Sundarban-Prakitir Pratisodh (in Bengali), Gangchil, Kolkata. In early days, he was associated to conceptualize the idea of 'Mangroves Ecological Park' in Jharkhali, Sundarbans, India, while it was established by Dr. K.R. Naskar who was Dr. Mandal's Supervisor for Ph.D. work. Dr. Mandal has a passion for thinking on mangroves, the Sundarbans mangroves in particular. He visited almost all known mangroves habitats of the east and west coasts of India, and keenly observed the adaptive habits of different mangroves from an ecological perspective of coastal regions.

Abstract: Mangroves are defined as the plant communities comprising mostly trees, shrubs, palms and ferns, grow in the intertidal sheltered coastal areas. As such the characteristic of coastal areas is dynamic, as governed by the different environmental actions such as tidal fluctuations, tidal thrust and ingression, tidal inundation and duration, land accretion and erosion, and salinity variation. All these environmental factors influence the mangroves ecosystems and thus, play an important role over mangroves to be changing with time and space – as considered to be dynamic. The general process of habitat progression occurs from instability to stability through various intermediate sequential states. This changing process of vegetation, often termed as Succession, is accompanied by the successive occupation of a site by different plant communities reflecting pioneer, intermediate and mature stages in relation to the prevailing condition. When mangroves vegetative dynamics of a given areas change with time, the existing mangroves communities are replaced with other mangroves communities. Such a condition reflects the changes in the mangroves diversity. So, mangroves vegetative dynamics lead to the new pattern of mangroves diversity. The common mangroves succession can suddenly be disrupted, resulting in the appearance of the new mangroves sequence, caused by the natural events such as storm, tidal thrust, tsunami, collapse of land mass, pollution, and exploitative activities. The effects of these disruptive events depend to a large extent on when they

happen since the coastal environment is mostly unpredictable. Similarly, when mangroves vegetation comprising a set of known plant diversity collapse due to the natural events, it is difficult to predict what vegetation occurs through regeneration and what set of plant diversity appears. The condition depends upon what plants propagules are available and whether they are able to withstand in the new situation. All these conditions are variable and unpredictable. Usually, in the new siltation, a group of algae starts consolidation of soil bed followed by few grass species or halophytes appearing, known to be the pioneer species, in the succession process. Following the trend, high salinity tolerant species such as *Avicennia* spp. or low salinity tolerant species *Sonneratia* sp. occupy replacing the earlier ones, which depends on the salinity condition of the respective areas. Gradually in the process of land mass consolidation, known to be stable land, other species such as *Agiceras sp. Agialitis sp., Rhizophora spp*., *Bruguiera* spp., *Xylocarpus* spp. replace *Avicennia* spp or *Sonneratia* sp. in the respective areas. Then *Excoecaria agallocha, Heritiara fomes*, *Phoenix paludosa* establish in as much as stable/mature land. It appears that mono-specific mangrove stand such as *Avicennia* spp./*Sonneratia* spp. in a given land is replaced with hetero-specific stand comprising many mangroves species. In this process, mangroves vegetative dynamic leads to the changing of mangroves diversity. This is a usual phenomenon in mangroves habitats. In the transforming agriculture scenario to maintain coastal zone management, it is necessary to understand the mangrove vegetative dynamics in relation to the mangroves diversity considering the ecological process of the coastal areas. It is essential because the understanding of mangroves vegetative dynamics in relation to their diversity may definitely help the planners/managers of coastal zone development take the appropriate as well as suitable effort to protect the coastal areas and thus to promote coastal people to have promising livelihood as well as stable income generation.

T4S1I03

PARTICIPATORY MANGROVE CONSERVATION AND MANAGEMENT IN ANDHRA PRADESH, INDIA

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Dr. R. Ramasubramanian had joined M.S. Swaminathan Research Foundation in 1996 as a mangrove biologist. As a mangrove biologist, he has carried out extensive bio-physical surveys in the Godavari and Krishna mangrove wetlands of Andhra Pradesh. He is instrumental in executing the mangrove restoration activities jointly with the stakeholders such as the local community, forest department staff and the NGOs in Andhra Pradesh and restored about 900ha of mangroves. His books on mangrove identification manual, mangrove nursery and mangrove restoration techniques were utilized by the forest department field staff. He has trained large number of community members, PRIs, NGOs and forest department staff on the mangrove sylviculture practices. Recently, he established a mangrove genetic garden with 25 mangrove saplings collected from East and West Coasts of India jointly with the AP Forest Department in the Coringa Wildlife Sanctuary. He also worked on halophytes and has established agronomic practices to grow halophytes in the saline soils using salt water. He is a member in the wetland management committee of the State of Andhra Pradesh. He has participated several national and international

training programmes /seminars and presented the work of the foundation. He has over 20 peer review publications in journals, authored 5 books and 10 chapters in books to his credit.

Abstract: Krishna and Godavari mangrove wetlands of Andhra Pradesh are important coastal wetlands providing livelihood security to the coastal community and ecological security to the coastal areas. Mangroves are potential carbon sinks contributing to reduce the climate change impacts. Despite these benefits mangroves are being degraded due to both manmade and natural causes. Participatory mangrove conservation and management approach gained greater significance in recent years in South Asian countries. M. S. Swaminathan Research Foundation is implementing mangrove conservation and management programmes from 1996 involving multiple stakeholders namely the state forest department, revenue department, local self government and the community. Gender balanced village level institutions (VLIs) were formed to plan, implement and monitor the mangrove conservation activities. The leadership skill of the community was enhanced to plan, implement and sustain the activities. Participatory rural appraisal was used to identify the status of natural resources, their utilization pattern and the issues related to mangrove conservation and management. The causes of degradation were assessed jointly with the community. The degraded mangrove areas were restored through digging shallow canals to facilitate tidal water flow into the degraded area. Most of the degraded areas were elevated and tidal water flushing is very rare for most part of the year leading to increase in soil salinity. The tidal water flow in the canals reduces the soil salinity. Nursery raised mangrove saplings / propagules were planted along the canals. Local community played active role in the mangrove restoration works which provided employment opportunity as well as a sense of ownership. Apart from mangrove restoration, socio-economic activities to improve the livelihoods of the community and alternatives for mangroves were implemented for the mangrove dependent community. An area of about 900 ha of degraded mangroves was restored and this paper deals the experiences of the participatory mangrove management methods and strategies adapted for mangrove restoration.

T4S1I04

POLICY FOR INTEGRATED MANAGEMENT FOR ECOLOGICAL SUSTENANCE OF COASTAL AND MANGROVE ECOSYSTEMS IN INDIA

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Dr. Ravishankar Thupalli has been making exemplary contribution to the sustainable management of Forests and Mangroves Biodiversity through participatory approaches to address land use and land change patterns altering ecosystems and contributing to its re-generation since 1984 in cognizance with MEAs from 1972 Stockholm Conference to the 2015 SDGs. Presently Dr. Ravishankar works as Climate Change Specialist for Food and Agriculture Organization of United Nations in the Maldives. Dr. Ravishankar worked as Project Coordinator of UNDP GEF EGREE Project on Mangroves in Kakinada. He has worked with UNDP, GEF, Asian Development Bank, World Bank, Common Fund for Commodities in Nepal, Bhutan and Bangladesh on Forest and Agriculture conservation and policy development from 2005 till to day. He has participated and presented papers in international conferences in 23 countries and has over 84 publications which include; 35 Research Papers in National and

International Journals and 27 books including bookchapters, 10 abstracts and 12 national and international country reports till today. He is one of the editors of African Journal for Agriculture, Kenya. He has been awarded Young scientist award and is a member of several national and international societies and professional bodies. He is a resource person for United Nations University, Tokyo, Japan and United Nations University, Hamilton, Canada. He has delivered guest lectures in Mc Gill University, Canada and in several research Institutions, Universities, Colleges and Schools across India. He is a Member in the Research Advisory Committee of post graduate students (M. Tech) of the Department of Environmental Engineering, Jawaharlal Nehru Technology University, Kakinada, Andhra Pradesh, India. He has teaching experience as Lecturer at State Forest Service College, Coimbatore and Andhra Pradesh Forest Academy, Rajahmundry, India. Member of Board of Studies of colleges under University of Madras, Adikavi Nannaya University, Rajahmundry and Andhra University, Visakhapatnam in India.

Abstract: Coastal forests and mangroves that occur along estuarine areas are important ecosystems that constitute the soft structures which are otherwise called as Nature based Solutions (NbS). These plants are able to survive in hard windy and wetland conditions by adapting to the local environment. The mangrove wetlands particularly serve as spawning and nursery grounds for many economically important freshwater and marine fishes. Mangroves also play an important role by acting as nesting grounds for birds. Coastal forests with greater diversity and mangroves that consist of inter tidal flora and fauna are found in tropical and subtropical regions of the world. Coastal forests and mangroves protect mainland areas from cyclones and tsunamis. They also prevent soil erosion along the beaches and the mangroves along the river coast, preventing sedimentation near the river mouth and allowing normal nutrient flow into the sea. The mangroves in India have been conserved and managed through an initiation called Joint Mangrove Management (JMM) by the Ministry of Environment Forests and Climate Change, Government of India in collaboration with Universities, NGOs and community institutions which involves the resident multiple stakeholders. On record around 1,400 ha of degraded mangroves were restored and 15,000 ha of verdant mangroves were brought under JMM along the east coast of India. It incorporates mechanisms like daily loan schemes, empowerment-oriented training on coir rope making, tailoring, raising homestead kitchen gardens, and use of community woodlots to reduce dependency on mangroves. Villagers who were members of Eco Development Committees and Forest Conservation Councils, involved in canal construction work realized their potential and the value of hard work and the need to conserve mangroves on which their livelihoods depend. The wages for undertaking restoration work also generated income within the village. However, the same efforts and concentration is lacking as far as coastal forests and ecosystems are concerned which is resulting in loss of lives and livelihoods due to frequently occurring cyclones in India as well as in neighboring countries. In the above context there is an urgent need for comprehensive integrated management through community participation. Supporting policy for ecological sustenance should be developed and implemented taking into cognizance the existing policies and Acts. The JMM model that was implemented with vigor in some states should be used in other states and in Asian and SE Asian countries with similar conditions. Development and implementation of a Policy for Integrated management for ecological sustenance of coastal and mangrove ecosystems in India will be discussed and presented in the full paper.

T4S1I05

COMMUNITY GOVERNANCE IN FOREST MANAGEMENT IS KEY TO ENSURE LONG TERM PROTECTION OF FOREST ECOSYSTEMS

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Ajanta Dey, is now acting as Joint Secretary & Programme Director of a Non-profit organisation, Nature Environment & Wildlife Society (NEWS). Being a ranker and gold medallist in School Leaving Board Examination, having studied mathematics from Presidency College, Kolkata, she was driven by passion towards conservation of nature and natural resources. She left the prized Government job in the leading Insurance sector of the country, completed Masters in Environmental Science, Vidyasagar University and is working as a conservation practitioner, since last twenty years. She has been the Principal Investigator and Project Co-ordinator in various projects, particularly in Sundarban and is working for building resilience in coastal landscapes with community-based forest management approaches, in implementing nature-based solutions. She has learned through her experiences working in the field and has also many publications on biodiversity related issues, to her credit. She is editor of *Environ* - (a quarterly publication on environment and wildlife issues); Member of Commission on Ecosystems Management (CEM-IUCN); Regional Coordinator of Living Lakes and Wetlands, South Asia and Faculty for Centre for Continuing & Adult Education, Vidyasagar University; also acting as Advisor to National Green Tribunal on Sundarban chapter.

Abstract: A forest, in different landscapes, provides multi-various services that include elements of various disciplines. Integrated forest management essentially intends to encompass all such disciplines for long term protection of the forest so that the ecosystem services continue to be available over generations. Focussed on conservation with intergenerational equity at its core the integrated forest management sets values much beyond forest protection. The forest ecosystem dynamics include the conditions, factors and parameters that influence the economic, social and ecological fabric around the forest. While accounting for the degradation of the forests, in most of the cases anthropogenic reasons have been identified to be pivotal. These reasons stem out from development policies and approaches adopted either within and around the particular forest ecosystem or even farther away from the degraded forest site but affecting the ecosystem dynamics at that site. Also, it impacts the social and cultural context of the local communities whose life and livelihoods are entwined with the forest ecosystem, its goods and services. Thus, securing participatory approach in forest management is not a new word in this context; however, it has become a means to communicate to the local communities rather being the objective of it. The community governance, beyond participation, is to establish a system that entails inclusion, participation, engagement of the communities in the planning, execution and monitoring design from the very onset of the activities and what sustains within that established milieu. A case study in Sundarban, India illustrates how the local communities especially women played a major role in building a mangrove forest and are continuing with it over last eight years. It has been observed that financial benefits play a major role, but also taking part in processes that contribute to the larger dictum of the society gives them a pride that translates into ownership and steadily into community governance – a system that energise from below with all the stakeholders in action.

T4S1I06

PHYTOGEOGRAPHIC, EVOLUTIONARY AND ECONOMIC IMPORTANCE OF COSTAL ENDEMIC PLANTS OF KERALA

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Dr. A. G. Pandurangan is former Director of JNTBGRI, Thiruvananthapuram and presently serving as Advisor for Centre for Innovation in Science and Social Action (CISSA). He is having 38 years of research and development experience in Plant Taxonomy and Biodiversity, Conservation Biology, Reproductive ecology, EIA studies etc. He has conducted extensive explorations to the entire Western Ghats and documented plant genetic resources in the form of floras, revisions and monographs. The notable taxonomic contribution includes discovery of 28 flowering plants and one fungi species new to science, 460 endemic species, 126 RET species, 40 rediscoveries and 37 new distributional records. The taxonomic studies on the families of Dioscoriaceae, Balsaminaceae, Gesneriaceae, Poaceae, Cyperaceae etc, regional floras such as Thriveni Hills, Athirapalli region, Pamba and Pooyamkutti river basins, Peppara and Shenthuruni Wildlife sanctuaries, status report of Agasthyamala, Gulf of Mannar and Nillgiri Biosphere Reserves were well acclaimed by the scientific community. The status reports prepared on the advice of the Ministry of Environment, Forests and Climate Change, Govt. of India were recognized by the UNESCO's MAB Programme. He also served in Spices Board, Govt. of India as Extension Officer and involved in improving production of Cardamom and other spices in Karnataka, Kerala and Tamil Nadu. He had assessed population structure and reproductive dynamics of 49 threatened species of Western Ghats and among that 29 species were rescued by restoring viable populations in seven MPCA's across Kerala in collaboration with State Forest Department. He had established an exclusive RET species park in a six acre plot at JNTBGRI with the financial support from MoEF & CC, Govt of India contains 1250 live specimens representing 145 endemic and rare species of India. The park is served as a demonstration Garden and first of its kind in India. He had also planned and executed for developing a strong School of Taxonomy in JNTBGRI by establishing a modern herbarium with state-of-art facilities. Four new species were published on Dr Pandurangan's name in recognition of his contribution to plant taxonomy and conservation biology. Indian Association for Angiosperm taxonomy (IAAT) has conferred the Fellow of IAAT in 2011, awarded Prof. V.V.Sivarajan Gold Medal in 2015 and become elected as President of the association for the year 2018. Guided 15 PhD's and 5 of them were received young Scientist award from National and State Scientific bodies. Currently, engaged in assessing threat status of our rare species by analyses of various causal factors inducing rarity as per IUCN guidelines. The outcome is certainly assist the planners and policy makers to implement suitable conservation measures for conserving rare genetic resources from untimely extinction.

Abstract: The study of endemic species is of phytogeographical significance as the distribution of these species is restricted to limited geographical area. Moreover, a country's uniqueness in terms of biological wealth is determined by its endemic nature of flora and fauna. There are two major categories of endemism being recognized namely paleoendemism and neoendemism based on the geological time scale which attracts lot of phytogeographical significance. Neoendemism can be defined as the species of resent origin due to chromosomal rearrangement induced by adaptive radiation. Paleoendemism are those species which are once enjoyed wider distribution in the geological

past and presently due to its unadaptive nature to the changing environment confined to restricted geographical areas. In both the cases, these species are confined to restricted geographical areas and this phenomenon give insights in the evolution of flora and fauna of a particular region.

The flowering plants of India is characterized by high percentage of endemism and the recent estimation indicates that 4,045 taxa belonging to 975 genera in 155 families are considered as strict endemic to the present political boundary. The peninsular India holds nearly 2,000 endemics of which the Western Ghats alone harbor 851 endemic species. The State of Kerala, phytogeographically, shares its endemism with the Western Ghats, low lands and coastal areas. All together the state has recorded 262 endemic taxa (236 species, 1 sub species and 25 varieties) spread over 127 genera and 50 families and this constitutes 5.5% of the total flowering plants of the State. On further distribution analysis shows that out of 262 endemics of Kerala, 62 species are exclusively confined to the coastal regions which are extended North - South direction to the length of 560 km from Kasaragod to Thiruvananthapuram. The coastal regions of Kerala further categorized based on habitat / niche preference as northern Malabar Coast with 13 endemics, Southern fresh water low land (20), backwater estuaries (30), mangroves (5) and sacred groves (8) respectively. It is interesting to note that some of the grass and herbaceous species adapted more than one habitats as mentioned but strictly having restricted distribution on the coastal regions. The coastal endemic species evolved, adapted and grow in the mist of humans and continue to serve by offering provisional and ecological services to the coastal region. The local people depend on them for food (25 species) includes edibles (7), vegetables (5), spices (3), tubers (3), rhizome (7); fodder (33); fuel (15); medicinal (12); timber and other materials (14) and ornamentals (15). In addition, many of these endemics, nearly 30 species form wild relatives of cultivated crops and they are valuable gene donors for crop improvement ensuring food security of the Nation. Ecologically, they enrich nutrient status of the region which act as nursery ground for fishes, prawns, crabs, molluscus, other aquatic animals etc. Mangroves and associated vegetation stabilize shoreline environment by acting as buffer against erosion by the sea. The Indian flora are generally considered as part of 'Gondwana Stock' due to continental drift and finally India's collision with Asia (55 mys ago) created the present day land configuration. In other words, major part of our flora belonging to paleoendemics. However, the coastal endemics are of mostly recent origin and human interference negatively affects the expanding the populations of these species in to newer areas and thus confined to their area of origin. The coastal area of Kerala definitely fit for consideration of declaring as "Hotspots" by taking in to account of exceptional endemic diversity and also by serious levels of habitat loss by humans and vagaries of Nature. At present the coastal region has no legal protection except "Coastal Regulation Act" which concentrates only shoreline protection and few mangroves in selected areas. Most of the endemic species have left to fend themselves and the causal factors of population reduction continue to operate, they may face uncertain future which accelerate them on the road to extinction.

T4S1ORAL01

Application of Modified Forest Canopy Density Model to Identify Mangrove Forest Dynamics during Pre and Post Aila Cyclone

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The Sunderbans is an archipelago of several hundred islands, spread across 9,630 sq. km in India and 16,370 sq. km in Bangladesh. These low, marshy islands are still in the process of formation through the action of tidal currents and siltation. It is home to the world's largest mangrove ecosystem. However, these mangroves are sometimes threatened by certain catastrophic events. One such event was the severe cyclonic storm, Aila, which hit the Sunderbans in India and Bangladesh on May 25th, 2009. The present paper is an attempt to assess the impact of Aila on the vegetation of Sunderbans using the various vegetation indices. Vegetation indices have long been used to monitor the dynamics of mangrove forests since intensive fieldwork is often hindered by the inaccessibility of the areas within the mangrove ecosystem. Here an attempt has been made to apply the modified Forest Canopy Density Model (FCD) to identify changes in mangrove cover of two deltaic islands of Sundarban- Prentice and Lothian Islands. This biophysical model was calculated using spectral indices like AVI, BI, SI, VD, and SSI along with several other indices like NDVI, ANVI, PVI, SAVI, SLAI COSRI, and NDWI calculated to validate the model output. LANDSAT Satellite data for two different periods (2009 and 2010) have been used to assess the pre-Aila and post-Aila conditions of the mangrove ecosystem. Canonical Discriminant Analysis was performed to assess the accuracy of the classification output of the modified FCD model. A change detection matrix was created using class combination analysis between FCD 2009 and FCD 2010 to identify the pixel to pixel changes in forest canopy density. Long term inundation and formation of hyper-saline tracts due to cyclone induced surge have caused canopy degeneration in 14.03 sq. km of the total area. On the other hand, due to sedimentation along the rim of the islands new mangroves have emerged and canopy cover has regenerated. Overall, the cyclone has affected the successive pattern of the mangroves in this area indicating that the bio-geomorphic fate of all islands of the Sundarban delta system is largely determined by recurrent storm activities in the Bay of Bengal.

T4S1ORAL02

Assessment of Land use/Land Cover Change and Vegetation Health Condition for the Implementation of Integrated Management Policy in South Andaman Island, India

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Andaman and Nicobar group of Islands (ANI) are rich in natural resources and a variety of ecosystems are found here together. Every ecosystem provides various goods and services. Land cover and its configuration in the landscape are crucial components in the provision of biodiversity and ecosystem services. The analysis of land use and land cover change provides information about natural and human processes and their impacts on the island ecosystem. The study assesses the spatial-temporal land use and land cover changes between 2002 and 2014 using multi-temporal Landsat data. ArcGIS 10.1 software was used for image processing, geo-rectification, digitizing,

mapping, evaluating, and analyzing the land use and land cover change. On the other hand, the new Vegetation health indices, characterizing moisture and thermal conditions and the entire vegetation health, were applied successfully for the prediction and estimation of losses in the forest resources of the South Andaman District. Unlike other remote sensing techniques, the new method is based on the three ecosystem laws implemented for the analysis of vegetation health in response to environmental changes. One of the important advantages of this method is using a combination of NDVI and 10.3-11.3 µm IR channel. South Andaman District has undergone outstanding changes in various land use/land cover categories and such changes took place mainly because of the population growth, urbanization, tourism recreations, and 26th December 2004 tsunami. The overall result of LULC change shows adverse and undesirable environmental impacts. Therefore, it is needed to monitor the LULC change to prepare effective land management policies for the conservation and sustainable development of the natural ecosystem. The overall vegetation condition is good in the natural sites of the study area and poor in the rural and urban areas due to the increasing human development activities.So in this present context, Environmental Zoning Approach is the most effective tool for resource management and conservation in the oceanic island. Considering the ecological and economic significance, the total landmass of the island is categorized into different environmental zones and each environmental zone is selected for different land use and land cover practices for the implementation of integrated management policy in South Andaman Island.

T4S1ORAL03

Studies on the Diversity in Muthupettai Lagoon Ecosystem

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Muthupettai lagoon comes under the Muthupettai reserve forest along the south east coast of India; and this lagoon covers an area of 16.27 km^2 and an important ecological sensitive area with mangrove forest and other brackish water fauna and flora. The lagoon is connected to the Palk bay by a wide mouth around 1km wide, located at the southern part. This lagoon is a shallow brackish water body, with an average depth of about 1 to 2 feet during the low tide and 3 to 4 feet during the spring high tide. The boundaries of this lagoons are; western side (10°19’20.8 N and 79°28’15.1” E), Eastern side (10° 21’31.0 N and 79°35’11.4” E), Northern side (10° 20’48.0” N and 79°32’35.2” E) and on southern side (10° 18’29.9” N and 79°31’05.9” E). The lagoon cannot be accessed directly but through meandering distributaries by boat to reach the lagoon. The great Vedaranyam swamp is one of the largest coastal wetlands found in the state of Tamil Nadu and the Muthupet mangrove is a part of the Great Vedaranyam swamp. Muthupet mangrove wetlands is divided into six reserve forests. Each reserve forests (RF) embodies different categories of wetland such as healthy mangroves, degraded mangroves, Lagoon, tidal creeks and Creeks. The total area of the Muthupet Mangrove is about 12020 ha. Out of 12020 ha, healthy mangrove forest found only 1855 ha (15%). Whereas, degraded mangroves cover an area of about 7180.62 ha (60%). The area occupied by Lagoon and other water bodies is about 15%. Five distributaries of river Cauvery viz., Paminiyar, Koraiyar, Kandaparichanar, Kilaithangiyar and Marakkakoraiyar discharge water into the Muthupettai lagoon. The lagoon receives freshwater discharge during the northeast monsoon months from October to December and remaining period freshwater discharge is negligible. Poor discharge of freshwater creates a salinity gradient in the shallow lagoon. The salinity

generally increases from the mouth of the lagoon towards the landward from 32 ppt to 45 ppt. The mouth of the lagoon is open year round and it brings in silt/clay fraction, hence the water is always turbid. Muthupettai lagoon has the following species of mangroves *Avicennia marina, Aegiceras corniculatum, Excocaria agallocha, Acanthus ilicifolius, Rhizophora mucronatoa and Lumnitzera racemosa* however, *Avicennia marina* is found to be the single dominant species. The Northern and Western borders of the lagoon are occupied by muddy silt ground which is devoid of mangroves. The lagoon acts as an important nursery ground for shrimp and Sea bass and a natural barrier from the rough seas. Wild collection of these resources inside the lagoon is a livelihood option for the fishermen around. Six species of sea grasses, ten species of seaweed and 80 species of finfish resources are commonly seen in Muthupettai lagoon. During this study the existence of mixed bed of oyster *Crassostrea bilineata* (Röding, 1798) and Green mussel *Perna viridis* (Linnaeus, 1758) was found at geographic coordinates 10° 19'25'' N and 079° 32' 31'' E and scattered for 1 km inside the lagoon. Greater flamingos are routinely spotted during August to March and it is reported that about 160 species of birds use Muthupet mangroves for feeding, nesting, roosting and other activities which include 80 species of migratory birds.

T4S1ORAL04

Beach-Cast Seagrass Wrack Diversity along Coastal Ramanathapuram District and Its Management

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Beach-wrack refers to cast away seaweed and seagrass on the shores during rough weather seasons. These seagrass wrack boasts unique natural community that brings life to the beach. A natural wrack line is a key component of a healthy beach ecosystem. However, in tourist important beaches the beach wrack is considered nuisance as it is felt to reduce the aesthetic value of the beach. In the present investigation Ariyaman beach, which is a 2 Km long stretch of white sand beach along the Palk Bay enroute to Rameswaram Island was monitored from 2017 to 2020 for studying the diversity and quantification of beach wrack during monsoon seasons. It was noticed that the northeast monsoon season (November to January) brings lot more beach wrack than the southwest monsoon season. There are about 14 species of seagrass species reported from this region and the diversity of beach-wrack seagrass consisted of *Cymodocea serrulata, Enhalus acoroides, Thalassia hemprichii, Halophila ovalis, Halodule uninervis, Halophila minor, Syringodium isoetifolium, Cymodocea rotunda,* and *Thalassodendron ciliatum*. Among these seagrass varieties the dominant species were *Syringodium isoetifolium*, and *Cymodocea serrulata*. These beach wrack seagrass biomass is utilized by farmers for grazing purposes during November-January from adjoining villages. As such no manure preparation work is in vogue at this region. It is estimated from this study that in a 2 km stretch of Ariyaman beach about 5-10 tons of beach wrack sea grass per annum could be collected during the northeast monsoon season. The 275 km long coastline of Palk Bay offer wide scope for the collection and processing of this mineral rich seagrass resources in to a valuable organic fertiliser; hence this study suggest that this potential resource could be put in to further use by converting them into manure along coastal Ramanathapuram district which is bordering the Palk Bay.

Theme IV:

Forestry & biodiversity and spatio-temporal changes, integrated forest management policy for ecological sustenance and eco-tourism for livelihood

SESSION II:

Eco-tourism for livelihood security

T4S2I01

COMMUNITY BASED TOURISM AROUND COASTAL AGRICULTURAL HERITAGE SITES OF INDIA: A NEED FOR PROMOTING IMPROVED LIVELIHOOD OF THE COASTAL INHABITANTS

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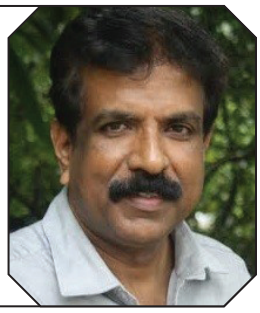

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Abstract: The potential of coastal tourism with the objective of protection and development of the natural endowments and heritage around India's long coastline (7517 km) has not been fully realized despite there are many efforts towards this direction globally. The latest attempt is by the Ministry of Tourism of Govt. of India for developing 17 spots around the country's coastal line and making them most tourist-friendly destinations. Unlike the yesteryears' tourists, the 21st-century tourists are better informed about the ecological and social footprints of their travel and demand for more responsible products and services from the destination. It will not be easy to attract and retain the new generation tourists in many destinations unless their demand is satisfied for enjoying a protected, clean and regenerative environment that safeguards the cultural heritage and meet the improved standard of living of the host population. One of the sound pathways to promote such kind of sustainable and responsible tourism has been Integrated Coastal Zone Management (ICZM). Two key factors of successful delivery of ICZM are the System approach and Empowered local community who are capable of using strategic planning tools and techniques in offering responsible products and services whilst ensuring sustainable management of natural resources. Those 17 blue spots identified by the Tourism Ministry have hundreds of villages around where the everyday life of people revolves around small-scale fishery, agriculture or other natural resource-based livelihoods. The value of synergy between such heritage, culture, biodiversity and tourism should be used to its maximum potential for identifying local heritage sites and promoting local livelihoods. Identifying and declaring such bio-cultural heritage (section 37 of the BD Act) should be an important strategy for the local panchayaths. This paper identifies 9 criteria for identifying and promoting agricultural heritage sites and making them attractive to tourists. These are complementary to each other, and fall into three broad categories - Ecological and Environmental; Socio-cultural and Economical & System Sustainability.

T4S2I02

AGRO-TOURISM AS AN INNOVATIVE INTEGRATED FARMING SYSTEM MODEL FOR SUSTAINABLE AGRICULTURE IN THE COASTAL ECOSYSTEMS

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Dr. Eaknath Bhanudasrao Chakurkar, began his career as Assistant Professor of Gynaecology at the Bombay Veterinary College, Parel, Mumbai from July 1990 to July 1991. He entered ARS on 5th August 1991 at NAARM Hyderabad and then joined ICAR Research Complex for Goa in July 1992 as Scientist, Animal Reproduction and further worked in different capacities as Senior Scientist and Principal Scientist in the same Institute. His area of specialization is Animal Reproduction and Veterinary Gynecology. His Research interests are on Animal Reproduction Technology and Integrated Farming Systems. At present he is the Director (Acting) of ICAR-CCARI Goa from 12th September, 2016 to date. He has published 76 Research articles in referred journals, 8 technical bulletins, 22 extension folders. He has expertise in techniques related to Infertility Management in dairy animals, Embryo Transfer in cattle, Artificial Insemination in Pigs, Goat reproduction and Rabbit production. He could register Agonda Goan first Livestock breed of Goa region and first recognized breed of Pig in Coastal region of the India (Registered with NBAGR, Karnal, Accession No. INDIA_PI_3500_AGONDA GOAN_0903 in 2015) and Shweta Kapila Cattle Breed, Goa registered by NBAGR, Karnal. An application No. 3037/MUM/2015 dated August 11, 2015 entitled "Extender for preservation of boar semen" invented by him has been granted patent No. 355114 dated January 1, 2021. He has the experience of handling two projects from DBT, four projects from RKVY apart from other institute projects. He has established the Agro-eco Tourism unit at ICAR-CCARI Goa and is also the Principal Investigator for the project entitled 'Prospects and promotion of agro-ecotourism in coastal region of India'. He is the recipient of the "FAKHRUDDIN ALI AHMED AWARD (bianum)" on 16th July 1998. He was conferred "Fellow of National Academy of Veterinary Sciences" in 2007.

Abstract: Agricultural activity occupies about 40% of the world's terrestrial surface for crops cultivation, animal husbandry and fisheries that offer huge scope for livelihood and economic development. Agro-eco-tourism (AET) is an innovative strategy that associates sustainability in terms of economic, social and ecological components and emerging as an optimal solution for rural areas. The AET is a synergistic combination of agriculture and tourism for the sustainable production and diversification of agriculture and allied activities to ensure economic viability and ecological sustainability in farming enterprise. Agro-ecotourism possesses the potential to boost the economic growth especially in developed countries. Overall, the concept of AET entails visiting a working farm or any agriculture, horticulture or agribusiness operation, for the purpose of leisure, refreshment, recreation, education and active involvement in the activities of the agriculture including agricultural operations, fishing, dining, and celebrating local festivals with the farming communities. The development of AET is primarily aimed to give awareness and knowledge on conservation of environment and natural resources in a participatory mode with farmers and to improve the livelihood of farmers in the developing nations. Many scientific studies have reported that tourism combined with rural resources and traditional products would be an important tool for revitalizing rural

areas. Coastal region of India possesses rich diversity of flora and fauna and there are large number of international and domestic tourist destinations throughout the coastal region. Considering this scope for combining the natural resource available in the coastal region synergistically with agriculture and tourism activities, it is essential to promote the concept of AET. It can also act as a sustainable source of income to rural youth and women. Diversity of flora and fauna can be sustainably utilized through AET. Apart from the core agriculture activities, the animals and fish components can be easily linked with AET models to effectively blend the natural resources within the system in an integrated way. However, there are no systematic studies that quantified the functioning of AET models and their ecosystem services. Being an important tourist destination, state of Goa offers tremendous scope for AET as its own cultural heritage being agriculture and tourism. Agriculture and allied activities such as animal husbandry, dairying and fisheries form an integral part towards the economy of the state. The state has huge diversity with respect to agriculture commodities and enterprises with field and horticultural crops, livestock, fisheries, etc., and is bestowed with natural ecosystems such as Khazan wetland (0.18 lakh ha), rivers (250 km), brackish water (0.04 lakh ha), reservoirs (3448 ha) and estuaries (100 km^2), that gives scope for integrating eco-tourism with agriculture. There are more than 15 functional AET units in Goa that attracts both domestic and foreign tourists. The major activities of these systems include agriculture and allied activities such as honey bee keeping, mushroom production, animal husbandry, fishing, ornamental fish culture, fish pedicure, processing and value addition, traditional dining and accommodation in tree homes and cottages, nature adventures etc. We would hereby analyse the scope and potential of the AET units in Goa and extension of these models with refinements in the west coast of India.

T4S2ORAL01

Dhanvantari Vatika – A Model Herbal Garden for an Agro-Eco Tourism Unit

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Agro eco-tourism units are new dimension of agriculture that merges the features of agriculture and tourism. It showcases the farm land as a tourism spot and agriculture and allied activities as entertainment and adventure. Visitors can learn and experience various farming activities and enrich the knowledge of biodiversity, tradition and culture. Foreign tourists as well as urban dwellers and school children will enjoy the experiences of an agro eco-tourism unit. Establishment of an agro eco-tourism unit improves livelihood status of the farmers by imparting additional income and promotes conservation and sharing of knowledge and resources. A herbal garden is an integral part of an agro eco-tourism since it makes the unit holistic and close to nature. Dhanvantari vatika; herbal garden of ICAR-CCARI agro-ecotourism centre has more than 100 plant species including medicinal trees, shrubs, climbers and herbs.It also has aromatic plants, fruit crops, vegetables, flower crops and spices with medicinal uses. Each species is labelled precisely with English and Hindi names, botanical name, botanical family, parts used and major medicinal uses.The unit is under organic production using vermi- compost and livestock manures. Pest and disease problems are addressed by biopesticides such as neem oil and jeevamruth. Micro sprinklers are installed to ensure adequate water supply. Plant propagation, minimal processing and sales of the produces are being done in the unit itself. Inclusion of new species, new planting systems, categorization and cataloguing and phytochemical characterization is under progress. Thus, Dhanvantari vatika act as a model for replication in agro eco tourism units across the country.

Theme V:

Climate change and disaster occurance, its impact, IT & remote sensing for rapid dissemination and early warning protocols, mainstreaming climate change policies for regional integration

SESSION I:

Climate change trends a dynamic phenomenon and its impact on agriculture, fisheries, forestry & animal husbandry

T5S1I01

IMPACTS OF CLIMATE CHANGE AND WEATHER FORECASTING ON AGRICULTURE AND FOOD SYSTEMS IN COASTAL ECOSYSTEMS OF INDIA

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Abstract: Over 40% of the global population reside in coastal areas by depending on natural resources, agriculture and artisanal fishing for their livelihood. "Agriculture" in coastal zone is challenging as these areas frequently exposed to arrange of climate-related hazards viz., sea level rise, sea water instruction, storm surges, surface temperatures, costal salinity, cyclones, floods etc., leading to a series of socio-economic impacts in the coastal zones. Indian sub-continent has coast line to the extent of 7500 km. States like Andhra Pradesh, Odisha, West Bengal, Tamil Nadu, Kerala, Karnataka, Maharashtra and Gujarat are often affected by climate change impacts such as cyclones. Small Islands in Andaman & Nicobar and South Parganas of West Bengal are also equally affected with cyclones, sea water intrusion and floods. Hud-Hud cyclone affected coastal Andhra Pradesh led to huge economic loss in terms of property and plantation and horticulture crops. Livelihoods of coastal farmers and fishermen often affected by climate change impacts in coastal ecosystems. Poultry industry and fruit production is equally affected with high intensity cyclones in this region. Technologies like wind breaks, resilient crop cultivars, flood tolerant varieties, shelter management in livestock and poultry systems, earthling of horticulture crops contributed to reduce the negative impacts of cyclones in coastal ecosystems. Vaccination and hygiene shelters contribute to overcome emerging diseases in animals and poultry. Fisheries, rice production and biodiversity of coastal areas are under extreme pressure as a result of global warming; such changes will be further accentuated in near future. Short-term climate change impacts viz., loss of production and infrastructure and long-term impacts viz., reduced availability of wild seed and competition for freshwater, severely distressing the aquatic production system and marine biodiversity. Natural fish production in rice fields drastically reduces due to the scarcity of fresh water thereby affecting the productivity of rice. Further, increasing heat stress resulting into lower crop production in coastal soils. Thus, creating awareness about the immense value of social–ecological system is pivotal. Government of India and State governments are implementing several programs towards sustainable and climate resilient agriculture and food systems in India. Indian Council of Agricultural Research (ICAR) developed 650 agriculture contingency

plans and implementing towards preparedness based on weather forecasting in India. Climate Resilient Villages (CRVs) established in 151 districts of coastal and island ecosystems act as models to replicate by respective state governments. For building resilience, climate adaptation must be multi-dimensional and multi-sectoral. Integrated assessments of climatic change in coastal areas are crucial to support the management policy development in order to achieve sustainability in coastal agriculture under climate change.

T5S1I02

IMPACT OF CLIMATE CHANGE ON COASTAL AGRICULTURAL ECOSYSTEMS - ADAPTATION INTERVENTIONS FROM NICRA

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Abstract: Impact of climate change on agriculture and allied sectors in India is evident. One or other part of the country is experiencing frequent extreme weather events causing severe yield and income loss. Recognizing the urgency faced by the increased frequency and intensity of weather extremes as evidenced by the recent IPCC Special Report on Global Warming of 1.5°C (SR15), it is important to accelerate climate change research towards developing resilient technologies and their up scaling. To meet the challenges of sustaining domestic food production in the face of changing climate, the Indian Council of Agricultural Research (ICAR), Ministry of Agriculture and Farmers' Welfare, Government of India launched a flagship network project 'National Innovations in Climate Resilient Agriculture' (NICRA) in 2011. The project aims to develop and promote climate resilient technologies in agriculture which will address vulnerable areas of the country and the outputs of the project will help the districts and regions prone to extreme weather conditions like droughts, floods, frost, heat waves and cold waves etc. to cope with them. The project is implemented through components viz. strategic research, technology demonstration (151 clusters of villages in each one of the identified climatically vulnerable districts) and capacity building. The interventions fall into thematic areas like natural resource management, crop production, livestock and fisheries and creation of institutional structures. Over the past nine years, NICRA project contributed significantly for climate resilient agriculture and some of the major achievements viz., climate smart crop varieties/cultivars tolerant to

abiotic stresses for different crops, livestock breeds and management practices developed to bring climate resilience in agriculture; prepared district level risk and vulnerability assessment of Indian agriculture to climate change (572 rural districts); in rice, wheat, maize, pigeonpea and tomato crops, core sets of genetic resources were assembled and field-phenotyped to identify sources of tolerance to climatic stresses; and ICAR along with National Agricultural Research and Education System (NARES) has developed District Agriculture Contingency Plans for 650 districts in India. Demonstrations of climate resilient technologies were being taken up in 151 climatically vulnerable districts by taking one representative village in each district across the country. In coastal ecosystems, flood and lodging tolerant paddy cultivars (MTU-1061, RGL-2537, MTU-1064) and desilting of drainage channels helped in minimizing rice yields up to 88%. Relay cropping of pulses after rabi rice for optimized resource utilisation and increasing income for coastal AP. Various technologies developed through strategic research and demonstrated for coastal ecosystems include i) flood tolerant varieties for flood-prone areas of West Bengal, Odisha, Uttar Pradesh, Bihar and Assam; ii) improving the resilience by land levelling, arresting erosion and land improvement; iii) construction of new check dams, renovation and desilting of existing check dams for capacity augmentation and storing excess-runoff ;iv) community paddy nursery as a contingency measure for adapting to rainfall variability; v) relative vulnerability assessment of Indian marine fishes to climate change using impact and adaptation attributes and mitigation options to combat vulnerability; vi) carbon sequestration potential and associated microbiota from 4 wetlands of West Bengal; vii) rejuvenation of farming in cyclone and flood prone coastal agro-ecosystems through land shaping (dugout pond with embankment, raising the level of main field and land embankment with excavated soil); viii) integrated farming system (rice-fish-poultry farming) and integrated duck and fish rearing; ix)captive rearing of fish seed as a livelihood opportunity in flood-prone areas; x) shelter management for small ruminants (semi intensive system of rearing of small ruminants in a slatted floor with proper roof); xi)spawning behavior of economically important fishes in relation to climatic factors; xii) blue carbon potential of mangroves and carbon sequestration of mangroves; xiii) a centralized web portal and mobile application for national small wetland management and real-time advisories; xiv) supplementation of 25% higher level of phospholipid, soylecith into improve weight gain in P. *vannamei* at 35°C as an adaptation measure; xv) black clam (*Villorita cyprinoides*) for culture in climate resilient pen system (CRPS) to withstand the devastating floods. Upscaling of such proven resilient technologies would enable farmers to reduce the yield losses and enhance their adaptive capacity against climatic variability in coastal regions.

T5S1I03

CLIMATE CHANGE AND MARINE FISHERIES OF ANDAMAN ISLANDS, INDIA

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mentored over 30 Ph.D. students. He has been a member of the Indian Antarctic Expedition in the year 1996-97. He is a recipient of the Gold Medal from Asiatic Society and is a member of the West Bengal State Coastal Zone Management Authority, nominated by the Government of India. Some of his ongoing projects include 'Opportunities and trade-offs between the SDGs for food, welfare and the environment in deltas (UKIERI-DBT)', Tidal energy for village electricity supply in Indian Sundarban biosphere (UKIERI-DST), Vulnerability Assessment of Mangroves and Corals of West Bengal, Odisha and Andaman Islands (DST), Study of carbon dynamics in near shore waters of Hugli Estuary (NRSC), Geospatial assessment of mangrove's species discrimination in Indian Sundarbans, their health and effect of environment and climate using airborne hyperspectral (AVIRIS NG) and RISAT-I remote sensing data (SAC) etc.

Abstract: The Andaman Islands enclosed by 950 km^2 of fringing coral reef and 400 km^2 of mangrove forest provide an ideal habitat to both pelagic and demersal fish stock. The coral reef with largest species diversity in the country and comparatively healthy mangrove flora of Rhyjophocea family host a sizable stock of ornamental reef fishes along with tuna, snappers, anchovies, groupers, mullets etc in the surrounding coastal water. While climatic change in the form of rapidly rising summer temperature since 1990s, repeated strong El nino phenomena and warm Indonesia through flow, rising rainfall since 2009 promoting excess sediment run off have already taken a toll on the health of coral reefs and mangroves , but their impact is hardly discernable on the marine fishery sector where even 30% of the estimated potential has not been exploited so far. With the Climate projection under the bias corrected CNRM-C5 run of RCP4.5 scenario for the area, the paper investigates it's potential impacts on the corals, mangroves and associated marine fisheries of Andaman islands and argues for improving the fishery strategies ensuring sustainable fishing practices as well as preserving pristine environmental condition of this unique eco-region.

T5S1I04

MANAGEMENT OF CLIMATE CHANGE AND NATURAL DISASTER IMPACTS IN AGRICULTURE

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Dr. Mannava Sivakumar has over 40 years of international experience in the area of Agroclimatology, having served for 20 years in the ICRISAT, and then in in the World Meteorological Organization (WMO) for 20 years where he served as the Chief of the Agricultural Meteorology Division (1996 to 2008), the Director of the Climate Prediction and Adaptation Branch (2008-2012) and as Acting Secretary of the Intergovernmental Panel on Climate Change (2016). He has organized over 60 international workshops and expert group meetings in all six continents of the world. He has over 300 publications to his credit, including 54 books and 87 articles in various international journals. In recognition of his international contributions, he was elected as a Fellow of several international scientific societies including the National Academy of Agricultural Sciences of India, the National Environmental Science Academy of India, the Indian Meteorological Society, the American Society of Agronomy, the Royal Academy of Overseas Sciences of Belgium, the Academy of Georgofili of Italy and the Association for the Advancement of

Biodiversity Science. He has received several awards which include the Lifetime Achievement Award from the Association for the Advancement of Biodiversity Sciences.

Abstract: Climate change is widely accepted as the single most pressing issue facing society on a global basis due to the increasing greenhouse gas (GHG) emissions. GHG emissions growth between 2000 and 2010 has been larger than in the previous three decades. Hence each of the past 3 decades has been successively warmer than the preceding decades since 1850. Continued emissions of greenhouse gases will cause further warming and changes in the climate system. Agriculture is one of the important economic sectors of the global society and climate change/variability is having a profound influence of the agroecosystems, posing serious threats to food security, human health and protection of environment. Of the total annual crop losses in world agriculture, many are due to increasing frequency and magnitude of weather and climate extremes such as droughts, flash floods, untimely rains, frost, hail, and severe storms. Agricultural impacts from natural events and disasters most commonly include: alteration of ecosystems, contamination of water bodies, loss of harvest or livestock, increased susceptibility to disease, and destruction of irrigation systems and other agricultural infrastructure. Between 2003 and 2013, natural hazards and disasters in the developing regions affected more than 1.9 billion people and resulted in nearly 500 million US dollars in estimated damage. Effective decision making to limit climate change and ensure economic development of agriculture sector can be made by a wide range of analytical approaches for evaluating expected risks and benefits; recognizing the importance of governance, ethical dimensions, equity, value judgments, economic assessments and diverse perceptions and responses to risk and uncertainty. Comprehensive agrometeorological adaptation policy guidelines, focusing on preparedness and adaptation measures to support sustainable agricultural development are needed to cope with the impacts of climate change. The major international agreements in 2015, such as the Sustainable Development Goals (SDGs) and Paris Agreement, to which almost all countries are now committed, emphasize that countries should implement policies aimed at climate change adaptation, and greater sustainability in the agricultural sector.

T5S1I05

WATER CHALLENGES NEED HOLISTIC APPROACH AND CONVERSATIONS

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Abstract: Hydrologically, socially and politically, and in many different ways, the universe of water in Ganga basin is vast, complex and fragile, and faces serious challenges. While past intervention has impacted the waterscape, global climate change is causing additional impacts that is cascading through the regional water cycle. The dynamics of the monsoon system is undergoing changes. In the upland, the snow and glacier are being depleted, the mid-hills the springs are being depleted while in the plains the rainfall groundwater dynamics are undergoing changes. Coastal areas face the challenges of declining flows from the upstream while the rise in sea level will lead to millions being displaced. The combined impact in the upland-lowland-coast will be major misery if we do not take corrective measures. Instead of holistic corrected measures, the current approach tends to fragment the hydrological cycle in a siloed approach. We need to begin deeper conversations across sectors, disciplines, social orientations, and generations.

T5S1I06

ADAPTATION AND DISASTER RISK REDUCTION IN THE COASTAL MUNICIPALITIES OF MANILA BAY

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Abstract: This presentation highlights the coastal flooding risks along the northern coastal region of Manila Bay due to sea level rise. The major drivers of vulnerabilities of local communities, and land subsidence that compounds coastal flooding in the area are also briefly described along with the past and current measures implemented to reduce the harmful impacts of coastal flooding. The presentation will conclude with a discussion on the proposed measures indicated in the draft Manila Bay Sustainable Development Master Plan (MBSDMP) of the National Economic and Development Authority (NEDA) of the Philippines to enhance the adaptation and reduce the exposure of vulnerable communities to coastal flooding.

T5S1I07

ADAPTATION TECHNOLOGIES/PRACTICES TO THE ADVERSE EFFECTS OF CLIMATE CHANGE IN THE AGRICULTURE SECTORS OF COASTAL REGION OF BANGLADESH

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Dr. Md. Golam Rabbani is head of the Climate Bridge Fund (CBF) in Dhaka, Bangladesh. He has been working on environment and climate change issues at national and regional level for about seventeen years, mainly in the areas of climate risk and vulnerability assessment, risk management, policy and institutional analysis and adaptation to climate change. He was of the key team members for preparing Bangladesh's National Adaptation Programmes of Action (2005), Second National Communication (2012) and Adaptation Chapter for the Third National Communication of Bangladesh. His contribution to research work has been well acknowledged through both national and international publications. His current areas of interest include climate finance, climate change adaptation assessment, adaptation technologies and practices, loss and damages and migration issues. He is also involved in climate negotiation since 2008. He holds a Ph.D. in climate change adaptation from the Department of Environmental Sciences, Jahangirngar University, Dhaka, Bangladesh and a Master of Science and Technology (M. Sc. Tech) in Environmental Science from the University of New South Wales, Sydney, Australia. He also completed B.Sc. (Hons) and M.Sc. (Fisheries) from the Department of Zoology, University of Dhaka, Bangladesh. Before joining Climate Bridge Fund (CBF), BRAC, he held research positions at the Bangladesh Centre for Advanced Studies (BCAS).

Abstract: Bangladesh is constantly struggling with some challenges that impede its growth and development. Climate Change is one of the major challenges that the country is already experiencing. The climate related hazards that are already affecting the country include variations in temperature and rainfall, increased intensity of flood /flash/ recurrent flood, cyclone and storm surges, drought, and salinity intrusion in surface and ground water and so on. The people of the coastal zone are very vulnerable because of the mentioned climatic hazards. The farmers in the coastal zone are getting severely affected by these hazards. It is to be noted that most of the farmers produce rice in not only in the coast but also all over the country. Some of the major requirements for the farmers to adapt particularly in the coastal zone include hazards resistant variety and its availability, sufficient water for irrigation especially in winter rice farming (main crop season for Bangladesh), strong infrastructure e.g. irrigation adjustments, embankments/ polders to protect damage of standing crops from floods, water logging (caused by river overflows or excessive rainfall in short period) and cyclonic events.Specifically, the farmers in the coastal zone are practicing a number of climate tolerant rice cultivars to adapt with the adverse condition. Most of the available adaptation technologies in crop agriculture in the coastal zone are likely to address the present climate related hazards. This paper will review relevant secondary literatures and focus on some of the current and potential adaptation technologies in the agriculture sector in the coastal region of Bangladesh.

T5S1ORAL01

Tuber Crops in Konkan: An Alternative Crops for Climate Smart, Sustainable, Economical Viable and Nutritionally Rich

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Konkan, the coastal belt of Maharashtra, being one of the largest region of Western Ghats is considered to be traditionally rich in biodiversity. The region, in general, warm and humid climate receives heavy rainfall. Tropical root and tuber crops are considered as the third important crops after cereal and grain legumes. These crops are also climate resilient. These crops grow and produce economic yield where other crops may fail; hence these crops are expected to play a key role in food security. Konkan region of Maharashtra is a known as hub of tuber crops. Due to suitable soil and climatic conditions, the farming community of Konkan grows almost all type of crops in their homestead / backyard as sole crop or as intercrops in their own consumption. Under changing climatic scenario, tuber crops plays vital role in crop diversification. They are available and sustain their production even in adverse weather conditions. That is why, tuber crops are known as the crops of adversity. Tuber crops can tolerate drought and shade, are adaptable marginal environment, low input situation, adverse soil and climatic conditions and also have great flexibility to thrive in mixed cropping systems. Cassava is drought resistant and able to withstand dry spells for more than three months. Sweet potato and yams has also wide climatic adaptability. Taro can withstand water logging. Xanthosoma is grown in warm and humid climate and is giving sustainable production as intercrops grown in irrigated fruit crops like coconut, arecanut, sapota. Elephant foot yam is shade loving plant and is suitable for any cropping and intercropping systems. The results of different field experiments conducted by AICRP on Tuber Crops at Wakawali showed that all tuber crops realized highest net returns and B:C ratio. Comparative economics of the different varieties of sweet potato indicated that net returns and returns per rupee invested (C:B ratio) was the highest in Kamala Sundari (₹ 77,238 ha^{-1} and 1:1.47). The greater yam variety Sree Kartika (Da-199) realized highest net returns of ₹ 2,42,078 ha^{-1} with a B:C ratio of 1.70. The economics of the different varieties of elephant foot yam suggested that gross and net returns were highest in the variety Gajendra (₹ 5,11,370 and ₹ 1,53,444, respectively). In lesser yam the spacing 90 x 30 cm realized the highest net returns of ₹ 3,66,619 ha^{-1} followed by the spacing of 60 x 30 (₹ 3,38,590). However, the C:B ratio of 1: 2.21 was highest in spacing of 90 x 60 cm. In the event of global warming tuber crops can be a good alternative to mitigate the effect of climate change and also to sustain marginal farmers in Konkan region of Maharashtra. Several nutritional disorders due to deficiency of vitamin A, vitamin C and calcium could be easily alleviated by consumption of root and tuber. All these crops are energy rich in nature. The total dietary fibre content are also more. Since, tuber crops are affordable to the poor people, the nutritional balance can be easily achieved. These crops add variety to the diet in addition to offering numerous desirable nutritional and health benefit.

T5S1ORAL02

Trend Analysis of Rainfall and Temperature of Coastal Districts of West Bengal for Computing Irrigation Water Requirement of Jute Crop Using CROPWAT Model

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Rainfall and maximum air temperature (T_{max}) and minimum air temperature (T_{min}) are the important basic climatic parameters for planning of agricultural cropping system. Rainfall is one of the vital components of hydrologic system and it has direct correlation with water resources of concerned region. The trend analysis of long-term rainfall and T_{max} and T_{min} data are critically important for coastal region of West Bengal for its developmental planning including agricultural planning. In this study, the historical 102-year (1901-2002) rainfall, and T_{max} and Tmin data (Indiawaterportal.org) of the coastal districts of West Bengal such as East Medinipur, South 24-Parganas, and North 24-Parganas, were analyzed for monthly and annual trends. The increasing and decreasing trends and their corresponding magnitudes were identified by using Mann-Kendall test and Sen's slope model at 5% level of significance. CROPWAT model v8.0 was used to compute irrigation water requirement for jute crop for different sowing time. In all the three costal districts, March rainfall was in decreasing trend but T_{max} and T_{min} were in increasing trend. April rainfall, and T_{max} and T_{min} were in increasing trends for all the three districts, except T_{max} in East Medinipur district. May rainfall was in decreasing trend both in North 24-Parganas and South 24-Parganas, but it was in increasing trend in East Medinipur district. T_{max} and T_{min} were in decreasing trend in East Medinipur but that was in increasing trend in North and South 24-Paraganas districts. Monsoon rainfall started from June and sustained up to September. Except decreasing trend of June rainfall found in East Medinipur, the rainfall in monsoon months was in increasing trend in all the districts. From this it can be concluded that rainfed jute crop may be sown in April months in the coastal district of West Bengal instead of March for better crop growth and establishment due to Nor'wester rain (*Kalbaishakhi*). When the jute crop was sown in the month of March, the irrigation water requirement (IWR) varied 100-150 mm. For sowing of jute in 3rd and 4th week of March, the respective IRW were 125-150 and 100-125 mm. When the jute crop was sown in April, the IWR varied from 30-100 mm. For sowing in 1st, 2nd, 3rd, and 4th week of April, the respective IWR were 80-100, 70-80, 50-70, and 30-50 mm. However, when jute was sown within the first fortnight of May, IRW was 20-30 mm. In general, due to the combined effect of decreasing trend of rainfall and increasing trend of air temperatures, 2-3 numbers of intermittent irrigation are required for better jute fibre yield in the coastal districts of West Bengal.

T5S1ORAL03

Effect of Climate Variability on Jute-based Cropping System as Perceived by the Agricultural Scientists

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Jute-based cropping system is one of the popular traditional cropping systems in eastern states of India especially in West Bengal, Bihar and in north-eastern state like Assam. Livelihood of the jute growing farm families and makers of jute diversified products is directly or indirectly dependent on jute cultivation and quality of fibre. Due to the global phenomenon of climate change and its resultant weather vagaries and climatic aberrations, this cropping system

is also being affected like other cropping systems. To address this issue, a study has been undertaken to explicit the perception of the agricultural scientists about the effect of climate variability on jute-based cropping system. A comprehensive list of probable effect of climate variability on jute-based cropping system was prepared through review of relevant literatures and consultation with experts. Then the scientists of ICAR-CRIJAF, Barrackpore were requested to give their responses about these probable consequences of climate variability on jute-based cropping system on a five point continuum ranging from 'strongly agree' to 'strongly disagree' category. The effect of climate variability on jute-based cropping system about which majority of the scientists were in 'strongly agree' and 'agree' categories could be identified as the impending effect of climate change on jute-based cropping system. The effect of climate variability on which the greater level of consensus amongst scientists was found were as follows: duration of traditional crop seasons has been changed, desirable soil moisture has become unavailable during sowing time of crops, dependency on ground water for irrigation has been increased, ground water table has fallen, weed, insect and disease infestation has become high due to hot and/or humid weather, flood/water stagnation has been occurring due to sudden/untimely heavy rainfall, heavy rainfall during harvesting has been causing huge yield losses in vegetables, pre-maturing flowering has been observed in jute due to unexpected low temperature, water availability during retting period has become scarce, existing water bodies in village for retting of jute has become dried and not available for retting, incidences of crop damage and yield losses due to unfavourable weather condition have been increased, crop lodging before harvesting becomes a common phenomenon due to high wind and/or hail storm, jute is suffered more due to erratic behaviour of rainfall, drought and storm/norwester during its early growth stages resulting in reduction of fibre yield and erratic rainfall during jute harvest is also affecting retting of jute and sowing of the succeeding crop. The mitigation and adaptive strategies perceived by the scientists like change in agronomic practices, adoption of SRI, nitrification inhibitor etc., jute-green gram intercropping, mixed cropping, diversified farming, rainwater harvesting, in-situ retting, soil mulching, adding organic matter in soil, green manuring, soil test based fertilizer application, split application of N fertilizers, IPM and INM practices, sowing in furrows, making proper drainage channels, drip irrigation in vegetables, low cost poly-houses and weather-based agro-advisory servicecould be the potential ways for the farmers struggling against the adverse consequences of climate change and adoption of those strategies could pave the way towards climate smart jute based cropping system.

T5S1ORAL04

Climate Resilience Livestock Production in Coastal Ecosystem of India

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Climate change is one of the important factors influencing livestock sector affecting their production and reproduction. India has large areas of highly productive coastal ecosystems which include approximately 5,000 km^2 of mangroves, 1,700 km^2 of salt marshes, 177,000 km^2 of sea grass ecosystems and approximately 2,300 km^2 of coral reefs. Human activities like pollution, expansion of agricultural land, urbanization, overexploitation of natural resources, soil erosion and deforestation are causing substantial damage to the coastal ecosystems. Climate change is having detrimental effects coastal ecosystems via global warming, increasing severity as well as frequency of cyclones and associated storm surges, acidification of seawater, occurrence of floods and increases in air and water temperature. Report says there was a loss of 3,15, 886 head of cattle during the super-cyclone that happened in Odisha in 1999. Studies suggest that if sea temperature rises by 2-4 °C, intensity of cyclones hitting the coastal areas can rise by 10-20%. Increase frequencies of extreme weather conditions, floods, lack of rain will degrade grasslands decrease fodder production as well as the quality of the fodder produced. Even if the green fodder is available from

other regions, that will cost high leading to increased cost of production. Therefore, the livestock sector as well as the livestock keepers needs to be resilient to the changing environment and continue to improve its production to meet the demand from the growing population. Resilience is defined as the capability of the animal to be minimally affected by disturbances or to rapidly return to the state pertained before exposure to a disturbance. (Colditz and Hine, 2016). According to Intergovernmental Panel on Climate Change, resilience is defined as the capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure while also maintaining the capacity for adaptation, learning and transformation. In–time weather forecasting for early warning of hazardous weather conditions will allow the farmers to take necessary preventive measures to save the animals from bad weather conditions like severe heat and cold waves, heavy rains and thunderstorm, cyclone, tsunamis, flood and disease outbreaks. Adopting several strategies like use of locally adapted breeds/varieties that sustain well in the climate, genetic improvement of animals, use of molecular genetic markers for heat tolerance in selection program, constructing scientifically designed housings, improving diets, better herd management to improve output, better management of grassland, establishment of climate resilient, smart villages with shelters for man and animals during climatic havocs etc will help in combating with the changing climate.

T5S1ORAL05

Assessment of Climate Change Vulnerability in Coastal Districts of India

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India, being a developing country facing serious problems such as insufficient land and water and an increase impact of climate change. Climate change and extreme events will adversely impact the agricultural production and increase the vulnerability. Therefore, to ensure food security of the country, appropriate mitigation and adaptation strategies need to be adopted. In this regard, integrated climate change vulnerability assessment of agriculture is the pre-requisite for developing climate-smart strategies and technologies. Though climate change is a global phenomenon, its manifestations and impacts vary locally, so do the mitigation and adaptation strategies. So, local vulnerability assessment is needed for development of mitigation and adaptation strategies specific to the community needs and priorities at the local level. Data pertaining to sensitivity, exposure and adoptive capacity indicators were collected for coastal districts of India. Individually indices were calculated for sensitivity, exposure and adoptive capacity using principal component analysis (PCA). The results showed that the exposure was the maximum for Porbandar district (0.321) of Gujarat while the minimum exposure was recorded for Uttara Kannada (0.080). Among the west coastal districts, maximum and minimum sensitivity was observed for Raigarh (0.068) and Amreli (0.028) district, respectively. The districts of Maharashtra and Kachchh district of Gujarat showed higher sensitivity to climate change. The maximum adaptive capacity was observed for Porbandar (0.130) and the minimum was recorded for Uttara Kannada (0.095). The districts of Gujarat showed maximum vulnerability to climate change while districts of Karnataka and Kerala were found to be less vulnerable. Strategies and development activities should be channelized to the climate vulnerable areas to facilitate adaptation strategies.

T5S1ORAL06

The Challenge of Climate Change in Agriculture Management in the Persian Gulf-Oman Sea Coasts in Iran

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Agriculture is a major part of Iran's economy that will face different threats and opportunities and threats from future climate change. Changing rainfall and temperature patterns challenge long-term agricultural management and planning. In this study, the effect of climate change on agricultural management on the coasts of the Persian Gulf and the Makran has been investigated. For this purpose, precipitation, and temperature parameters of 10 synoptic stations under RCP scenarios (2.6, 4.5, and 8.5) have been simulated with the SDSM tool. The results show that the probability of increase and decrease of temperature and precipitation, respectively in Persian Gulf stations is higher than that of Makran coast. The southern coasts of Iran have the longest growing season in the country due to their unique geographical and climatic characteristics. Also, in the northwest of the Persian Gulf, where agricultural production is especially important, under RCPs 2.6, 4.5, and 8.5, the maximum temperature shows a further increase in the future. However, increasing maximum temperature could decrease crop diversity and threaten plants with lower temperature thresholds in the Persian Gulf coast. Also, in the east of Makran coast the temperature will increase significantly for RCP8.5. Generally, agricultural management and the effects of climate change in the Persian Gulf coastal require the application of mitigation /adaptation plans.

T5S1POS01

Planting Date and Nutrient Management: Adaptation Strategies for Rice Production in Coastal Areas under Present Climate Change

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Rice is the staple food crop for most of the people living in Asia and provides 23 per cent of the global human per capita energy and 16 per cent of the per capita protein (IRRI, 1997). Introduction of high protein rice is an important step towards nutritional quality. Occurrences of climatic changes during the critical growth stages of rice significantly reduce the yield. Reduction in crop duration, average grain weight and increase in respiration, sterility and resultant decline in yield are expected as a result of deviation in rainfall pattern, increase in temperature and solar radiation. The effect of sowing time and proper fertilization particularly nitrogen (N) on rice cultivation assumes pivotal significance. Results from the study done during 2017 to 2019 showed that during reproductive stage, the higher temperature range was recorded in early planting (July) and normal planting (July-August) as compared to late planting (August). The highest number of helio thermal units was recorded with late planting (August) in rice crop because more bright sunshine hours was present during the flowering stage to maturity stage. More sunshine at the time of panicle emergence to fertilization leads to greater yield. Among the different time of planting, the late planting (August) took more number of days for physiological maturity followed by early planting (July) and normal planting (July-August) during both the years. Panicle initiation stage, 1st flowering, 100 % flowering, dough stage and maturity stage took more number of days with application of 150% RDN applied in 3

splits (1/2+1/4+1/4), which was statistically at par with 150 % RDN applied in 3 splits (1/3+1/3+1/3) during 2017 and 2018. The crop could express its potentiality, when planted on suitable time of planting with required amount of nitrogen. Higher grain yield and protein content was recorded with late planting (August) through application of 150% RDN in 3 splits (1/2+1/4+1/4) (N4).

T5S1POS02

Microhabitat Preferences of Rhodophyta on Shore Platform of Dwarka, Gujarat, India

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Red marine algae (seaweeds) are macroscopic, multicellular, benthic organisms. They are visibly red in colour and may also occur in green, black and brown in colour. Red marine algae have chlorophyll but this is dominated by phycocyanin and phycoerythrin pigments which give them their distinctive reddish colour. Phycocyanin and phycoerythrin pigments also allow rhodophyta to photosynthesize in lower light levels and thus grow in deeper waters where green seaweeds may not survive. Red marine algae are ecologically significant as primary producers and providers of structural habitat for other marine organisms. They are commonly marketed as food in the form of spices, condiments, pasta and also employed in the phycocolloids industry (agar, carrageenan) as food additive acting as gelling agents, emulsifiers, due to their water retention and other physical properties. Some red marine algae are also important in the formation of tropical reefs, an activity with which they have been involved for millions of years. These are reef building rhodophyta, commonly called as coralline algae because they secrete a hard shell of calcium around themselves, same like corals. Present study shows the microhabitat preference of rhodophyta on shore platform of Dwarka, Gujarat, India. Rhodophyta were surveyed based on systematic random sampling for two years: April 2013 to April 2015. Total forty nine species of rhodophyta were identified through intensive fieldwork based on line transect and quadrate based method. Rhodophyta distribution was tagged with shore platform's zonal morphology. This study identifies four microhabitat preference groups like: (i) Cliff base group; (ii) Intertidal platform group; (iii) Subtidal group and (iv) Ubiquitous algae as per their micro-zonal preferences on the shore platform. The cliff base group, intertidal platform group, subtidal group and ubiquitous group were identified with 10, 11, 2 and 12 exclusive species respectively.

T5S1POS03

Probability Analysis of Weekly Rainfall for jute Crop Planning in North 24 Parganas, West Bengal

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Rainfall variability has major implications on country's economic prosperity, as it is important to understand the underlying process of rainfall pattern in a agro-climatic region. In this study, historical rainfall data of last 31 years (1980-2020) were analysed for selection of most appropriate probability distribution in North 24 Parganas, a coastal district of West Bengal. Two and parameter probability distributions were compared to identify the most suitable

distribution based on Anderson–Darling (AD) test and probability plot. It was observed that a single distribution cannot adequately describe all the weeks. Weibull probability distribution was found to be most appropriate for most of the SMWs followed by Gamma and log logistic distribution. Minimum assured rainfall at 40-50% probability level was found to be in close agreement with the long-term average weekly rainfall data. In jute growing season, minimum assured rainfall of about 4.2 and 12.1 mm are expected with 70% probability. Where from first week of April onwards, 27.8, 15.2, 25.7,8.5, 15.2, 12.9, 14.1 and19.8 mm are expected from SMW13 to SMW20 at 70% probability, respectively. Markov chain analysis revealed that, chances of occurrence of a dry spell week is high during early part of the season. Probability of occurrence of wet week of more than 20% starts from SMW14 onwards (first week of April). As per the variability in weekly rainfall, jute crop, predominantly a rainfed crop, is supposed to complete the sowing by mid-April instate of early sowing (15-30 March).

Theme V:

Climate change and disaster occurance, its impact, IT & remote sensing for rapid dissemination and early warning protocols, mainstreaming climate change policies for regional integration

SESSION II:

Meteorological, hydrological & geological disasters: characteristics and likely impact on population dynamics

T5S2I01

CLIMATE CHANGE AND EXTREME WEATHER EVENTS

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Dr. D. R. Pattanaik was born in a small village Padampur in western Odisha, India on 1st March 1970, he obtained his B.Sc. & M.Sc. degrees in Physics from Sambalpur University and M. Tech. & Ph.D. in Atmospheric Sciences from Pune University. He joined the India Meteorological Department (IMD) as a Meteorologist in June 1998 while doing his PhD at the Indian Institute of Tropical Meteorology, Pune. At present, he is the Head, Numerical Weather Prediction Division, IMD, New Delhi. He has worked in various sections of IMD as operational forecaster, researcher, NWP modeller and also as instructor in providing training in Meteorology. He has been engaged in research work in the areas of monsoon variability, monsoon forecasting, extended range forecasting and extreme weather events, climate change etc. He has published about 70 research papers in peer reviewed international/ national journals and also contributed many chapters in books. He is the recipient of the award for outstanding contribution in the field of Atmospheric Science & Technology by the Ministry of Earth Sciences, Government of India in 2011 and the Young Scientist Award for the best research paper published in Tropical Meteorology for the years 2014 by Indian Meteorological Society (IMS).

Abstract: As India receives about 75 to 90% of its annual rainfall during the monsoon season JJAS and a failure in monsoon rainfall leads to drought conditions and can affect the economy of the country. One-sixth area of the country is drought-prone, with the western part of the country, including Rajasthan, Gujarat and some parts of Maharashtra beingmore vulnerable and are hit very frequently by drought condition. In some years with deficient rainfall, the situation spreads into other parts of the country. The other extreme of the monsoon rainfall associated with excess seasonal rainfall during JJAS and heavy rainfall can lead to flood conditions over many parts of the country. About 7.5 million hectares get flooded every year during monsoon season. The plain region of India is affected by floods almost every year during the monsoon season due to heavy rainfall. Thus, the inter-annual fluctuations in the summer monsoon rainfall over India are sufficiently large to cause devastating floods or severe droughts.

The annual mean temperature over Indian land mass shows an increasing trend of 0.61°C/100 years during 1901-2019. Associated with the observed climate change it also indicates increasing trend of frequency of heavy rainfall events over many parts of the country. The climate change can have adverse impact at global, national and regional levels. The current trends of climate change are expected to increase the frequency and intensity of existing hazards, an increased probability of extreme events. The Intergovernmental Panel on Climate Change (IPCC) in its Fifth Assessment Report has also projected more frequent and intense weather events in the twenty-first century with high confidence levels. Due to climate change the challenges in predictability of mesoscale events is going to enhance with the prediction of extreme rainfall events likely to decrease with the decrease of error doubling time of extreme rainfall event during last 30 years in recent years, which will have implications on the disaster management.

T5S2ORAL01

Soil Management Interventions in Cyclone Affected Coastal Areas in Andhra Pradesh

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Coastal ecosystem in India occupies an area of about 10.78 million hectares. Cyclone may bring a tremendous amount of suffering and chaos, and secondary disasters. The most immediate and visible impact of cyclone and related flooding on agriculture is the damage to standing crops, soil, livestock, household property, physical assets and infrastructure. Deposition by floods of a layer of alluvium on cultivated land may bury crops and change soil quality. This process may also improve soil quality and yields in subsequent years, but the crop production potential may be lowered if the deposits are rather infertile and drought-prone sandy matter, or silts which may initially be saturated and inhospitable to plant roots and soil organisms. In some areas, good topsoil may be washed away, exposing less cultivable soil layers. The impact of a cyclone on the soil depends on the preceding climatic conditions (soil moisture, water level). We studied the impact of cyclone in eastern coastal area of Andhra Pradesh which is affected by at least one cyclone every year. Our study shows that the major soil related parameters which were required to assess after cyclone are hydrologic variables such as soil moisture (needed to evaluate as local moisture availability), soil physical condition (Cyclone associated flood water also brings sand and silt along with it to the crop fields), excess accumulation of soluble salts, toxicity and deficiency of nutrients in soils. These parameters in turns are also affected by factors such as topography and soil type, including soil depth, moisture holding and drainage capacity. Various soil related interventions can help the farmers vis-à-vis agriculture to bounce back effectively after cyclone in this area. Sub surface water harvesting structures (SSWHS), Land modification techniques for better cyclone / flood resistance such as raised and sunken bed technique would be highly effective in utilization and channelization of the available water. Bio-drainage options, practice of de-sanding, de-siltation and land shaping will help in bringing desirable shift in soil physical condition under post flood situation. GIS is an effective tool to interpret information by creating thematic maps which show spatial patterns, trends or relationships, making it easier to analyse the information. Training programmes to farmers and other stakeholders for cyclone prone area related to soil management and preparedness is a must to combat effectively.

T5S2ORAL02

Impacts of Cyclones on Perennial Horticulture Crops and Sustainable Management Strategies for Livelihood Security

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Cyclones are the major natural hazards that affect Indian Agriculture causing major losses to crops and allied sectors. India has a coastline of approximately 7,516 km which is vulnerable to cyclones with varying frequency and severity threatening the entire coast. The North Indian Ocean generates only about 7% of the world's cyclones,

but their impact is comparatively high and devastating.Direct and indirect effects of cyclones adversely affect farm income.Tropical cyclones impact 13 coastal states and union territories in India among which the most vulnerable regions to cyclones are from Tamil Nadu, Andhra Pradesh, Odisha, West Bengal and Puducherry on the East coast and Gujarat on the West coast. The direct damages are from high-speed winds, torrential rain and extensive floods. Super cyclone Phailin in 2013, Hudhud 2014 and Fani 2019 have severely affected crop production and livelihoods of farmers in the east coast. A team of scientists from ICAR-CRIDA visited the affected areas of Vishakhapatnam, Vizianagaram and Srikakulam districts of Andhra Pradesh. Perennial horticulture crops in coastal areas were affected by crop damage and poor crop productivity. They caused severe damage to crops like coconut (40%), cashew (30%), mango (30%), jackfruit (35%), and banana (100%). The results of our study on the impact of cyclones (Phailin in 2013, Hudhud 2014 and Fani 2019) showed that the damages included crown twisting, leaf breaking, uprooting, bending one side and fruit and flower drop in coconut. In cashew, guava, jackfruit and mango the damage included uprooting, twisting of branches and fruit and flower drop. Post-cyclone contingent measures and crop management strategies like planting shelter belts for orchards, selection of high yielding dwarf varieties in coconut, saline tolerant varieties, raised bed for banana cultivation etc. may be adopted to reduce the damages caused by the cyclones. Support from institutions and government organizations are required for revival of the affected areas.

Theme V:

Climate change and disaster occurance, its impact, IT & remote sensing for rapid dissemination and early warning protocols, mainstreaming climate change policies for regional integration

SESSION III:

Disaster management: IT and remote sensing -scope for preparedness, early warning models to combat adverse impact, researchers' code as per UN guidelines

T5S3I01

ADVANCES IN EARLY WARNING SYSTEMS FOR OCEANOGENIC HAZARDS IN INDIAN OCEAN REGION

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Abstract: Robust and reliable early warning system is an essential component for disaster risk reduction. INCOIS is investing technological advancements and research findings with its operational early warning systems for the

Indian Ocean region. Presently, early warning systems for oceanogenic hazards such as Tsunami, Storm surge, High Wave, Swell surge, Tidal flooding and Oil spill are operational at INCOIS. The Indian Tsunami Early Warning Centre (ITEWC) was established in October 2007 to provide tsunami advisories to India and Indian Ocean Rim countries. The tsunami warning centre is capable of detecting tsunamigenic earthquakes occurring in the Indian Ocean as well as in the Global Oceans within 10 minutes of their occurrence and disseminates the advisories to the concerned authorities. Since inception, ITEWC monitored 638 earthquakes (M>6.5), out of which occurred 101 in the Indian Ocean Region and provided timely advisories to stake holders. Storm Surge Early Warning System is established for the Indian coasts in collaboration with India Meteorological Department (IMD).Once the wind and pressure fields are generated using the track forecast from IMD, the storm surge model will be launched at HPC in the real-time. The respective module of the storm surge Decision Support System will generates storm surge advisory bulletins and notifications. Also, the early warning services for occurrence of high waves (> 3 m) associate with cyclone and remotely forced disturbances, Joint Ocean state bulletins with IMD during cyclones, the coastal flooding (kallakadal) associated with high period swell waves, the tidal flood warnings associated with perigean spring tides is operational at INCOIS. In addition generation and usefulness of multi-hazard vulnerability maps and trajectory predictions systems for manmade disaster like oil spills is discussed. The backbone of these system are, robust in-situ and satellite observation systems, state-of-the-art numerical models with assimilation systems, computational facilities running multi-model simulations and importantly, adoption of the latest Information and Communication Technology (ICT) tools for effective dissemination to various stakeholders. The accuracy of the early warnings and the reliability of the systems in Indian Ocean is also discussed.

T5S3I02

EVOLUTION AND MORPHODYNAMICS OF BHASAN CHAR ISLAND USING MULTI-TEMPORAL SATELLITE REMOTE SENSING DATA AND CYCLONE VULNERABILITY

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Abstract: Bhasan Char island is located in the Meghna estuary, close to Chittagong, Bangladesh. The evolution of the island was studied using time series satellite data of 2001 to 2020. The young island evolved in the year of 2001 and undergoing morphometric changes till date. The present island appeared as a small annular land mass, oriented in NE-SW direction in 2003. After that several changes are noticeable. From 2004 to 2008 orientation changed in clockwise direction. Not much change was observed in the orientation between 2009 and 2011 but landmass increased substantially in the southern side of the island which continued till 2012. A new lobe of landmass, in the southeast direction of the mainland, has evolved during the same year. The extension of the main island along north-west direction continued till 2014. Little reduction was observed in 2015 especially in the south-east direction including the lobe area. In 2016 the reduction is landmass is prominent all around the island and more so in the eastern side. The process continued till 2018, but in 2019, once more it started increasing, along the north direction and continuing till 2020.The morphology of the island is continuously changing due to the river hydro-dynamics and sediment load. The vulnerability of the Bhasan Char island was assessed based on the historical cyclone data that made landfall mainly over Cox's Bazar, Chittagong, Noakhali, Sandwip and Hatiya island since 1900. It is interesting to note that 17% of the tropical cyclones had their landfall at Bangladesh since 1900 due to favourable topography, hydro-morphological processes and funnel shaped coastal area as well as re-curvature of the tropical cyclones over Bay of Bengal as in the case of Cyclone 'Viyaru' and 'Bulbul'. From the track analysis of the past years, it is observed that two of the major cyclones ('Komen' in 2015; 'Roanu' in 2016), have traversed across the island. Based upon the past experience the maximum wind speed of cyclonic storms varied from 85-260 kmph and the storm surge from 0.6 to 7.1 m. The cyclones of 1963, 1970 (Bhola) and 1985 (Urir Char) had very high wind speed, ranging between 154-230 kmph and storm surge height of 3 to 5. 5m. As the elevation of the island is very low (lower than Sandwip, 7-17 m) the storm surge of these magnitudes may trigger extensive flooding. It is inferred that the Bhasan Char island is in its young stage, the morphology of which is continuously changing. The vulnerability to cyclones and flooding very high being a very low-lying area and to protect the island extensive bioshielding is required.

T5S3I03

FLOOD MONITORING, MAPPING AND MODELLING USING SPACE DATA

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Abstract: Flood is one of the worst natural disasters affecting the social and economic life of millions of people every year. India is second worst flood affected country in the world and these disasters became more frequent in recent years due to change in climatic conditions. Floods cannot be controlled fully but the damage can be minimised to the great extent by adopting suitable structural and non-structural methods. Satellite remote sensing provides comprehensive, synoptic and multi-temporal coverage in near real time and at different temporal intervals and, thus, has become valuable for continuous monitoring of flood disasters. Thus, it has been found to be more suitable for mapping/monitoring and modelling (i) near real-time flood inundation (ii) flood damage assessment. (iii) flood propagation (iv) study of river morphology (v) flood hazard zonation, and (vi) flood early warning. This information is a vital input in various phase of disaster for relief and rescue operations and for disaster risk reductions. Space and aerial based inputs like digital terrain models, satellite based rainfall products provides very valuable information for flood forecast and spatial flood modelling. Geostationary satellites provide continuous and synoptic observations over large areas on weather including cyclone monitoring.

T5S3ORAL01

Animal Shelter Designs and Construction in Tropical Cyclone Prone Coastal Areas as Disaster Management Strategies for Livestock

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In coastal areas of tropical countries cyclone is one of the most common natural hazard that cause damages to human settlement, livestock, agriculture and ecosystem. Every year globally several million people affected by tropical cyclone. Information on the extent of cyclonic damage to livestock houses solely due to construction practices and faulty shed designs are very less. This paper summarizes the improvement in animal shelters' construction practices, modification of designs, orientation of farm stead buildings, choice of better quality materials for livestock house construction, landscaping of livestock farm and farmers' house which can reduce the degree of damages in livestock houses of coastal areas due to cyclone. The shape and dimensions of animal houses, roofing materials, roof design and slope of roof are very important concern to withstand high wind speed. Foundation of buildings of animal house, walls, ventilation and other different structural elements need special attention to reduce the risk of structural damages and incase, damages happen that could be repaired with minimum expenditure to make usable by shortest possible time. This paper provides some information on animal shelters' construction, design and modification aspects of building elements that can minimize collateral losses of animal owners of coastal areas and some other related livestock management strategies to mitigate disasters owing to cyclone.

T5S3ORAL02

Satellite based assessment of Agricultural Drought in Coastal states of India: Comparison of 2018 with 2020

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Drought is one of the major reoccurring natural disasters in Indian subcontinent. India is an agriculture dominant country where a large proportion of working population (54.6%)is involved in the farming occupation. Indian agriculture is rainfall driven and kharif season majorly depend on South-West monsoon rains. Over 68-70% of total sown area in India is vulnerable to drought. Coastal states are known for disasters like flood and cyclone. But due to irregularity in rainfall pattern during recent past years, coastal states are also facing droughts. In this context, satellite based remote sensing data has been shown to be highly useful for crop condition assessment and drought monitoring. Under National Agricultural Drought Assessment and Monitoring System (NADAMS) project, agricultural drought assessment is carried out in major states of the country including seven coastal states i.e. Andhra Pradesh, Gujarat, Karnataka, Maharashtra, Odisha, Tamil Nadu and West Bengal at district and sub-district level as per the methodology mentioned under the Drought Manual of 2016. Under this methodology first Trigger-1 is checked through Rainfall Deviation (or SPI, Standardized Precipitation Index) and Dry spell. If the Rainfall Trigger is ON, the severity of drought can be assessed based on 3 out of 4 impact indicators (Remote Sensing, Crop sowing, Soil moisture and Hydrological indices). The drought assessed using impact indicators needs to be validated through ground truth. Year 2018 was the period when Andhra Pradesh, Gujarat, Maharashtra, Karnataka and Tamil Nadu states faced moderate to severe drought and loss of agriculture and economy of the farmers. In 2018, except Odisha and West Bengal all 5 states had deficit cumulative rainfall deviation from normal (-20 to -59.99 %) from June to September. SPI was also found to be extremely dry (<-2) in Maharashtra and Karnataka

and mildly dry to severely dry (-0.99 to -1.99) in Andhra Pradesh, Gujarat and Tamil Nadu. Most of the districts of Andhra Pradesh and Tamil Nadu were under severe drought category. Kharif season 2020, was a good year in respect of rainfall and agriculture area and production. During kharif 2020, out of 197 districts of all the 07 coastal states, only 30 districts were observed under Trigger-1, where majority of the districts were under excess (+20 % or more) to normal rainfall situation (+20 to -19.99%). Though the soil moisture was under moderate and severe drought category (<50%), satellite derived vegetation index (NDVI/NDWI) were not low (>-20 % Deviation from normal) and crop sown area (derived from satellite data) was under Normal (>85% sowing) category. No district was found under severe category in the coastal states. Overall crop and moisture condition was good during kharif 2020 as compared to 2018.Using various remote sensing and agro-meteorological based indices, it was possible to capture at an early stage the possible impacts of an impending drought. This has been successfully showcased and operationalized by the NADAMS programme.

Theme VI:

Technology impact on the socio-economic, gender issues, ICT application to assess and monitor, strengthening market linkage and business models on post-harvest and value chain for livelihood security and employment generation

SESSION I:

Technology impact on socio-economy: food & income security and market linkages

T6S1I01

SUSTAINABLE DEVELOPMENT AND COASTAL ECOSYSTEMS: AGENDA FOR CHANGE, INNOVATIONS AND IMPACT INVESTMENT

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Abstract: With the deepening flux in the world, sustainability agenda stand at the precipice of a big turning point for the future of nature and human beings. In context of coastal and marine ecosystems, existing approaches such as Marine Protected Areas (MPAs)- a tool offering potential to enforce specific regulations for different uses, protection and restoration agenda or Locally Managed Marine Area (LMMA)' that provides a planning and strategic approach to the development of coastal cities and implementing Integrated Coastal Zone Management bear potential in addressing sustainability challenges. Toward technical support to these frameworks-Marine Spatial Planning (MSP) emerged as a collaborative method and public process of analyzing and allocating the spatial and temporal distribution of demand for human activities and protection measures for marine ecosystems calling for ecosystem-based management (EBM). However, lack of institutional and policy support and limited financial and technical capacity is a common barrier to the enforcement and scaling of these agendas. Furthermore, the recently Global Assessment Report (2019) of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) highlighted some blaring facts including, how marine plastic pollution in particular has increased tenfold since 1980 and how to direct exploitation of organisms (mainly fishing) had the largest relative impact on nature in coastal and marine ecosystems. It calls for priority action to steer change – cocreation, and collective action, and guidelines for a shared vision of valuing nature and nature's contribution to people. To be successful, these agendas need financing resources, a dedicated public budget, technical capacities, and supporting policies. The 'Impact Investment' is an upcoming narrative in the conservation and restoration landscape. A vital example of this

is the 'Blue Finance' framework of UNEP seeking to deliver an expanded investment portfolio via Public-Private Partnerships (PPPs). In closing, taking note of two projects- Ecosystem-Based Adaptation approach for Sustainable Management and Governance of Coastal Ecosystems (ENGAGE, 2016-2018) and GlobalSeaweedSTAR (2017-2021)- the opportunities and challenges toward safeguarding the future of the coastal ecosystems and communities are explained. GlobalSeaweedSTAR program, funded by the Global Challenge Research Fund of UK Research and Innovation (UKRI)is working to safeguard the future of the global seaweed industry by bringing together an international team of experts in science, policy and economics from nine partner institutions across the developed, emerging and developing economies. The ENGAGE project funded by Asia Pacific Network, Japan identified innovative approaches for capacity development by employing the 'Training-cum-Workshop (TcW) model' complimented with multi-stakeholders dialogue workshops bringing together experts, decision-makers, and scholars from South East Asia to dialogue on barriers and opportunities for regional cooperation on EBA framework to coastal management. It is no doubt that 2021 has to be the year for significant transformation. The United Nations Decade on Ecosystem Restoration (2021-2030) tasks nations and communities to scale up restoration efforts and restore degraded ecosystems towards the goals of sustainable and healthier futures. The decade will supplement the existing frameworks and agendas and provide a roadmap for the delivery of the Sustainable Development Goals (SDGs), in particular, SDG 14 – to conserve and sustainably use the oceans, seas, and marine resources for sustainable development.

T6S1I02

DEVELOPMENT OF COASTAL AGRO-ECOSYSTEMS: ROLE OF TECHNOLOGY AND POLICY

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Abstract: The coastal agro-ecosystems are spread over six percent of the agricultural lands and contribute much more than land share to the value of agricultural production. The climate is also quite diverse from humid to dry sub-tropical and therefore practices different agricultural systems. The eastern coasts practices mostly rice-based

farming systems, while the dry western coasts practices groundnut-based systems. Aquaculture and plantation crops like cashew and coconut and fruit like mango are other major sources of farm income. These farming systems are characterized as high productivity and high risk in comparison to other systems of the country. Salinity is another major problem of the coastal systems and therefore, multiple risk tolerance varieties are popular in the region. Wetlands in the coastal region are another important ecosystem which contribute quite significantly to economic and ecological functions of the system. The valuation studies indicate that the value of ecological contributions is much higher than economic value of the produce. Important among these services are biodiversity, protection from natural hazards, and cultural & amenity.

The coastal systems have experienced significant expansion of aquaculture, which has contributed to economic development in a big way. This was possible through response of the farmers to rising growth opportunities, including exports, and technological backstopping by the R&D system. Introduction of shrimp, development of hatcheries, disease management, and technology like cage culture has made significant impact. In marine system, cage culture, fishing crafts and weather forecasting have made significant improvement in the marine systems. Another important activity associated with marine system is ecotourism which provide livelihoods to the people.

There are few policy issues which need attention to improve the coastal systems. First and foremost is resolution of the conflicts arising from ingression of salinity in the areas practicing aquaculture. The crop fields adjacent to aquaculture farms are affected with salinity, affecting their yields. This needs to be compensated. The second major issue is related with the riparian rights of coastal water bodies. These rights are weak and poor people away from water bodies do not have access to the resource and benefits therefrom. The modification of riparian rights to meet requirements of the resources and local communities should be evolved. Access to the resources like wetlands and coastal areas should be restricted to conserve the resource and enhance biodiversity of the system. The funds accumulated through cess etc. on ecotourism and leasing-out of the resource should be shared with local bodies managing these systems.

T6S1I03

UNDERSTANDING THE DIFFUSION AND IMPACT OF AGRICULTURAL TECHNOLOGIES IN INDIA

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Consultant for many national and international institutions including FAO and World Bank. He has made significant contributions to agricultural economics and policy research. He wrote more than 110 research papers in national and international research journals on various agricultural development issues. He has also contributed more than 70 papers/chapters to important books and proceedings. His contributions have been well recognized, and he is a Fellow of the National Academy of Agricultural Sciences (NAAS) of India. He has won a number of awards from national and international institutions. To list a few, he was awarded the prestigious Rafi Ahmad Kidwai Award (2017), Lal Bahadur Young Scientist Award (2005); and NAAS Young Scientist Award (2003).

Abstract: Diffusion of technologies is influenced by a number of socio-economic factors, including the farm and farm household characteristics, local endowments of natural resources, institutions, infrastructures and policies. The literature, however, mainly focuses on the investigation of household-level determinants and ignored quantification of the roles of the higher-level determinants that may simultaneously influence the technology adoption behavior of farmers. We analyze the mutually reinforcing and reciprocal relationships between people (compositional effects) and places (contextual effects) to know the relative importance of different geographical or administrative levels on the adoption of modern varieties of cereal crops in India. Our findings show a strong contextual effect at the state-level and an equally strong compositional effect at the household-level, that indicate the need for a greater policy emphasis on agricultural research and development, and redressal of the constraints that farm households face in the adoption of new technologies. Further, the study also finds a significant positive impact of the adoption of new agricultural on food security and farmers' livelihoods. There is a need for greater coordination of programs and strategies between different administrative levels for the faster dissemination of modern technologies and consequently realization of their economic and social outcomes. Policies need to be framed to encourage greater participation from the private sector in the development and extension of agricultural innovations to supplement the efforts of the public sector in the promotion of new agricultural technologies.

T6S1ORAL01

Impact of Jute Production Technological Interventions on Farm Women Empowerment

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A study on impact of technological intervention on farm women empowerment was conducted at Makaltala village of North 24 Parganas, West Bengal where jute based farming system prevails. A baseline study was conducted initially in both the villages to analyse the existing farming situation and level of farm women's participation in farming activities. A cafeteria of technologies suitable for the area was introduced slowly in the villages over a period of three years inorder to technologically empower the farm women by providing skill on improved jute production technologies, providing drudgery reducing tools and implements and also training them on value addition which is a part and parcel of sustainable agriculture system. The impact of introduction of farm interventions in terms of participation of farm women in farming activities, the level of drudgery and the overall perceived impact of the interventions were studied. Participation of farm women in farming activities in two dimensions like physical participation and participation in decision making was considered for the study. More than half of the respondents always participated in activities like drying and storing (72.5%), record keeping (65%) and weeding (57.5%) during post intervention period where as in pre intervention period the percentage of respondents participating in various farming activities regularly were very less, the highest being in weeding operation(15%). In the post intervention period Majority of the farm women participated in decision making always in activities like drying (95%) ,weeding (70%), storing (70%),record keeping (69.23%)and harvesting (50%). The level of reduction in drudgery in farming activities due to introduction of interventions were studied by collecting the data of pre and post intervention

period. In the pre intervention period the the mean score for drudgery was highest for field preparation(2.925) and sowing(2.925) followed by retting(2.92) , irrigation(2.72) and weeding(2.7) whereas in the post intervention period the mean drudgery score had decreased for all the activities , the higher decrease was observed in case of retting (1.525) followed by sowing (1.225) and weeding (1.05) A study on the impact of the interventions on farm women in terms of their individual abilities revealed that the highest difference level in mean was attained in case of self-confidence.Training on fisheries, poultry and entrepreneurship development was given additionally to the tribal farmers and farmwomen to enhance their livelihood security. More than 80 % of the tribal farmers have reported that the new interventions adopted by them had contributed to an increase in income and confidence in farming activities. The entire programme had a special impact on farm women as they reported that they could gain self-confidence, reduced drudgery and their social participation increased in addition to the enhancement in livelihood.

T6S1ORAL02

Neglected Edible Leafy Vegetables-Road to Nutritional Security

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Many key components of biodiversity for food and agriculture at genetic, species and ecosystem levels are in decline. Supplying enough safe and nutritious food for a growing world population poses many challenges. Despite repeated warnings about the loss of biodiversity and its key role in food security and nutrition, production systems are becoming less diverse. The modern-day agriculture has a 66% cultivation comprising 9 plant species, thereby, ignoring the goodness and nutrition offered by 30,000 edible plant species. In 2020 FAO celebrated World Food Day with the theme "Grow, Nourish, Sustain, Together". A large part of our population does not have the access to the recommended dietary requirement in their diet. It may require the domestication of additional food-producing species and increasing the use of underutilized and neglected species. Out of 600 species of vegetable crops, only one-forth is utilized and rest are either underutilized or unutilized. Wild foods found in the local area are an important source of food for many households. Eating them can alleviate micronutrient and/or protein deficiency and make diet more balanced and nutritious. Unconventional green leafy vegetables are such a group of vegetables are confined to the people living in areas where they grow. They provide vitamins, minerals and some of these leafy vegetables are packed with phytochemicals, and are inexpensive source of micronutrients. These groups of vegetables provide diversity in the food basket as well as add taste and flavour. Exploration and exploitation of these species may become a viable livelihood strategy for rural & tribal population as well as urban residents. Most of the leafy vegetables are short-lived herbaceous seasonal used by the local inhabitants to supplement their staple food. Many weed species like chenopodium are also eaten as edible leafy vegetables as different recipes. Still, in many areas, these wild edible leafy vegetables constitute an integral part of tribal diet either as raw or cooked. Wild underutilized vegetables likes; Marsilea, Portulaca, Commelina, Enhydra, Centella, Ipomoea, Paederia, Oxalis, etc etc are going to play a major role in nutritional security. In India, where malnutrition is significant, there is a need for systematic exploration for underutilized edible leafy vegetables to overcome nutritional problems.

T6S1ORAL03

Impact of Improved Jute Cultivation Practices in Jute Farmers' economy

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Jute is a commercial fibre crop which plays a significant role in the economy of Asian countries especially India and Bangladesh. In India majority of jute farmers belong to small and marginal farmers' category. A cluster of technologies has been developed by Central Research Institute for Jute and Allied Fibres for improving the jute production and fibre quality,in order to improve the profitability from jute, the socioeconomic status of jute farmers and thus regain the past glory of jute. The improved technologies were taken to farmers' field of almost all the jute growing districts of West Bengal through various lab to land programmes under NFSM, Jute ICARE, SCSP,TSP etc. During 2015-20, 2286 demonstrations were conducted in two agro-climatic zones covering four major jute growing districts of West Bengal (Nadia, Murshidabad, Hooghly and North 24 Parganas) and about six lakhs farmers are benefitted during last five years. The promising jute production technologies selected for demonstrations were improved variety of jute JRO 204, Multirow seed drill, Jute weeder, retting using microbial formulation-CRIJAF SONA etc. Seed drill resulted in reduction of seed rate by 50 % i.e. 3-4 kg ha^{-1} (6-7 kg ha^{-1}) in broadcast sowing), Saved labour for weeding and thinning by 15 man-days and maintained uniform plant population of 5 - 6 lakh ha^{-1}. Line sowing also facilitated post-sowing operations, increased fibre yield by 10-15 % thereby farmers could earn an additional income of Rs. 6,500 ha^{-1}. Similarly, Jute weeder saved labour requirement for weeding by 60 man-days, Increased fibre yield by 10-15 % and saved about Rs. 15000 - 17000 ha^{-1} per ha over manual weeding operation. Use of CRIJAF SONA in retting reduced the retting duration by 6 – 7 days, Improved fibre grade by 1- 2 grade.Increase in fibre weight by 5 – 8 % was also reported from the demonstration sites. Case studies from different parts of jute growing areas revealed that overall package of improved jute production technologies resulted yield improvement in jute,which was 12-15 % over conventional method and net income increased by more than Rs. 14,000 -20,000 ha^{-1}. The results prove that ICAR-CRIJAF technologies had played an important role in profitable and sustainable jute production by small and marginal farmers of West Bengal.

T6S1ORAL04

Food Security Contribution of Coastal Agriculture in India – Status and Policy Perspectives

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Coastal Zone in India covers 7516 km coast line, 9 States, 2 Union Territories, covering 77 districts, (69 from main land and others in Island system, is accounted for 10.8 million ha of land and housing 171 million populations (14.2% of India) in the country. Agricultural land in coastal saline environment (1.25 million ha) is accounted for 19% of the total salt-affected soils (6.73 million ha) in India. Farmers in coastal region view their farming operation as a system where crop and fisheries are integral part of their farming system. Management of agricultural land to improve farm income in coastal saline environment is quite challenging and most of the agricultural area is characterized by mono-cropping with rice in kharif (rainy/wet) season. The district level information on key agricultural parameters were collected for the states having major coastal areas such as Andhra Pradesh, Gujarat, Karnataka, Maharashtra, Odisha, Tamil Nadu and West Bengal. Overall, it was estimated that coastal salt-affected soil (SAS) districts across states were accounted for 54% of the population and 43% of the net sown area within the

respective states. The SAS districts across the states were accounted for producing 43% of rice in their respective states. At districts level, average income from agriculture for SAS districts was estimated as Rs. 6263 as compared to Rs. 7719 household^{-1} month^{-1} at the state level. Average yield of rice in SAS districts was 2.57 t ha^{-1}, which was lower than to states' average yield of 2.66 t ha^{-1}. Under fragile coastal environment, sustaining the livelihoods of this resource poor farmers become a real challenge both for technology developers as well as policy makers. To increase the farm income under the coastal saline environment, key strategies are dissemination of salt tolerant crop varieties and more importantly water harvesting, storing and appropriate soil and water management through different kinds of land shaping technologies. By adopting these management options coastal saline soils can be managed sustainably and profitably. Technological options are available for management and productive use of natural resources in coastal zones which needs enabling policies for its large scale adoption and thereby increasing cropping system intensification and farmers' income. There is a need for suitable policy support for wider application of these technologies, has been highlighted in this paper.

T6S1POS01

Identifying the Factors Influencing Farm Women's Information Network Output

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This empirical study was conducted to identify the different factors influencing farm women's agricultural information network output in terms of knowledge. The study was conducted in Cooch Behar district of West Bengal with the help of ex post facto research design. It was found from the study that independent variable like size of family, occupation, participation of farm science centre programme, material possession, livestock possession, type of family, economic orientation, e resources exposure, mass media exposure, communication skill, information exchange, decision making ability, attitude of the farm women towards farm science centre scientist and constraints are crucial factor of agriculture information network output of farm women.

T6S1POS02

Has Brackish Water Shrimp Farming Development Been Gender Neutral: A Case of Maharashtra

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Brackish water shrimp farming is one of the fastest growing forms of aquaculture and India stands at fifth position with production of 8.0 lakh tonnes. Andhra Pradesh is leading state in shrimp farming and Maharashtra ranks sixth. As per official records, there are 165 shrimp farmers in Maharashtra and majority are men. About 6% of farms are registered in name of women. But at ground level these shrimp farms are run by men which show that farm ownership is dominated by men. The question which this study addresses is that why participation of women has been slow in this fastest growing form of aquaculture and how roles of women kept reducing whereas the sector grew to new heights. These questions are addressed with a study done in Maharashtra as it is one of the major

maritime states, offers vast scope for development of brackish water aquaculture. It has about 10,400 ha area which is suitable for shrimp farming but only 1,291 ha is used for shrimp farming. This means that about 9,109 ha area is left unutilized indicating high potential. Interviews were done with 151 shrimp farmers to explore role of women and men from the time shrimp farming started, how roles of women were displaced and constraints hindering participation of women in taking up shrimp farming. It was reported that during emergence of shrimp farming in 1990's men took up shrimp farming as owner of shrimp farms. Role of women was as farm workers and they were involved in pond digging, wild shrimp seed collection, feed material collection, feed making and post-harvest handling. But as the sector grew, mechanization and new technologies were introduced. Modernization in shrimp farming practices like use of machines for pond digging, hatcheries for seed supply, factory feed, automatic feeder, zero water exchange system, biosecurity measures, direct marketing through companies displaced women's work. Thus, in shrimp farming which is financially rewarding, women have been left behind raising the question whether shrimp farming development has been gender neutral. High level of investment, lack of skill, high risk, delay in allotment of land, poor infrastructure facilities, lack of awareness about new technology, less family support and security issues were reported to be major constraints for women to undertake brackishwater shrimp farming. It is suggested that reducing the masculinity of capital and having an inclusive approach from policy to implementation can be helpful to make this development gender neutral.

T6S1POS03

Popularizing Drought-Tolerant Rice Variety Sahbhagi Dhan in Upland Areas of Goa State through Front Line Demonstrations - An Impact Assessment

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Rice is an important food crop of Goa state. Rainfed upland ecology is an important ecology in the state that constitutes 10-12% of the total rice area. These fields are locally called Morod land. They are mostly terraced fields on the hill slopes suitable for rainfed paddy cultivation during Kharif season. The productivity is low due to the non-adoption of improved technologies and package of practices. Further, most of the varieties used by the farmers in these areas are bred for the irrigated ecosystem and hence are highly susceptible to drought spells prevailing in the upland ecosystem. Therefore, to increase the productivity of the upland ecosystem and profitability of upland rice farmers, Front Line Demonstration on paddy variety Sahbhagi Dhan was carried out for four years during Kharif season from 2017-18 to 2020-21. Sahbhagi Dhan, a drought-tolerant variety developed at ICAR-NRRI-CRURRS, Hazaribag in collaboration with IRRI Philippines, is a early variety maturing in 105-110 days with a yield potential of 5.0 t ha^{-1} under favourable upland ecology. Two villages viz., Gaodongrim and Cotigoa in the Canacona block of the South Goa district were selected for FLD purposes. Altogether 114 FLDs were conducted between the period 2016-20 covering 70 ha area. The components included in the FLD were quality seeds, proper tillage operation, seed treatment, and balanced dose of fertilizer application, weed management, and improved plant protection measures. The yield data were collected in both demonstration (improved technology) and farmers' practice by random crop cutting method. The parameters such as technology gap, extension gap, and technology index were calculated as per the standard formula. Results indicated that Sahbhagi Dhan recorded grain yield ranging from 44.0 to 49.42 q ha^{-1} as against the farmers' practice ranging from 34.12 to 39.45 q ha^{-1}. The highest grain yield for Sahbhagi Dhan was recorded during the Kharif season of 2018 with 49.42 q ha^{-1}, while the lowest grain yield was recorded during 2020 (44.00 q ha^{-1}). In farmers' practices, the highest grain yield (39.45 q ha^{-1}) was recorded during 2017, and the lowest grain yield of 34.12 q ha^{-1} during 2020. Overall, Sahbhagi Dhan recorded 29.62% more grain yield compared

to the farmers' practice. Technology gap was 2.44, 0.58, 3.13 and 6 during 2017-18, 2018-19, 2018-19 and 2020-21, respectively. On an average Sahbhagi Dhan recorded a technology gap of 3.04 over the farmers' practice variety Jyothi. The extension gap ranged from 8.11 to 13.28. It was highest during the year 2018-19 and lowest during 2017-18. The technology index was 4.88, 1.16, 6.26, and 12 during the year 2017-18, 2018-19, 2018-19, and 2020-21, respectively. Overall, the net returns of Rs. 68620 per hectare was recorded in the case of improved technology compared to farmers' practice which generated Rs. 47580 with a Benefit-Cost ratio of 2.75 for Sahbhagi Dhan and 1.90 for farmers practice. The variety Sahbhagi Dhan over five years covered more than 450 ha area and is recommended variety for cultivation in the upland areas of Goa state. The successful demonstration of Sahbhagi Dhan has brought acceptability among the farmers and millers and now this variety is popularly called by the name 'Dhove Jyothi' (Dhove meaning white in Konkani) as against the previous popular variety 'tamdi Jyothi' (red in Konkani).

T6S1POS04

Contribution of Women in Agriculture – Insights from Coastal West Bengal

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Agriculture is the main sources of livelihoods for large proportion of (54%) workforce in Indian economy and women play a very important role in building this economy. Women play multi-dimensional role, involved in agricultural and allied activities like sowing, transplanting, weeding, harvesting, winnowing, livestock rearing, fodder collection, milking etc. along with domestic activities like cooking, child care, household maintenance etc. The presemt study was conducted at seven villages of two blocks, Canning 1 and Patharpatima. The objective of the present srudy was to know about the women participation and their contribution in households income from agriculture and also to know about the reason behind their participation and different constraints faced by them. All the villages from the two blocks were selected randomly. A total of 100 households (hh) were surveyed to collect the data from all villages consisting of women farmers contributing while staying in the male headed households (68 households) and exclusively as female headed households (32 households). Female headed households were those who managed most of their farming operation by themselves due to absence (either widow or husbands migrated) of male members in the family. Income from agriculture managed by female farmers was estimated to be Rs. 1.84 lakh hh^{-1} $year^{-1}$ which was almost at par with the male headed farmers (1.97 lakh hh^{-1} $year^{-1}$). The income from agriculture was accounted to be 64% and 66% of total income of the male headed and women headed households, respectively, indicated women farmers have significant contribution in agriculture. It was observed that women farmers were as good as the male farmers in terms of efficient management of the land and has significant contribution in agriculture. The cultivation in kharif season was mainly dominated by paddy cultivation for both women and men farmers. Women farmers preferred to grow more vegetables instead of paddy, particularly in rabi season, whereas male farmers preferred to grow both vegetables and rabi paddy. Reason behind women participation in agriculture is mainly due to migration (seasonal or for longer period) of the male members and followed by their absence (widow) in family. Women farmers were utilizing the loan taken from institutional sources like SHGs & their repayment pattern was also good. Some suggestions for betterment of women farmers could be (1) they should get opportunities to continue their higher study; (2) wages should be given same to the women farmers for the similar work, (3) government may promote schemes supporting exclusively growing vegetables for women farmers, and (4) awareness should be spread about the govt. schemes to make those more effective.

T6S1POS05

Impact of Technology Integration among Women Farmers of Coastal District, Alappuzha, Kerala

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Inclusive development involves empowering rural women through science and technology, especially in agriculture for improving their livelihood status. Technology, extension, market and agricultural development through integration ought to be gender neutral. But social, economic factors like literacy, asset or resources, access and support for women in general warrants changes towards meeting their individual and community needs. Their livelihood infers to income as well as ownership and rights reducing vulnerability as a community. They usually operate multiple livelihood options including farming, animal husbandry, and marketing along with household chores and involving in social issues. The underperformance of agriculture in many countries could be related to the constraints and aggrieved role performance of women, who are vital resources in farming. This study was taken up in Pathiyoor panchayath, Alapuzha district which is a coastal district of Kerala State wherein the ICAR Farmer FIRST Programme (FFP) is being implemented since 2016. The study was undertaken during 2020 among 140 women farmers selected in multistage random sampling with an objective of assessing the impact of technology integration in FFP among women as individuals and groups and to bring out process in gender empowerment through interventions in various technology modules. The methodologies used were personal interview based on pre tested questionnaire, socio economic index among women farmers and Self Help Groups (SHG), Knowledge and adoption of technologies using indices, process documentation based on guidelines by Mowo (2007) and impact on income and social changes. The results indicated that the socio economic index of FFP women farmers are 78 more than non FFP and knowledge and adoption of scientific production and post harvest operations was significantly higher than non FFP farmers. The work participation of women in FFP panchayath is higher and occupationally diversified in FFP locations. Use of social media and mobile phones, access to extension, mobility and participation in training programs were significantly higher and purposefully employed by FFP women farmers. The marketing behavior of FFP women farmers as groups were distinctly better than non FFP villages due to higher marketable surplus, newer crops, experiential learning from continuous involvement and participation, cross learning, multiple linkages and convergence with ICAR CPCRI and MGNREGS. Social leadership, partnership and engagement resulted in community impact along with individual empowerment. Land consolidation was a crucial social capital evolved in the action research for women as a agricultural community in this study area. The innovations of women farmers in climate resilient actions and decisions, post harvest operations, small enterprises, creating active networking also documented in the study. The policy noting based on the study was to include women farmers /group representatives in agriculture research designing and requirements for delineating their requirements as major stakeholders, gender aggregated data generation for evolving appropriate extension strategies, redefining capacity building exercises/ICT for gender mainstreaming, and women leaders to be considered for leveraging gender participation in agricultural research and development.

T6S1POS06

Soil Salinity Effects on Traditional Agricultural Practice in three Coastal, Rural Villages of Indian Sundarban, West Bengal

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Soil salinity enables risks livelihood in densely populated tropical deltas, which is likely to have a negative effect on human and ecological sustainability of the area and beyond. The farming community in Indian Surdarban is dominated by poor, marginal cultivators and landless people. This study is an attempt to analyses the adaptation strategies undertaken by the people with the rise in soil salinity. The community perceptions about the adaptation strategies have been captured through a survey of three selected villages—Gopalganj, Dakshin Garankati and Kaikhali—in the Kultali block. Both Focus Group Discussion and in-depth interview werehelping to us to known the changes of farming strategies. A total of 204 households have been surveyed (80 households in Gopalganj64 households in Kaikhali and 60 households in Dakshin Garankati) in 2016. Salinity is a severe problem which is not only reducing agricultural potential, but also creating affect on livelihood strategies of farmers. A higher level of soil salinity has adversely affected the cultivation of indigenous rice varieties and there has been a shift towards HYV-soil tolerant varieties and practicing too. A part of such cultivable land has been replaced with bitter gourd and chilli cultivation, crops which can sustain in soil with a higher pH. Farmers were switching single paddy to double paddy cultivation and more dependent on irrigation. Land shaping of cultivable plots has also been adopted as a coping strategy to minimize the effects of soil salinity. Those people who were not coping with livelihood security challenges they changed their occupation profile and forcefully migrated for seek job to urban area.

Theme VI:

Technology impact on the socio-economic, gender issues, ICT application to assess and monitor, strengthening market linkage and business models on post-harvest and value chain for livelihood security and employment generation

SESSION II:

Innovative ICT applications and effectiveness of on-going government schemes and their contributions

T6S2I01

DECISION SUPPORT SYSTEM (DSS) FOR MONITORING COASTAL AGRO-ECOSYSTEM: CONCEPT, SCOPE, AND APPLICATION

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Abstract: The dynamics of coastal ecosystem of India is not only comprehensive, but also complex. The coastal lines stretching more than 7500 km are becoming increasingly vulnerable to climate change, sea level rising and unabated in grace of saline water to disrupt the ecological resilience and livelihood of millions depending on agriculture and fisheries mainly. The increasing frequency of extreme climates including cyclones, floods and other abiotic stresses invite the need for the creation and functioning of a DSS (Decision Support System) for sustainable ecosystem management. The uncertainty of weather, the unpredictable production behaviour and chaos in livelihood generation deserve to have planning, management and monitoring implication and application as well. The DSS and MIS (Management Information System) can move together in generating and customizing essential data base for proper forecasting and simulating the future scenario of managing the ecosystem inkling biodiversity, production and livelihood stability of multilayer stakeholders. All these are possible by creating a group of climate managers at the community level in both strategic and contingent requirement. Weather kiosks, community disaster centres, water auditing and biodiversity protection task force, micro planning group need to be created with a support extended by both the DSS and MIS in participatory monitoring approach.

T6S2I02

ICT SBASED FISHERIES VALUE CHAIN EXTENSION BY STARTUPS AND AQUAPRENEURS

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Abstract: Fisheries and Aquaculture provides better opportunities to ensure the nutritional security, rural employment and socio-economic well-being of the large number of rural populations. Hence, the national governments, developmental institutions and civil society organizations are giving renewed importance to ensure the sustainable and resilient fisheries systems. There are a considerable number of public and private fisheries research and development systems in place. However, access to fisheries knowledge and support services is very limited for the small and marginal farmers due to various reasons. To promote sustainable, responsible and inclusive fisheries production-post harvest and marketing systems are of paramount importance to the fisheries development. Among the list of fisheries stakeholders and initiatives, Information and communication technologies (ICTS), fisheries startups and aquapreneurs are making the Fisheries Value chain become more efficient in providing access to knowledge, advisory, technology, and support services, better inputs, facilitating postharvest and adding value to consumers. Number of tech-startups are using IoTs, AI, MI and sensors for data driven fisheries production and supply chain management systems.

Theme VI:

Technology impact on the socio-economic, gender issues, ICT application to assess and monitor, strengthening market linkage and business models on post-harvest and value chain for livelihood security and employment generation

SESSION III:

Business models on value chain and post-harvest use: FPOs, Impact on income & livelihood security, employment opportunities in rural sectors

T6S3I01

ANALYSIS OF SEAWEED VALUE CHAIN TO IMPROVE COASTAL LIVELIHOOD AND BLUE ECONOMY OF BANGLADESH

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Abstract: Seaweed culture in Bangladesh door to blue economy of Bangladesh by significant contribution towards eradication of poverty, improving to food and nutrition security, mitigation and adaptation of climate change and generation of sustainable and inclusive livelihoods of coastal communities. Almost 3 cores people in 19 coastal districts largely depend on the sea. About 133 species of seaweeds have been recorded in the coastal and estuarine areas of Bangladesh and eight of them are commercially important. A shortfall in protein supply from capture fisheries has emphasized the Bangladesh government to focus on alternative cheap sources of protein like seaweed which is not well studied. Thus, this study analyzed the seaweed value chain sector of Bangladesh using primary and secondary data. Primary data were collected from 33 seaweed farmers and 15 different market actors by using pre-tested questionnaires. Fieldwork was conducted between March 10 to 30 2019 among seaweed stakeholders involved in the value chain using mixed methods approach- in depth interviews with key informants, focus group discussions, household surveys and personal observation. Qualitative and quantitative data are collected from both upstream (seaweed farming) and downstream (seaweed processing) activities involving farmers, market actors (middlemen), processors and officials. Seaweed was sold in two forms: dried seaweed to be used as raw materials in carrageenan processing (approximately 88% of total harvest) and fresh seaweed to be used as a source of seedlings (approximately 12% of total harvest). The value chain map ended with carrageenan form, which is started from farmers and reached to the local tribal consumers and some portion is exported to international markets. The price of dried seaweed varied according to a combination of seaweed quality, the strength of farmer's relationships with intermediaries and processors and in response to demand from the carrageenan industry. The prices obtained by farmers for dried seaweed and carrageenan remained low, BDT 80 and BDT 1280 per kg, respectively. The intermediaries in the seaweed business were limited as the consumers are not aware about the benefits of seaweed. The value chain analysis was a useful tool to identify and map the market, with the results providing a better understanding of the seaweed sector, which could be helpful in supporting further development of this sub-sector. Seaweed, if systematically cultured, explored and marketed, could emerge as a vital agricultural product for coastal

communities, be consumed as dishes and used in the pharmaceutical and cosmetic industries and contribute to the livelihood improvement and blue economy of Bangladesh.

T6S3I02

STRENGTHENING AGRICULTURAL &ALLIEDPRODUCE VALUE CHAINS FOR INCOME AND LIVELIHOOD SECURITY IN COASTAL ECOSYSTEMS

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Abstract: India's costal economy supports a significant number of predominantly rural, small-holder households who depend on a diverse set of primary activities comprising of crop and animal husbandry, capture and culture fisheries, forestry, integrated farming, post-harvest processing and value addition and other value chain related activities for their basic sustenance. A considerable part of agricultural production in coastal zone happens in homestead farms which are mostly mixed farming systems. Intensification of cropping system and diversification to high value crops has been a major driver that sustained agriculture in these farms. Capture fisheries has been driven mostly by mechanization of crafts, advancement in propulsion systems, innovations in gears, and better mechanisms for fish finding and harvesting. In recent times, coastal aquaculture and mariculture has experienced a

great spurt owing to technological innovations as well as initiatives on the part of government, private entrepreneurs as well as civil society organizations. Notwithstanding these, several regions in the coastal continuum still remains cut off from the mainstream developmental momentum and umpteen challenges act as speed breakers in the way of continuous development of these regions. Lately, the coastal ecosystems are particularly exposed to climate change and associated extreme weather events that deepen the vulnerability of production systems and economic processes. Occurrence of tropical cyclones in quick succession year after year causes crop loss and destruction of fishing vessels and other coastal structures thereby resulting in significant hardships to the affected people. Apart from these, there are problems related to submergence, salt water intrusion, destruction of fragile wetlands and mangrove habitats due to expansion of non-agricultural and industrial activities. Sustainable development of small-holder dominant coastal livelihood systems requires efficient and cost-effective farm production, competitive markets, well-functioning value chains, transparent management and governance regimes as well as dynamic policies that are sensitive to the changing national and global environments. Continuous technological innovations, not only in production processes, but also in the realms of institutions and governance are indispensible to ensure income and livelihood security of the dependent population. Development of efficient business models involving promising enterprises and strengthening the associated value chains can play a significant role in ensuring steady employment and income for the coastal worker force. Widening the avenues for trade and enhancing international competitions of farm products is another sensible option to catalyze growth momentum. Considering the above aspects, this lecture presents a comprehensive set of strategies and options with emphasis on technological interventions and promising enterprises with potential for boosting costal economies; steps needed to improve efficiency of agricultural, livestock and fishery value chains; policies to create farm and off-farm employment; social safety nets for improving resilience and adaptability of marginalized coastal dwellers and so on. Further, policy interventions for enhancing effectiveness of governance in the costal farm sector are also dealt with.

T6S3ORAL01

Value chain of the Marine Ornamental Reef Fish Trade in Trincomalee, Eastern Sri Lanka

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Marine aquarium reef fishery, a livelihood strategy for thousands of fishers in all over the world is a multimillion-dollar industry. Value chain of an industry or a business describes the activities needed to achieve the final output. The study, aiming at analysing the value chain of the marine ornamental reef fishery in Trincomalee, Sri Lanka was conducted over two years from February2019 to January 2021. Stakeholders of the industry were identified through snowball sampling technique, and the production flow and input flow of the marine ornamental reef fish industry were analysed using the data gathered through administrating semi-structured interviews, focused group discussions and participant observations, from total of 112 respondents. Fish collectors, middlemen and exporters were the main operational components in the horizontal market chain. Approximately 600 fishers, 11 middlemen (local buyers) and 21 exporters actively participated in the market chain. In addition, two local aquaria played minor role in value chain purchasing 2% of fish & invertebrates from the middlemen. The whole catch of the fishers was bought by middlemen who distributed the catch among exporters and local aquaria basing on the demand. Study found that the price of fish & invertebrates was increased nearly by ten folds from fish collectors to exporters. Fiberglass Reinforced Plastic boats with Outboard motor (OFRP) and canoes were used as the fishing vessel in fishing operations, for which Kerosine & Gasoline for OFRP boats and Oxygen filled cylinders were provided by

middlemen. Each fisher possessed own diving equipment, thus diving equipment dealers, OFRP boats and canoes builders directly connected with the fishers, whilst the Gasoline filling stations contributed to the value chain indirectly through middlemen. Boatmen/ supporters played a key role at the fishing operation by maintaining water quality of the fish storage containers and performing every mechanical operations of the fishing vessels. Accountants and supportive staff of local fish purchasing centre & exporting companies contributed in financial management and maintaining the quality of live fish until selling to the buyers, respectively. Relevant input suppliers supplied accessories for fish storage and packing for the local fish purchasers and exporting centres directly. Department of Fisheries and Aquatic resource, Sri Lanka Navy, Sri Lanka Custom, National Aquatic Resource Research and Development Agency, Marine Environment Protection Authority, Sri Lanka Export Development Board, Divisional Secretariat office, and Urban Councils directly involved in managing and regulating the marine ornamental reef fishery. Study indicates that long chain between fish collectors and final destination of the fish results comparatively lower price for the fishers.

T6S3ORAL02

Bean to Bite Chocolate: A Model Value Chain for Cocoa Growers

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Cocoa is an important beverage crop of the world and commercially grown in the costal ecosystem as an intercrop in coconut gardens in India. National Horticulture Mission identified cocoa as a potential crop to meet both domestic demand and export earnings and encouraged area expansion in traditional and non-traditional areas A complete processing protocol (consisting of fermentation, drying, roasting and winnowing of cocoa beans, refining of nibs with coconut sugar and cocoa butter, tempering, moulding, refrigeration, demoulding, packaging and storage) for the preparation of bean to bar chocolate using coconut sugar was standardized. Besides, the effect of varying levels of coconut sugar (30-50%), cocoa liquor (35-45%) and cocoa butter (15-25%) on sensory and textural proprieties of dark chocolate were also studied using response surface methodology. The effect of roasting temperature on percentage shell removal and effect of grinding on the particle size of chocolate were studied in detail. The optimized combination consisted of 70% dark chocolate using 45% cocoa liquor, 30% coconut sugar and 25% cocoa butter with a maximum desirability of 0.96 for which the predicted sensory score for appearance, mouth feel, texture & taste and textural hardness were 8.14, 7.98, 8.05, 7.55 and 52.14N respectively. The technology is beneficial particularly to the women farmers and entrepreneurs. A farmer having at least 10 cocoa plants can opt for home scale bean to bite chocolate venture. The technology was assessed by providing hands on training to the interested woman entrepreneurs from Kerala, Karnataka, Tamil Nadu and Andra Pradesh. The cost economics also was calculated. We have facilitated the incubation of the technology. With our intervention, three entrepreneurs have benefitted. Bean to bite chocolate venture is moving up as it is healthy with high in polyphenols and antioxidants.

T6S3POS01

Entrepreneurial Behaviour of Agricultural Input Dealers in West Bengal

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Indian agriculture is characterized by the presence of small and marginal farmers, with fragmented land holdings and they are lagging behind in terms of resource and knowledge base. However, there is a lack of enough field level staff and absence of systematic mobility of information and advisory services to the end users in present agricultural extension system. In this scenario, agricultural input dealers become a prime source of extension advisory services, clearly having a location advantage, good rapport and easy accessibility by the farmers. The present research was undertaken to assess the entrepreneurial behaviour and role performance of agricultural input dealers in agro-advisory services. The study was conducted in Purba Bardhaman and Hooghly districts of West Bengal during 2019-20. Both the districts are very popular agricultural areas with diversified agricultural scenario persisting in these two districts. Purba Bardhaman is known as the 'Granary of West Bengal' and Hooghly serves as the main potato belt of West Bengal. Crops are grown thrice in a year and various cropping systems are followed. Due to the potentiality of the areas in agricultural production, both the districts are having a large number of agricultural input dealers. Eighty agricultural input dealers, forty from each districts were interviewed using pre-tested interview schedule. Ex-post facto research design was used for the study. It was found from the study that majority of the respondents had medium entrepreneurial behaviour (38.75 %) followed by 36.25 per cent and 25.00 per cent of the respondents with high and low entrepreneurial behaviour respectively. variables such as education, cosmopoliteness, entrepreneurial experience as an agricultural input dealer, types of agricultural inputs sold, self-confidence, training received, extension contact, extension participation, deferred gratification, social participation, mass media participation, information sharing behaviour had positive association with entrepreneurial behaviour of agricultural input dealers and was significant at one per cent level of significance. Variables such as competition orientation, credit orientation and empathy are also had positive association with entrepreneurial behaviour of agricultural input dealers, however they are significant at five percent level of significance. Whereas age, annual income, location of the enterprise, opinion of trained input dealers on DAESI training, level of aspiration and mode of advertisement had non-significant association with entrepreneurial behaviour of agricultural input dealers. It was also found that independent variables such as training received, types of agricultural inputs sold, mass media participation, information sharing behaviour, cosmopoliteness and extension participation were causing significant variation in the entrepreneurial behaviour of agricultural input dealers. The R^2 value of this regression model says that these six independent variables could explain up to an extent of 72.40 per cent variation in the entrepreneurial behaviour.

T6S3POS02

Creation of Employment Opportunity Through Organizing Training Programmes on Traditional and Diversified Value Added Products of Tuber Crops

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Agriculture is considered as the main economic activity which adds to the overall wealth of the country.

Entrepreneurship is one of the key drivers for economic development. Entrepreneurship development appears to be the best substitute to find employment opportunities, income generation, poverty reduction and improvements in nutrition, health and overall food security in the national economy. Konkan region of Maharashtra is well known for diversified production of horticultural crops. Tuber crops are the important group of horticultural crops grown by farming community in Konkan. The tribal's and marginal farmers of this region grows almost all types of tropical tuber crops viz., sweet potato, aerial yam, lesser yam, greater yam, xanthosoma, colocasia, elephant foot yam, arrowroot etc. in their homestead/ backyards for their own consumption as well as income generation through marketable surplus.The tribals in this region have been growing local varieties with following traditional package of practices. Thus, tuber crop production in this region is naturally organic or eco friendly. Ultimately tuber crops have played a key role in their daily diet. These crops are energy bank in nature as well as rich in minerals, vitamins, alkaloids, antioxidants and dietary fibers. Therefore, under changing agro climate and rising of food and nutritional security problems, tuber crops has great scope and played an important role. The tribals in this region consumed these crops in the form of cooked/ boiled or making vegetables. But these tuber crops are amenable to processing and diversified value added products could be made from them. For popularization of these tuber crops and increase in the consumption of people in the daily diet, Tuber Crops Scheme Dapoli Centre has developed delicious recipes. The delicious traditional dishes (Puranpoli, Karanji, Kheer, Sanjori, Thalipeeth, Ladoo, Khichadietc), novel products (*Piyush, Cutlet, Alu Patra, Fadfade, Elephant foot yam Kap, Pattis, Kofta, Kabab* etc) and bakery products (*Biscuits* and *Cookies*) were demonstrated by organizing training programmes of Women's Self Help Groups at different locations in Konkan region.These value added products of tuber crops were popularized through organizing training programmes of women's Self Help Groups with the help of Department of Agricultural Extension, College of Agriculture, Dapoli, State Department of Agriculture, ATMA, Raigad and Thane District, NGO's. In all 14 training programmes were organized at different places in Konkan region. Through these trainings total 774 women's were trained. The feedback received from the trainees was encouraging and the women's liked these products very much. Some of the women come forward and prepared these products through their Self Help Groups. The women reacted that such type of programmes should be conducted on large scale so that Self Help Groups will get a new avenue for their entrepreneurship in Konkan region.

T6S3POS03

Group Dynamics Effectiveness among the Members of Farmer Producer Organizations in West Bengal

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In the recent past, Government of India is giving thrust on group approach in agricultural extension to facilitate transfer of technology among the farmers. Group approaches offer several advantages over individual approach like reaching large number of clients, improving the flow of information to farmers, time and cost saving etc. In this background, the Government of India amended the Companies Act, 1956 during 2002 that paved the way for incorporation of 'Farmer Producer Organisation (FPO)'. But the issue of concern is, many FPOs go through a high activity phase become inactive over a period of time. Group dynamics of FPOs is a critical factor contributing to its' effectiveness. As FPOs are playing a major role in today's development context, the present study was conducted to explore group dynamics of selected FPOs and to identify the associated factors. The state of West Bengal was selected purposively for this study as it represents among highest number of FPOs (SFAC, January, 2020 and NABARD Portal on FPOs, 2020) but very few researches have been reported on the performance of the FPOs. Five high performing and five low performing FPOs which were functioning for more than five years were selected. From each FPOs 2 office bearers and 10 general members were selected randomly. Total sample size was 120. The

data were collected through personal interview method. The scale developed by Vipinkumar (1998) was used for measurement of group dynamics effectiveness with necessary modification. Five dimensions i.e. Participation and decision making, Norms for operation, maintenance and management function, Group atmosphere and interpersonal trust, Feelings of social inclusion and Empathy were selected as indicators for analysing group dynamics. The high and low performing FPOs had a mean GDEI score of 87.37 and 73.29, respectively. The respondents of both high and low performing FPOs were found to be similar on two components of group dynamics, i.e., norms of operation, maintenance and management functions and participation and decision making, but the two samples of respondents were quite different on feelings of social inclusion, empathy and group atmosphere and interpersonal trust. Simple Correlation analysis suggested that variables such as education, extension personnel and cosmopolite channel contact, personal localite channel contact, social interaction with people, attitude towards FPO, attitude towards group, accommodation and assimilation had positive association with GDEI of members in high performing FPOs. In low performing FPOs, extension personnel and cosmopolite channel contact, social interaction with people, attitude towards group and assimilation had positive association with GDEI of members. Forward Regression analysis showed that extension personnel and cosmopolite channel contact, conflict, attitude towards FPO and competition can explain 68.2 per cent of the variation in GDEI in high performing FPOs. In low performing FPOs, attitude towards groups, extension personnel and cosmopolite channel contact, age, farming experience and social interaction with people can explain 60.6 per cent of the variation in GDEI. It may be concluded from the study that factors contributing to GDEI in high and low performing FPOs were different except extension personnel and cosmopolite channel contact.

T6S3POS04

Labour Productivity in Trawl Fishing of Kerala, India

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Fishing is an important source of livelihood in coastal regions. The sector is also dependent on a large labour force, especially in the mechanized sector. Even though, the contributions of labour is crucial, the stress has been on CPUE (catch per unit effort) and not on the productivity of labour in the sector. Trawl fishing is an important contributor to the fish production in Kerala state. Among the mechanised crafts, 3678 (78 per cent) were trawlers and contributes about 35 – 50% of total annual fish landings in the state. Wages onboard are generally based on share pattern, as is in several other types of fishing, and varies between individual trawlers. The present study attempts to assess the productivity of labour involved in trawl fishing in Kerala. The labour productivity estimation included both production and man-hour methods. The current working conditions and the associated aspects on labour in trawl fishing will also be addressed.

EARLY CAREER RESEARCHER

ECR01

Green Synthesized Zinc Oxide Nanoparticles as Nutrient Source for Maize (*Zea mays* L.) Grown on Calcareous Vertisol

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Plant mediated synthesis or green synthesis of zinc oxide nano particles (ZnO NPs) is gaining importance due to the disadvantages associated with chemical synthesis. The chemical synthesis followed by stabilization of synthesized ZnO NPs cause release of toxic by-products which are harmful to the ecosystem. Green synthesis has emerged as the best alternative to chemical synthesis of nano particles due to its simplicity, rapid rate of synthesis, cheapness and eco-friendly nature. Zinc is an essential element and has become the fourth important yield limiting nutrient after NPK. Zinc application to crop plants in the form of nano particles will serve as an efficient nutrient source which reduces the quantity of nutrient required and increase the effectiveness of applied nutrients. ZnO NPs were green synthesized using calotropis leaf extract and characterized for its size and shape using scanning electron microscopy (SEM). The chemical composition of green synthesized nano particles were determined using energy dispersive atomic X-ray analysis (EDAX). This was followed by a pot culture study with maize plants in calcareous black soil, supplying with different concentrations of green synthesized ZnO nano particles (50 ppm to 2000 ppm) to study its effect as a nutrient source. The experiment revealed that foliar application of green synthesized ZnO NPs at lower concentrations are very effective in enhancing growth as well as nutrients uptake of maize plants than the conventional zinc sulphate spray.

ECR02

Hyperspectral Remote Sensing-Based Prediction of the Soil pH and Salinity in the Soil to Water Suspension and Saturation Paste Extract of Salt-Affected Soils of the West Coast Region

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Rapid and reliable measurement of the salinity of the salt-affected soils of the coastal region is important for their effective management and sustainable utilization. Remote sensing could be one of the viable approaches to achieve spectroscopy-based salinity monitoring. The study aimed to investigate the use of hyperspectral remote sensing to predict the soil pH and salinity in the soil to water suspension and saturation paste extract of salt-affected soils of the west coast region. About 216 soil samples were collected from the salt-affected areas of the west coast region of India (State of Maharashtra, Goa, Karnataka and Kerala). The soil pH and electrical conductivity (EC) in fixed ratios of 1:1, 1:2, 1:2.5 and 1:5 soil to water extracts and soil saturation paste extract were determined and the spectral data measurement in the wavelength range of 350-2500 nm was carried out. The data was divided into calibration dataset (70% of total) and validation dataset (30% of the total dataset). The spectral data (raw spectral reflectance averaged at 10 nm) was modeled using multivariate analysis techniques – partial least square regression, principal component regression and support vector regression. The average soil pH of 1:1, 1:2, 1:2.5, 1:5 soil: water extract

and soil saturation paste (pHe) extract was 4.32, 4.96, 5.01, 5.15 and 5.33, respectively, whereas, the corresponding EC was 14.00, 7.65, 6.37, 3.52, and 19.96 dSm^{-1}. The pHe and EC of soil saturation paste extract (ECe) were in the range of 3.06-7.39 and 0.61-59.18 dSm^{-1}. The coefficient of determination (R^2) of pHe with pH of 1:1, 1:2, 1:2.5 and 1:5 soil extract ratio was 0.73, 0.73, 0.72 and 0.73 ($p<0.05$) respectively. The ECe had a R^2 of 0.85, 0.84, 0.85 and 0.84 ($p<0.05$) with EC of 1:1, 1:2, 1:2.5 and 1:5 soil:water extract ratio. All these relationships were linear and significant. Thus, the regression relation of ECe with EC1:2, ECe = 2.5272 × (EC1:2) + 2.77 (R^2=0.84, $p<0.05$) could be more useful for studies related to salinity of salt-affected soil of the west coast region of India where soil salinity is typically associated with the acidity. A good agreement between the actual and predicted pH and EC for different ratios and the extract were exhibited by the coefficient of correlation ranging 0.48-0.79 and 0.70-0.87, respectively. Among different multivariate techniques tested, partial least square regression outperformed principal component regression and support vector regression. Among all the parameters, the best prediction was achieved for ECe accuracy as r=0.87, R^2=0.76, RMSE=5.65 and rank=4 (lowest) with partial least square regression. Thus, the soil saturation paste extract salinity of the salt-affected soils of the west coast region can be monitored using visible near-infrared remote sensing.

ECR03

Development of Selection Index for Agroforestry Systems

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Agroforestry systems usually produce multiple outputs which should all be considered in evaluating the productivity of a system. The problem of multiple outputs can be tackled by producing an index that synthesizes them into a single value for comparison. Therefore, this study aimed to develop a single index that can be used for adequate assessment of agroforestry systems.A new selection index called *Agroforestry System Productivity Index* (ASPI),is introduced. The ASPI may be defined as a sum of the relative proportions of the equivalently scaled yields or products of tree and crop components of an agroforestry system. ASPI scores are calculated by converting the outputs of an agroforestry system to a common scale and then ranking proportions of the converted values for each year of production. The index is shown to be reliable in ranking agroforestry systems and therefore recommended for use in comparing different tree-crop agroforestry systems.

ECR04

Development of Chitosan Based Novel Antioxidant Film for Fish Packaging Application

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Development of active food packaging by incorporating antioxidative substances into packaging materials is becoming increasingly popular since oxidation is a major problem affecting food quality. The present study aimed to investigate the effect of addition of ginger (*Zingiber officinale*) essential oil, a well-known natural antioxidant at different concentrations from 0.1 – 1 % (v/v) into the chitosan (CS) film on its antioxidant properties and preservative action during fish packaging. Ginger essential oil (GEO) was extracted by hydro-distillation method using Clevenger apparatus. The total phenolic content of GEO was 1041.02±12.30µg Gallic acid equivalent/g. Native CS film showed a DPPH scavenging potential of 9.5±0.12 %, which increased with GEO addition and 1

% GEO added CS film had 36.10±0.75 % scavenging efficiency. The developed CS + 1 % GEO antioxidant film (CS-G) was used for packing barracuda fish (Sphyraena jello) steaks stored at 2 oC. Thiobarbituric acid (TBA) value of fish steak sample wrapped in the antioxidant CS film containing 1 % GEO was significantly ($p<0.05$) lower than control samples (C) throughout storage indicating delay in lipid oxidation due to its antioxidant potential. The results showed that addition of GEO substantially improved the antioxidant efficiency as well as characteristic properties of CS film and positively influenced the keeping quality of chilled stored barracuda steak in CS-G film, offering a valuable food packaging application.

ECR05

Spatio-Temporal Change in Salinity Dynamics in Different Land-Use Systems of Climatically Vulnerable Indian Sundarbans

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Sundarbans in West Bengal, India located in the eastern coast of the Bay of Bengal is one of the vulnerable islands subjected to abrupt climate change. The consequence of climate change is of particular importance because of its closeness to sea leading to sea water intrusion. Sea water intrusion not only affect the soil salinity and groundwater quality but also changes the salt dynamics of the region, hampering crop yield due to accumulation of salt in the root zone. The present study assessed the spatio-temporal change in salinity of soil and water for major land-use systems, namely rice - rice (RR), rice-fallow (RF), rice - vegetable (RV), rice- pulse (RP) and vegetable - vegetable (VV) in Basanti, one of the islands in Sundarbans delta. Spatial map was generated using ArcGIS for pictorial view of the analyzed data using Kriging interpolation technique. Top soil salinity (0-20cm) varied from 1.55 to 3.82 dSm^{-1} for winter season and from 3.55 to 9.77 dSm^{-1} for summer season. The average increase of soil ECe for summer season was 63%, 156%, 97%, 153% and 38% over that of winter season for the above landuse systems respectively. A linear regression analysis was run so as to form a predictive equation of soil salinity for different land-use systems using the parameters such as rainfall, evapotranspiration and ground water salinity as independent variables. The predicted equations had satisfactory accuracy which can be used to uptake proper management techniques to cope up with ever increasing soil ECe without depletion of crop yield and soil health.

ECR06

Nitrogen Dynamics in Organically Cultivated Paddy Soils of Coastal Cauvery Deltaic Region

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A field experiment was conducted at Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal in order to study the Nitrogen dynamics in organically cultivated paddy soils of coastal cauvery deltaic region. The present study was made to evaluate the extent of contribution of Nitrogen and their dynamics in soil by the added organics viz. green manures (Daincha, Sunhemp) and green leaf manures (Pungam and Glyricidia) with different

levels of vermicompost (0, 1, 2 t ha^{-1}). The mineralization pattern of Nitrogen as NH_4 - N and NO_3 - N during decomposition before and after transplanting had shown a gradual increase in release during earlier, later stages and with a steady release during mid-stage. In case of losses, the control registered significantly higher volatilization loss during 2nd week after transplanting while the organic treatments registered significantly higher volatilization loss during 13th and 14th week after transplanting. Similarly, the control registered significantly higher loss of NO_3 - N during the 1st Week after transplanting and the organic manures showed higher NO_3- N loss during 5th to 9th week after transplanting. Among the green manures and green leaf manures, Daincha produced significantly higher grain yield, taller plants and higher leaf area index at all the growth stages. With the interest of studying the residual impact on rice-fallow green gram it was observed that higher yield was registered at incorporation of vermicompost @ 2 t ha^{-1}.From the above, it could be concluded that Daincha was found to be the suitable green manure for rice crop which synchronized and released Nitrogen as per the demand of rice. Similarly, Daincha green manuring + vermicompost @ 2 t ha^{-1} shall be advocated to organic rice - rice fallow green gram system which resulted in higher grain yield of both the crops and higher net gain of Nitrogen in the soil edaphon.

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