ISCAR

Proceedings of the

14th National Symposium of Coastal Agriculture (NSCA) 'Harnessing Fragile Costal Ecosystem for Food and Environmental Security'

held at ICAR-Central Research Institute for Jute and Allied Fibres, Barrackpore, West Bengal during 28th February- 3rd March, 2025

The 14th National Symposium of the Indian Society of Coastal Agricultural Research (ISCAR), Canning Town, West Bengal was organized in collaboration with ICAR-Central Research Institute for Jute and Allied Fibres, Barrackpore; ICAR-Central Inland Fisheries Research Institute, Barrackpore and ICAR-Central Soil Salinity Research Institute, Karnal at ICAR-Central Research Institute for Jute and Allied Fibres, Barrackpore, West Bengal during 28th February to 3rd March, 2025.

Inauguration and Technical Sessions

The symposium was inaugurated by Shri Dhrubajyoti De, IPS, Additional Commissioner of Police, Kolkata Police, West Bengal as Chief Guest in presence of Dr. Gouranga Kar, Director, ICAR-CRIJAF, Barrackopore; Dr. B.K. Das, Director, ICAR-CIFRI, Barrackpore; Dr. R.K. Yadav, Director, ICAR-CSSRI, Karnal. The welcome address was delivered by Dr. U.K. Mandal, Symposium Organizing Secretary and Secretary, Indian Society of Coastal Agricultural Research (ISCAR), Canning Town, West Bengal and remarks regarding the symposium by Dr. B. K. Bandyopadhyay, President, ISCAR. The vote of thanks was proposed by Dr. Sanjoy Saha, Secretary, Symposium Local Organizing Committee, and Principal Scientist & Head, ICAR-CRIJAF, Barrackpore.

The symposium was held across 4 days. There were six Technical Sessions under five Themes that dealt with various aspects of coastal agriculture as below. Besides there were six poster sessions, Plenum lecture and invited lectures. On the first day (28nd February, 2025) evening a gala cultural programme was arranged for the delegates. The General Body meeting of Indian Society of Coastal Agricultural Research was held in the afternoon of 1st March, 2025. On March 2nd, 2025 a Farmers' Conclave was organized.

Technical Sessions:

Theme	Sessions	Chairman/Co-Chairman
1: Advances in management of agriculture, horticulture, plantation and fibre crops	Session 1: Advances in management of agriculture, horticulture, plantation and fibre crops and their	1st half: Chairman: Dr. Kaushik Brahmachari, Professor, BCKV Co-chairman: Dr. K.G. Mandal, ICAR-CRIJAF

and their tolerance to biotic and abiotic stresses	tolerance to biotic and abiotic stresses	2nd half: Chairman: Dr. Manish Das, Director, ICAR-DMAPR, Anand Co-Chairperson: Dr. A.K. Sreelatha, Head, KAU, Kerala
2.Technological advancement in fisheries, livestock and poultry management	Session 2: Technological advancement in fisheries management	1st half: Chairman: Dr. B.K. Das, Director, ICAR-CIFRI Co-Chairman: Dr. T.K. Ghoshal, Head, ICAR-CIFE, Kolkata 2nd half: Chairman: Dr. Srikanta Samanta, Head, ICAR-CIFRI Co-Chairman: Dr. Subir Nag, ICAR-CIFRI
	Session 3: Technological advancement in animal husbandry and poultry management	Chairman: Dr. Santanu Banik, Head, NDRI, Kalyani Co-Chairman: Dr. Ajoy Mandal, NDRI, Kalyani
3: Natural Resources management, forestry and biodiversity in coastal and marine ecosystem	Session 4: Natural Resources management, forestry and biodiversity in coastal and marine ecosystem	1st half: Chairman: Dr. R.K. Yadav, Director, ICAR-CSSRI Co-Chairman: Dr. Mohammad Mainuddin, CSIRO, Australia 2nd half: Chaiman: Dr. Soumitra Das, Director, South-Asia Nutrient Initiative: International Zinc Association. Co-Chairman: Dr. Sanjoy Arora, ICAR-CSSRI, RRS, Lucknow
4. Climate Change and disaster occurrence: impact and risk mitigation strategies	Session 5: Climate Change and disaster occurrence: impact and risk mitigation strategies	Chairman: Dr. Gupinath Bhandari, Professor, Jadavpur University Co-Chairman: Mr. Jayanta Chakraborty, Consultant, Indofil Industries Limited
5.: Impact of technological advancements, gender issues, market dynamics and new	Session 6: Impact of technological advancements, gender issues, market dynamics and new opportunities	Chairman: Prof. Sankar Kr. Acharya, Dean PG, BCKV Co-Chairman: Dr. Souvik Ghosh, Professor, Viswa Bharati

ISCAR has been organizing a lecture in memory of Padma Shri Late Dr. J.S.P. Yadav, an eminent soil scientist. During the 14th National Symposium on 28nd February, 2025, the 5th Dr. J.S.P. Yadav Memorial lecture was delivered by Dr. R.K. Yadav, Director, ICAR-CSSRI, Karnal on "Managing salt affected soils: Issues and challenges in changing world". This time ISCAR also organized 1st Dr. H.S. Sen Memorial Lecture in the memory of Dr. H.S. Sen, Patron, ISCAR & former Director, ICAR-CRIJAF and the lecture was delivered by Dr. Gouranga Kar, Director, ICAR-CRIJAF on 'Agriculture 4.0 and beyond: Relevance and priorities for higher and sustainable income in fragile coasts'. Three Plenum Lecture was organized during the symposium and 1st Plenum Lecture was delivered by Dr. A.K. Patra, Vice-Chancellor, BCKV on 'Beyond Food Security: Nurturing Soil Health for Sustainable Coastal Ecosystems'; 2nd Plenum lecture was delivered by Dr. P.K. Ghosh, Former Director, ICAR-NIBSM, Raipur on 'Innovation in Resource Management Technology under Diverse Agro-climatic Regions' and 3rd plenum lecture was delivered by Professor Biswapati Mandal, Former Pro VC, BCKV on 'Carbon farming in coastal agro-ecosystem– some random thoughts'.

During the symposium various honours and awards were also conferred by the Society to outstanding researchers working in the field of coastal agriculture. The ISCAR fellow award for the year

2022-23 was conferred to Dr. Sanjoy Saha, Principal Scientist & Head ICAR-CRIJAF, Barrackpore and Dr. T.D. Lama, Principal Scientist, ICAR-CSSRI, RRS, Canning Town. The Dr. J. S. P. Yadav Best Paper Award for the years 2022-24 was conferred to the paper entitled "An Innovative Approach to Delineate and Differentiate Clear and Turbid Water Ponds in Indian Sundarban Area Using Sentinel-2 MSI Data' by N. SUDARSAN, TANUMI KUMAR, CHALANTIKA LAHA SALUI, K. CHANDRASEKAR and SOUMYA BANDYOPADHYAY published in 2022 in Volume 40(2) at pages 14 to 32 of the Journal of the Indian Society of Coastal Agricultural Research.

The Dr. H. S. Sen Best Poster Presentation Award was awarded to D. BARMAN, R. SAHA, D. BANIK and G.KAR for the paper on 'JuteClimet and Climate Expert on Jute - ICT based decision support system for weather-based agroadvisory on jute production' as the Best Poster Presented during the Symposium. Besides best oral and poster presentation awards for each session were also given to the participants.

The Society also confers best paper presentation award to early career researchers (below 40 years). During the 14th National Symposium, the ISCAR Best Paper Presentation Award for Early Career Researcher Award was conferred jointly to Dr. Rinchen Nopu Bhutia, Scientist, ICAR-CSSRI, RRS, Canning for the paper entitled 'Trophic interactions and ecosystem modelling of the Matla estuary in the Indian Sundarbans' and Dr. Debarati Datta, Scientist, ICAR-CRIJAF, Barrackpore on 'Comparative study on waterlogging tolerance of tossa and white jute in West Bengal'. More than 50 farmers participated in the A farmers' conclave organized on 2nd March, 2025 where the recent technology on agriculture and fishery sector suitable for small and marginal coastal farmers were discussed.

At the end, in the Valedictory session was held where Shri M.C. Chakraborty, Jute commissioner, Govt. of India was the Chief Guest. Other dignitaries like Dr. Gouranga Kar, Director, ICAR-CRIJAF; Dr. Monish Das, Director, ICAR-DMAPR; and Dr. D.B. Shakyawar, Director, ICAR-NINFET grace the valedictory programme. During the plenary session the summary of the deliberations of different sessions were presented by the Chairman/ Co-Chairman/rapporteur of respective sessions. The experts of different disciplines of coastal agriculture from various parts of the country participated in the discussion and finalized the recommendations for sustainable enhancement of productivity in the coastal areas of the country.

The symposium was attended by more than 235 delegates comprising of researchers, academicians and students from various parts of the coastal states of India. The Symposium was supported by Indian Council of Agricultural Research (ICAR), New Delhi; National Bank for Agriculture and Rural Development (NABARD); National Fisheries Development Board (NFDB), Krishi Rasayan, Dhanuka, Delta Agrigenetics Private Limited, Creative Displayers, Next to Nature, Krishi Udyog, Joy Maa Tara, Bengal Biotech,

The recommendations that emerged out of the deliberations during the symposium are given below.

Recommendations

Theme 1: Advances in management of agriculture, horticulture, plantation and fibre crops and their tolerance to biotic and abiotic stresses

- Promote diversified cropping systems by encouraging the adoption of salt-tolerant and short-duration crops such as sunflower, maize, garlic, zero-tillage potato, watermelon, spinach, and onion. support early sowing practices to utilize residual monsoon moisture and avoid peak salinity periods.
- To harness the potential of direct seeded rice (DSR) in eastern India it is recommended to identify, exploit and introgress valuable traits into rice breeding programs tailored for DSR conditions. Development and promotion of DSR specific cultivars, combined with site specific, split nutrient and water management practices are essential for overcoming associated risks and enhancing crop performance.

- To develop climate-resilient rice varieties for coastal regions, there is a need in combining submergence tolerance (*SUB1A*) with other abiotic and biotic stress traits. Since *SUB1A* and *SK1/SK2* act oppositely, focus should be on identifying suitable landraces and using molecular tools to integrate stress tolerance and grain quality preferred by local consumers.
- A holistic approach combining soil management with integrated farming systems such as rice-prawn-duck-crab-goat and rice-prawn/fish-coconut-vegetable models should be promoted in the coastal acid saline soils of Kerala. Additionally, the use of saline tolerant rice varieties in combination with plant growth promoting Rhizobacteria (PGPR) can enhance productivity resource use efficiency and livelihood resilience in these challenging coastal agro-ecosystems
- Use the identified salt-tolerant RILs and linked QTLs with associated genes for marker-assisted breeding to develop rice varieties with improved sodicity tolerance. This approach will help create high-yielding, salt-resilient cultivars for saline-affected regions.
- Adopt no tillage with residue incorporation, especially in the Jute-rice-lentil cropping system, to enhance soil quality, sustain nutrient balance, and improve production efficiency, thereby promoting environmentally sustainable and economically viable jute-based agriculture.
- For effective weed management in jute, integrating herbicidal application of ipfencarbazone @ 90 g/ha pre-emergence with mechanical weeding using a single wheel or nail weeder at 21 DAS is recommended. This approach enhances fibre yield and economic returns without long-term negative impacts on key soil enzyme activities, supporting sustainable jute cultivation.
- For effective and sustainable management of jute yellow mite, it is recommended to cultivate mite-tolerant varieties such as JRO 204, JRO 524, and JROG 1 in combination with soil application of sulfur. This integrated approach reduces mite infestation and damage while enhancing plant growth and yield, making it a practical strategy for farmers to improve productivity and crop resilience.
- Salinity-tolerant rice genotypes such as Nona Bokra, Amalmana, and Canning 7, which exhibit increased root length, higher plant height, and stable relative water content (RWC), should be promoted for cultivation in saline-prone areas. Their ability to maintain lower yield losses under salinity stress makes them valuable for enhancing crop resilience and sustaining productivity in affected regions. These genotypes can also be used in breeding programs aimed at developing improved salt-tolerant rice varieties.
- The identified abiotic stress-responsive BTB BTB (Broad-Complex, Tramtrack, and Bric-à-Brac) genes in jute should be prioritized for functional validation and incorporated into breeding programs to develop stress-tolerant jute varieties. Integrating these candidate genes through molecular breeding or biotechnological approaches can enhance jute resilience against drought, salinity, and waterlogging. Further research is recommended to explore gene expression patterns under different stress conditions and to develop molecular markers for efficient selection in jute improvement.
- The groundnut variety TG 51 along with 100% RDF 20:60:40 kg N, P_2O_5 and K_2O ha^{-1} and a spacing of 30 x 10 cm produced 14.28% higher yield with B:C ratio 2.76 than the farmers' practice in coastal West Bengal is recommended for the region.
- Maize-based intercropping systems, particularly Maize + Groundnut and Maize + Chickpea, demonstrated superior growth, yield, and economic returns under optimal irrigation at ET_0: 1.0, with BCR values of 2.94 and 2.92 respectively. Even under deficit

irrigation (ET_o: 0.8), these intercropping systems outperformed sole cropping in terms of crop and water productivity. Hence, promoting maize intercropping with groundnut or chickpea under well-planned irrigation scheduling can be an effective strategy for enhancing resource use efficiency and farm profitability in water-limited regions.

- The identified moderately resistant lines (PL-100, PL-40, PL-99, PL-33, PL-89, PL-119, PL-1, PL-43, PL-118, PL-121, PL-6, PL-11, PL-55, and PL-86) against stem rot (M. phaseolina), particularly PL-100, PL-40, and PL-33 with higher fibre yield than the check variety JRO 524, should be prioritized for use in resistance breeding programs. These genotypes can serve as valuable donor parents for developing high-yielding, disease-tolerant jute varieties to enhance crop productivity and sustainability under biotic stress conditions.
- Adoption of soil test-based fertilizer prescriptions, along with FYM application, is recommended to enhance mustard yield in Eastern India. A ready reckoner should be shared with farmers and extension workers for balanced nutrient management. Training programs are needed to support effective implementation.
- Establish a well-characterized breeding core collection for Tossa jute (*Corchorus olitorius*) to conserve genetic diversity and support sustainable crop improvement. Strategic germplasm assessment and sampling will aid in developing resilient and adaptable varieties, laying a strong foundation for future breeding and research programs
- Promote hybridization and combining ability studies in *Corchorus olitorius* to break the fibre yield plateau and enhance genetic gains. Crosses like JROBA 3 × JRO 2407 and JROM 1 × JRO 8432 showed significant yield advantages due to non-additive gene action, highlighting the potential for transgressive segregant selection. Given jute's limited genetic variation, focused breeding strategies involving specific and general combining ability analysis are essential for sustained fibre yield improvement.
- Implement cropping system intensification in coastal regions through integrated farming approaches that combine crop, livestock, and fishery components. Encourage active women participation in vegetable and fruit production to enhance household nutrition and income. Promote the use of climate-resilient and salt-tolerant crop cultivars to sustain productivity under coastal stresses and ensure year-round farm utilization and livelihood security.
- Utilize differential gene expression analysis and RNA-seq to identify novel candidate genes for salinity tolerance in rice. Genotypes such as CST 7-1, CSR 36, SR 3-9, and Karjat 184 showed strong expression of salt-responsive genes at 3 and 6 dS/m, surpassing known tolerant and sensitive checks. A total of 50 differentially expressed genes were identified, including 14 novel genes with no homology in existing databases, indicating their potential role in unique salt tolerance mechanisms. These findings can guide functional validation and incorporation of novel alleles into breeding programs for developing salinity-resilient rice cultivars.
- Promote high cash value horticultural crops as a sustainable strategy for utilizing challenging and salt-affected soils. Focus on advancing genetic improvements and selecting salt-tolerant rootstocks for fruits, vegetables, and nut trees to enhance salinity resilience. Encourage research to generate quantitative salt tolerance data for under-studied crucifers like cauliflower, kale, and watercress, enabling informed crop selection and management in saline environments.

- Harness the vast potential of coastal horticulture by promoting crop diversification suited to local agro-climatic conditions, supported by region-specific technologies. Despite challenges like salinity, waterlogging, and extreme weather, coastal areas have shown significant growth in horticultural crop area due to better returns and nutritional benefits. To bridge the yield gap with inland regions, focus on quality planting material, stress-tolerant varieties, efficient crop and input management, and post-harvest handling. Strengthening farmer capacity through market linkages, technical advisory, and livelihood support will ensure sustainable prosperity in coastal regions.
- Promote agri-diversification and integrated farming systems in flood-prone and waterlogged ecosystems through a multi-stakeholder approach involving Central and State Governments. Policies should focus on infrastructure development like water storage, embankments, and drainage, along with farm-ponds for fish farming and multiple water uses. Encourage land shaping and crop diversification in shallow areas, and deepwater rice or rice-fish farming in deeper zones. Support aquatic crops like water chestnut and agroforestry with biodrainage plants. Converging existing schemes and strengthening farmer capacity will ensure sustainable livelihoods and climate resilience in these vulnerable regions.
- Apply silicon fertilizer to rice grown in coastal saline soils during the initial cropping seasons, as the crop shows a positive response. However, with continued recycling of 40% or more rice straw for four consecutive seasons (two Kharif and two Boro) and groundwater irrigation during Boro, silicon application can be discontinued without yield loss. This practice supports nutrient sustainability and reduces input costs.
- For quality, virus-free seed tuber production of potato in the new alluvial zone of West Bengal, adopt a spacing of 60 cm × 15 cm with dehaulming at 65 days after planting (DAP), when sown in the first week of November. Apply 50% of the recommended NPK dose (100:75:75 kg/ha) along with 0.1% boric acid foliar spray at 40, 50, and 60 DAP. This agronomic practice, validated under open field conditions, has been recommended by ICAR-CPRI, Shimla for seed tuber production in the region.
- Monitor and manage *Myzus persicae* populations in potato crops of the Gangetic basin by considering key abiotic factors influencing their dynamics. Temperature and relative humidity significantly affect aphid population fluctuations. There is a need for weather-based forecasting models and timely pest management strategies tailored to prevailing climatic conditions.
- Promote the cultivation and value addition of medicinal and aromatic plants (MAPs) as a sustainable livelihood option, especially in rural and marginal areas. By encouraging community-based cultivation, processing, and marketing, MAPs can enhance income generation, support traditional knowledge systems, and contribute to local and national economies. Policy support, capacity building, and market linkages are essential to realize their full potential.
- Adopt an integrated breeding approach combining single gene manipulation, meta-QTL analysis, and genomic selection to develop high-yielding, stress-tolerant rice varieties for India's coastal regions. This strategy will enable faster and more precise development of resilient cultivars suited to coastal environmental challenges

Theme 2: Technological advancement in fisheries, livestock and poultry management

- To restore the declining hilsa (*Tenualosa ilisha*) population in the Narmada estuary, a scientifically regulated fishing ban during the peak spawning season should be strictly enforced to protect brooders and support natural recruitment
- Establishment of national-level "Hilsa Conservation Aquaculture Program" focused on scaling up captive rearing protocols, standardizing broodstock management, and achieving successful breeding in captivity, with the dual aim of stock enhancement through ranching and market supply via culture-based production
- Promotion of integration of climate-resilient fish species such as *Oreochromis nilotica* and *Anabas testudineus* in micro-pond systems, utilizing jute retting slurry through community-based aquaculture programs, as a sustainable strategy to mitigate jute retting pollution, enhance fish production, and improve rural livelihoods.
- Implementation of comprehensive monitoring and mitigation program targeting emerging contaminants (e.g., microplastics, PPCPs, PFAS, and endocrine-disrupting chemicals) in the Hooghly estuary to safeguard aquatic biodiversity, ensure fish safety for human consumption, and support the sustainability of fisheries and aquaculture in the region
- To enhance the livelihood resilience and reduce overdependence on Chilika's fisheries, targeted interventions should be made to diversify income sources through promotion of eco-tourism, skill-based self-employment (e.g., tailoring, carpentry, e-rickshaw driving), and establishment of fish value chain infrastructure (ice factories, processing units, marketing facilities), along with revitalization of cooperative institutions and financial inclusion via SHGs and FPOs
- Promote adoption of integrated and species-diversified brackishwater aquaculture models-such as polyculture with cost-effective feed, IMTA, and periphyton-based systems-to sustainably enhance productivity, profitability, and resilience of Sundarban farmers
- Promote the development and dissemination of low-cost, species-specific farm-made feed formulations using locally available ingredients, coupled with farmer training on feed preparation, storage, and sustainable feeding practices to enhance aquaculture productivity and reduce environmental impact
- Stocking EHP (*Ecytonucleospora hepatopenaei*) -free post-larvae and using the phyto-based therapeutic "CIBA EHP Cura I" at 50 ml/kg feed for 10–15 days to effectively control White Faecal Syndrome (WFS) in shrimp thereby reducing the incidence and severity of WFS in shrimp culture
- Encourage large-scale field trials using a 1:1 mixture of vermicompost extract (prepared through anaerobic digestion of agricultural waste) and standard microalgae growth medium to grow *Graesiella emersonii*. This method is eco-friendly, reduces the need for chemical fertilizers, and can significantly improve biodiesel yield and quality, making it suitable for sustainable commercial production
- Use of hCG at 2000 IU/kg body weight for female broodstock and maintaining incubation conditions at 22 °C temperature and 25–30 ppt salinity for successful commercial seed production of Bengal Yellowfin Seabream (*Acanthopagrus datnia*), as this combination results in the highest spawning frequency, fertilization rate (93.32%), hatching rate (93.22%), and larval survival
- To ensure sustainability of estuarine fisheries in the Sundarbans, promote hatchery-based seed production of key brackishwater species and provide alternative livelihoods to traditional spawn collectors to reduce pressure on natural seed resources

- Farmers should adopt the mass outdoor culture of live fish food organisms like *Graesiella*, *Brachionus*, *Cyclops*, and *Moina* using optimized combinations of organic manures (e.g., raw cattle dung, oil cakes, and yeast) under suitable light and temperature conditions, as this method enhances production efficiency and supports sustainable aquaculture with reduced dependency on commercial larval feeds
- For sustainable and economically viable aquaculture of *Heteropneustes fossilis*, a stocking density of 60,000 to 80,000 fish/ha is recommended, as it ensures a balance between growth performance and net economic return, optimizing both yield and profitability without incurring excessive input costs
- Inclusion of species like *Pisodonopsis boro* and *Mystus gulio* in dietary plans and aquaculture due to their high-quality protein, essential amino acids, and beneficial omega-3 fatty acids, supporting both nutritional security and health benefits
- Regular monitoring of plankton and periphyton communities should be integrated into water quality assessment programs in the lower Gangetic region to enable early detection of pollution and guide targeted mitigation strategies
- To support sustainable Hilsa fisheries, regular monitoring and management of nutrient loads and industrial effluents in the Ganga, Haldi, and Rupnarayan rivers are essential to maintain healthy plankton communities along Hilsa migratory routes
- *Telescopium telescopium* should be adopted as a sentinel bioindicator species for routine monitoring of microplastic pollution in the estuarine zones of the Ganga River. Its high accumulation levels and sensitivity to environmental changes make it an effective tool for early detection and assessment of microplastic contamination, which can guide targeted pollution control and waste management strategies in the region.
- To sustain fish diversity and ecosystem balance in the lower Rupnarayan River, integrated water quality management should be prioritized, with particular focus on controlling nutrient loads (especially nitrogen and silicate) and maintaining water transparency and conductivity levels, as these parameters significantly influence ichthyofaunal assemblages and functional guild structure across seasons.
- To enhance the resilience of coastal wetlands in West Bengal against climate change, it is recommended to implement community-led mangrove restoration programs integrated with climate-resilient livelihood options, such as sustainable aquaculture or ecotourism.
- Implementation of seasonal monitoring and regulation program on post-monsoon runoff control and industrial discharge management, especially in hotspots like Diamond Harbour and Fraserganj, to reduce the influx of bisphenol A (BPA) into the River Ganga and to protect vulnerable pelagic fish species and aquatic biodiversity
- Implement regular monitoring and regulation of BPA levels in the Ganga estuary, especially in key Hilsa fishing zones. Establishing safe BPA limits in edible fish tissues and controlling plastic pollution sources are essential. Public awareness campaigns should be conducted to inform communities about the health risks of BPA. These measures will help protect both Hilsa fisheries and consumer health.
- Implement a seasonal monitoring and management program focusing on key environmental parameters-silicate, salinity, turbidity, and total suspended solids—as these significantly influence fish abundance and community composition in the estuaries of Ganges delta. Such targeted environmental regulation will support sustainable fishery practices and help maintain ecological balance in response to spatio-temporal shifts in fish guilds

- To improve the success of artificial insemination in Black Bengal goats, it is recommended to optimize the semen cryopreservation protocol by modifying extender composition, cryoprotectant concentration, and freezing-thawing rates to enhance post-thaw sperm motility, viability, and membrane integrity
- To enhance reproductive efficiency in coastal cattle, it is recommended to incorporate GnRH secretagogues—particularly novel peptides like kisspeptin—into breeding protocols for estrus synchronization and fertility management, especially in cases of anestrus or subfertility. This approach should be species-tailored and complemented with regular reproductive monitoring to ensure efficacy and safety
- Promote the widespread adoption of AI-driven health and behaviour monitoring systems in livestock farms to enable early disease detection, reduce veterinary costs, and enhance animal welfare for sustainable and efficient livestock production
- Establish AI-based Livestock Resource Centres in coastal areas to offer real-time weather alerts, disease prediction, precision feeding, and farmer training, supported by public-private partnerships and government subsidies
- Supplementing preweaned dairy calves with a combination of kitchen herbs (cinnamon, carom seed, and turmeric) and probiotics (*Lactobacillus fermentum* NCDC605 and *Lactobacillus rhamnosus* NCDC610 at 10^9 cfu/ml) in whole milk as an effective strategy to reduce the incidence of diarrhoea, enhance gut health, and improve feed intake and growth performance during the preweaning period
- Selective breeding and conservation program to be initiated for the native Aseel chicken populations of Sundarbans blocks, focusing on maintaining their distinct morphometric traits and comb-type diversity, while promoting in-situ conservation under backyard systems to prevent genetic dilution from crossbreeding with exotic or improved breeds
- Supplementing Leukemia Inhibitory Factor at a concentration of 15 nanograms per millilitre in the in-vitro maturation, fertilization, and culture media to significantly improve the development of cattle embryos, particularly increasing the formation rate of blastocysts compared to other growth factors and the control group

Theme 3: Natural resource management, forestry and bio-diversity in coastal and marine ecosystem

- There is a need for updating of database of salt affected soils and regular assessment of coastal salinity. Alternate land use systems, upscaling of 3D vertical farming model based on rice, vegetables and fish culture in lowlands and exploring rice genotypes with tolerance to coastal salinity is the need of the hour to tackle coastal salinity.
- Advance technologies like RS, GIS, loT, and geo-spatial tools, combined with the expertise and dedication of scientific professionals and the collective efforts of both government and non-government sectors, will play a pivotal role in revolutionizing agriculture in coastal regions. The precision agriculture and smart management of natural resources is the need of the hour.
- Emphasize the importance of both in-situ (at the point of rainfall) and ex-situ (runoff capture) water conservation methods. Assess surface water resources accurately and incorporate geomorphological parameters of watersheds using geoinformatics for effective planning and utilization. Encourage the construction and rehabilitation of community water

structures such as ponds, canals, and check dams to enhance freshwater retention and availability.

- Formulate adaptive water management plans that address sea-level rise, altered rainfall patterns, and increasing salinity intrusion. Promote the use of water-smart irrigation technologies like drip irrigation, pitcher irrigation, and bottle irrigation for high-value vegetable crops. Encourage the conjunctive use of saline and fresh water, with careful mixing ratios to reduce crop stress.
- Conduct regular assessments of soil and water salinity levels in coastal regions to monitor changes and prevent further land degradation. Combine engineering, chemical, and biological approaches to mitigate the effects of coastal salinity and restore soil productivity in saline areas. Implement conservation measures to protect soil and water resources.
- With sodicity increasing due to poor-quality irrigation, the use of FGD Flue Gas Desulfurization) gypsum can serve as an environmentally safe and cost-effective alternative to traditional gypsum, supporting circular economy principles.
- Upgrade the quality standards of bio-fertilizers and bio-control agents to meet international benchmarks. Establish state-level quality control laboratories and ensure the free supply of microbial inputs to farmers.
- Provide seasonal climate forecasts, real-time soil salinity data, and decision-support tools to assist farmers in making informed choices on crop selection, sowing times, and irrigation planning. Leverage mobile platforms to deliver timely, location-specific advisories.
- Identify and apply appropriate geo-textiles and agro-textiles for protecting earthen embankments and using mulches. These techniques aid in soil conservation, improve soil health, and contribute to food security.
- Encourage integrated systems to maximize resource recycling, improve productivity, and enhance long-term sustainability. These practices are vital for building climate resilience in coastal areas. Benefits include improved soil health, better water use, reduced erosion, and increased carbon sequestration.
- Provide policy incentives such as subsidies for water-saving technologies, financial support for community irrigation schemes, and access to credit for adopting climate-resilient crops and practices. Encourage the integration of climate-smart agriculture into local development agendas and national policies.
- Marine Gypsum a waste from coastal regions is effective in amelioration of degraded sodic soils and can be an alternative source of mineral gypsum for sodic soil reclamation.
- Halophytes and Halophillic microbes are efficient in stress release and can be used for bio-remediation of coastal and inland salt affected soils.
- Soil salinity can be rapidly identified and characterized by Proximal Sensors (EM meter) and can be used for delineating quick village level soil salinity monitoring.
- Coastal soils are generally considered as poor in soil fertility and deficient in essential plant nutrients, like N, P and micronutrients like Zn & B. Therefore, balanced plant nutrition should be strongly recommended. Micronutrients like zinc, boron, iron etc. play a crucial role in managing abitic and biotic stresses in agriculture.

- Utilize Sentinel-2 MSI data to accurately delineate and classify pond water turbidity across the Indian Sundarbans can guide policymakers in prioritizing pond treatment strategies based on turbidity classes and seasonal-spatial variability

Theme 4: Climate change and disaster occurrence: impact and mitigation strategies

- By judicious mixing of synthetic aperture radar (SAR), optical satellite and unmanned aerial vehicle (UAV) data along with mobile technology crop damage can be assessed in near real-time and can be used for satellite-based impact assessment of crop damage due to cyclone, flood. unseasonal rainfall/hailstorm in coastal region.
- Crop diversification is crucial for mitigating climate risks in long run, enhancing livelihoods, and ensuring food security in the region. For this reason, it is necessary to implement appropriate measures in order to increase crop varieties on the coastal plain of West Bengal.
- Potential area suitable for pest and disease infestation can be mapped using eco-climatic modeling in geospatial framework. Hence, there is an urgent need for a consorted effort by the knowledge institutes to utilize the existing and upcoming technologies such as mobile, UAV, proximal sensing etc. towards informed decision making.
- A model needs to be developed to study the regional scale coastal hazards with the local resources using satellite Remote Sensing and Geographical Information System (GIS) with due consideration on the environment, biodiversity and socio- economic conditions of the region.
- Climate Smart Drainage which includes integration of bio drainage, salt tolerant varieties, agroforestry, agro-horticulture with controlled surface and subsurface drainage, IoT/and Supervisory Control and Data Acquisition (SCADA) sensors should be promoted to manage the problems of coastal salinity and enhancing crop productivity.
- Emphasis should be given on management strategies to cope with climate change in vegetable crops like development of stress tolerant varieties, gene expression manipulation, adoption of integrated cropping and farming systems, alternate vegetable crops and perennial vegetables.
- Application of seaweed sap a 11.5 and 10% in groundnut and potato showed significant impact on plant growth parameters, productivity and profitability can be implemented.
- The free-flowing water retting method with CRIJAF SONA may be implemented for quality jute fibre production considering the non-availability of water or irregular rainfall pattern in jute growing areas of South East Asia,
- It was recommended to undertake jute production at 50 and 75% soil moisture depletion with irrigation amount of 75 and 100% of crop evapotranspiration to increase water productivity.

- To conserve mangrove wetland which not only protects the natural C sinks but also provides ecosystem services, besides Silvo- fishery, planting mangroves in aquaculture ponds, a sustainable approach that combines mangrove restoration with aquaculture production in reverse climate change as well as towards livelihood improvement.

- The Ganges River dolphin, a well-known and endangered freshwater species, is in severe jeopardy as salinity levels rise in the lower Ganga River. Immediate conservation efforts are required to solve this issue, such as restoring freshwater flow, managing water resources sustainably, and protecting critical habitats.
- A comprehensive approach is essential for ensuring the sustainability of Pulicat Lake fisheries. Restoring habitats, implementing sustainable fishing methods, engaging communities, and developing adaptive strategies to address climate impacts are essential routes to building resilience.
- The increasing trend of disastrous events in the present scenario the estuarine coastal tourism of Sundarbans is drastically affected, especially due to Climate Change. The vulnerability may be reduced by creating mangrove buffers and by following the rule of CRZ. The ensuring community participation need to be assessed, in tourism practice for sustainable tourism development. As a consequence, it would be emerged as an alternative livelihood apart from agriculture and fishing.
- The information on spatial variability of agricultural vulnerability and risk to climate change impacts in Ganges delta can help policy makers and planners to prioritize appropriate adaptive measures for the development of agriculture in the region

Theme 5: Impact of technological advancements, gender issues, market dynamics and new opportunities

- Zero tillage potato cultivation in salt-affected delta regions should be promoted with locally adapted protocols, as its potential for labour savings, particularly beneficial to women in male-migrating households.
- Participatory field demonstrations and local evidence-sharing are essential strategies for building farmer trust and scaling up new practices in coastal regions.
- Up-scaling of climate-smart agriculture should focus on improving collaboration among key stakeholders, and promoting partnerships with research institutions. Using localized demonstration models and aligning efforts across policy, research, and financing can increase adoption and support the development of climate-resilient agri-food systems.
- The development of Decision Support Systems (DSS) should be prioritized to support real-time monitoring and management of coastal agro-ecosystems by incorporating interdisciplinary knowledge. Designing DSS should take into account farmers' behaviour and decision-making patterns to ensure the systems are user-friendly, locally relevant, and responsive to their socio-economic needs.
- Face-to-face interactions with digital advisories should be institutionalized for tools like Rice Crop Manager to maximize adoption rates and yield benefits across different regions.
- Smallholder market participation in the Indian Ganges Delta requires localized market infrastructure, collective marketing mechanisms, better transport facilities, and investment in post-harvest storage.
- Sustainable value chains in aquaculture and fish processing should be developed with a focus on women entrepreneurs by facilitating market linkages, encouraging the formation of cooperatives, and investing in necessary infrastructure.

- Gender equity in the fisheries sector should be promoted by implementing supportive policies, and encouraging entrepreneurship among fisherwomen through targeted training and resources.
- Gender-sensitive extension strategies must be adopted by recognizing the unique roles and constraints faced by women in agriculture and allied sectors, and enhancing their participation in decision-making and entrepreneurial activities.
- Value chain development in jute and jute diversified products should be enhanced to empower rural farm families economically and socially, promoting rural livelihood diversification and gender inclusion.