



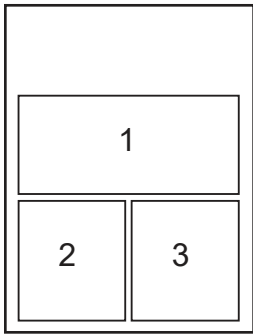
M. S. SWAMINATHAN RESEARCH FOUNDATION

2022-2023

**THIRTY-THIRD
ANNUAL REPORT**

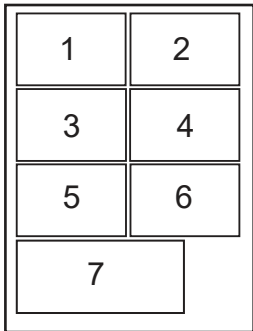
**CENTRE FOR RESEARCH ON
SUSTAINABLE AGRICULTURAL
AND RURAL DEVELOPMENT**





Front Cover

1. Inauguration of the International Consultation on ‘Sustainable Development in Hill and Coastal Ecosystems’ by Thiru Siva. V. Meyyanathan, Hon’ble Minister, Environment and Climate Change, Government of Tamil Nadu, 7th August 2022.
2. Dr Soumya Swaminathan, Chairperson, MSSRF interacting with the tribal women and men on Nutrition Garden and Health at Koraput, Odisha.
3. Thiru R. Sakkarapani, Hon’ble Minister, Food and Civil Supplies, Government of Tamil Nadu visiting small millets stall at MSSRF, Chennai during the ‘ LiFE - Lifestyle for Environment’ event, 27th April 2023.



Back Cover

1. Panel discussion to commemorate the birth anniversary of Ms Mina Swaminathan at MSSRF, 3rd April 2023.
2. Launch of Archives of Prof M.S. Swaminathan’s work at National Centre for Biological Sciences, Bengaluru, 11th October 2022.
3. Planting of mangrove saplings in the intertidal area of Pulicat Lake, Andhra Pradesh.
4. The whole genome sequence of *Brevibacillus laterosporus* MSSRFT15, a multibeneficial rhizobacteria.
5. Video-based online learning for pest management in paddy at Pudukottai, Tamil Nadu.
6. Millet harvesting by tribal women farmers in Koraput, Odisha
7. National Science Day observed with students of the ‘Every Child a Scientist’ programme at MSSRF, 28th February 2023.

Thirty-Third Annual Report

2022 – 2023



M. S. Swaminathan Research Foundation

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and Rural Development
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Foreword by Chairperson

The previous year has brought into sharp focus the increased frequency of unprecedented weather events and the need to strengthen climate-resilient adaptation measures, across different agroecological zones. The consultation on 'Sustainable Development in Hill and Coastal Ecosystems' organized at MSSRF in August 2022 that was inaugurated by the Hon'ble Minister of Environment and Climate Change, Government of Tamil Nadu was indeed timely. The Minister, in his speech, highlighted the ecological significance of mangrove forest restoration, bamboo plantations and increasing tree cover in the state to adapt to increasing climate risks. He also appreciated MSSRF's work at the grassroots level on the use of Information and Communication Technologies in empowering farmers and Panchayati Raj Institutions.

The launch of the Mangrove Initiative for Shoreline Habitats & Tangible Incomes (MISHTI) announced by the Union Finance Minister of India while presenting the 2023-24 budget, also highlighted the importance of mangroves and associated ecosystem conservation. MSSRF has been a pioneer in the restoration and management of mangroves for almost three decades by adopting a scientific and participatory approach in partnership with local communities. The MISHTI initiative, therefore, provides a platform to promote the conservation of this ecosystem more intensively. MSSRF continued mangrove restoration activities along the coast of Andhra Pradesh and Tamil Nadu, integrating newer innovations such as Integrated Mangrove Fish Farming Systems. The seagrass ecosystem along coastal regions

captures higher carbon and has great potential to mitigate climate change impacts. In a new initiative, model restoration of seagrass beds was commenced after an initial assessment at Pulicat Lake in Andhra Pradesh. The Fish for All Research and Training Centre (FRTC) received the Women Connect Challenge Award from United States Agency for International Development and Reliance Foundation to strengthen the post-harvest value chain for fish using digital tools. FRTC has also been recognized as a "Cluster Based Business Organization" by the National Fisheries Development Board to promote economy of scale in accessing productive resources by small-scale fishers. Coastal communities including both fishers and farmers are facing increasing livelihood challenges and the youth in these areas have different aspirations, which must be met.

MSSRF continued its work on agro-biodiversity conservation with the active participation of local communities, in Kolli Hills, Tamil Nadu, to strengthen the functioning of the multi-storey mixed farming system model, capacity-building programmes were organised to enhance the knowledge and skills of 500 tribal farmers on scientific management of plantations and possible intercrops. The Community Agrobiodiversity Centre at Wayanad, Kerala has also continued its *in-situ* conservation activities for paddy, tubers, vegetables and legumes as well as Rare, Endangered and Threatened species. Last year, our scientific staff, reported two new angiosperm species: *Ixora lavanya* and *Christisonia flavirubens* in the South-Western

Ghats in Kerala. At the Biju Patnaik Tribal Agro-biodiversity Centre in Jeypore, Koraput district of Odisha, finger millet and little millet cultivation was revived in 671 ha by bundling access to productive resources and services in partnership with the Odisha Millet Mission. The use of neglected and under-utilized species for the nutrition and food security of tribal populations will be deeply explored further.

The Biotechnology Programme continued to focus research on salinity tolerance mechanisms in crops and mangrove species. *Echinochloa* weed species in rice fields were identified using taxonomical and molecular tools. Culture conditions for eight vulnerable lichens species, categorized as non-timber forest products were established. In the farmer-centric Biotech-KISAN Hub programme, improved agronomic practices and integrated nutrient management for millet and spices cultivation were promoted. Mangrove rhizosphere-associated dimethylsulfoniopropionate (DMSP)-producing bacteria were characterized and the genome of a beneficial bacteria, *Brevibacillus laterosporus* MSSRFT15 was sequenced. These findings could help develop bio-inputs to improve yields, as well as understand the mechanisms associated with drought and salt tolerance in plants.

This year, 259 government school children participated in the “Every Child a Scientist” (ECAS) programme at Chennai. The ECAS course has now been extended to FRTC, Poompuhar (MSSRF), and 200 middle school students participated. Children in classes VI to VIII spent 15 days doing project work, laboratory experiments and hands-on computer exercises.

The Ecotechnology Programme has been supporting seven farmer-producer organizations (FPO) in Tamil Nadu and Puducherry that directly facilitated access to different productive resources and services for over 10000 farmers. Technical guidance was also provided to 11 FPOs, in partnership with the Government of Tamil Nadu. Digital tools have been effectively harnessed to provide farmer-centric agro-advisories that have enabled access to information, knowledge resources and skills for ~2 lakh farmers. The initiative, Water Security for Climate Adaption in rural areas, focused on management, planning and innovative climate actions of decentralised water resources and has been extended to five southern states in partnership with GIZ, New Delhi covering over 2500 Gram Panchayats.

The Agriculture, Nutrition and Health Programme continued its focus on strengthening the approach of the Farming System for Nutrition (FSN) to address the challenges of malnutrition and livelihoods. In Odisha, the FSN approach has been adopted by 1575 households by integrating both fish rearing and growing vegetables along with the cultivation of paddy and millets in farms. Specific focus was given to increasing diet diversity by promoting nutrition gardens among 2500 households. In addition, a new initiative of rice fallow management was undertaken to effectively promote crop rotation and intensification with pulses in over 4320 ha in Nayagarh, Koraput and Malkangiri districts. Similarly, the MSSRF Wayanad Centre has promoted diversified vegetable production in 400 home gardens and protected cultivation under rain shelters. Impact assessments are

underway to estimate the benefits of these programs to local communities.

The climate change programme in collaboration with the National Institute of Advanced Studies conducted the first-of-its-kind study on the equity implications of the modelled global mitigation pathways (scenarios) based on Integrated Assessment Models which feature in the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. The Climate Equity Monitor portal is cited in India's Long-Term Low Emissions Strategy submission under the Paris Agreement, to the UNFCCC.

Historical research contributions of Professor M.S. Swaminathan were chronicled at The Archives - National Centre for Biological Sciences, Bengaluru to provide access to historians, scholars and the general public interested in modern Indian agricultural development. It covers over 48,000 archival objects spanning more than 80 years of the life and work of M.S. Swaminathan. These are in the form of research notes, correspondence, unpublished writings, media clippings, photographs, published works, and administrative notes from dozens of institutions and committees, some dating back as far as early 1930s. The collection was made possible with generous support from TNQ Technologies and the Trustees of MSSRF and is accessible at The Archives website upon request.

To advance innovations and strengthen collaborative research to have a larger impact, this year MSSRF signed four new memoranda of understanding with the Council on Energy, Environment, and Water, New Delhi; University of Trans-Disciplinary

Health Sciences and Technology, Bengaluru; Avinashilingam University, Coimbatore; Centre for Environmental Concerns, Hyderabad and National Botanical Research Institute, Lucknow, (Council of Scientific and Industrial Research).

The birth anniversary of Ms Mina Swaminathan was commemorated in April 2023 by highlighting her contributions to childcare. A panel discussion titled 'Who Cares? Progress and Challenges for Early Childhood Development' was hosted by MSSRF and moderated by Dr Anjana Mangalagiri, Senior Fellow, Institute of Social Sciences, New Delhi.

Three Mina Swaminathan Media Fellows for the year 2022 shared field-level findings with researchers and policymakers on 'Gender Transformative Approaches for Sustainable Food Systems'. In 2023, three additional fellows have been selected and working on Gender Dimensions of Millet Production and Processing. The Communications and Media outreach functions were further strengthened, with more visibility on social media, as well as in the print media. Many workshops and public lectures were organized and webcast live.

Dr Madhura Swaminathan steered the MSSRF's work for the past 10 years as Chair of the board of trustees and I took over from her on February 1, 2023. I am thankful to her as well as former and current trustees for the scientific, technical, moral and emotional support they have provided to the scientific, developmental and administrative staff at MSSRF. We look forward to expanding and scaling our successful programs, to achieve even greater impact in improving the lives of rural and tribal communities. I thank Dr G N Hariharan,

Dr R Rengalakshmi, Dr V R Prabavathy and Dr Gayatri Venkataraman for coordination, Ms Suni Sebastin for copy-editing, and AMM Prints, Chennai for printing the Annual Report. The progress and key achievements presented in this report are due to the hard work and

commitment of the scientists, research scholars, developmental, administrative and support staff at all the different centres and field sites of MSSRF. Finally, I record my gratitude to our donors, well-wishers and supporters without which this work would not be possible.

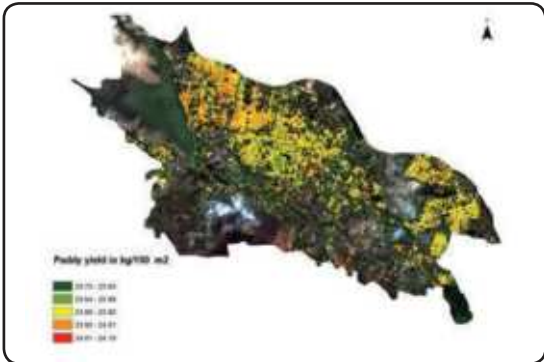
Soumya Swaminathan

COASTAL SYSTEMS RESEARCH

Coastal Systems Research has been involved in implementing participatory coastal resource management along the east and west coasts of India for over three decades by concurrently addressing the ecological security of the coastal resources and livelihood security of the dependent coastal communities. Mangrove conservation and management activities (desilting of canals, protection from grazing and casualty replacement) are being carried out in Basavanipalem in Krishna district and Koratallaiyar estuary near Ennore in Tamil Nadu. In addition, new plantations were established in the Uppeteru estuary near Chinnagollapalem in Andhra Pradesh, Gadilum estuary in Cuddalore in Tamil Nadu, and Pulicat Lake in Andhra Pradesh. This year, new initiatives, such as, the establishment of a non-mangrove bioshield at Chinnagollapalem and seagrass bed restoration in Pulicat Lake, were also launched. The Pest-Disease Advance Notification and Need-Based Agriculture Information (PANNAI) app has been expanded to cater to the needs of farmers in Pudukottai district, Tamil Nadu. Mangrove extent along the Tamil Nadu coast showed an increase by 1400 ha between 2008 and 2018.

The interventions of the Fish for All Research and Training Centre (FRTC) received recognition at various levels and expanded the outreach services. It has been recognized as a Cluster-Based Business Organization (CBBO) by the National Fisheries Development Board (NFDB) for promoting three Fish Farmer's Producer Organizations in Tamil Nadu and Puducherry. Recently, FRTC received the Women Connect Challenge (WCC) Award for strengthening the post-harvest value chain by integrating modern information and communication technologies. To promote sustainable flower shrimp management, a voluntary code of practice (CoP) was co-evolved with fishermen in the Palk Bay region. The 'Integrated Mangrove Aquaculture' model piloted in Pichavaram has received the best performance award from NABARD.

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Sub Programme Area 101

Mangrove and Non-mangrove Coastal Bioshields

101.1 Mangrove Restoration

Koratallaiyar estuary, Thiruvallur district, Tamil Nadu: During the current reporting period, canals developed in the restored area during 2018–19, were de-silted to facilitate the of tidal water flow. Mangrove saplings planted in an area of 15 ha attained a height ranging from 1.3 m to 3.2 m. In the restored area, a higher proportion of *Avicennia* seedlings were established naturally. The mangrove saplings planted in the restored area started fruiting. In elevated areas, the invasive species *Prosopis* was noted, and its removal will be addressed in the coming year. The fishermen living in nearby areas collect *Nereis* sp. from the soil and fish in the canals for their livelihood.

Kovalam estuary, Tamil Nadu: Based on inputs from the district collector of Chengalpattu and the district Green Climate Committee, a feasibility study to take up a mangrove planting on revenue land near the Kovalam estuary was undertaken. The project report was submitted to the district collector, and permission has been obtained for planting of mangroves in the identified location. Detailed baseline data on the physico-chemical parameters of water and soil were collected (Table 1).

Gadilum estuary, Cuddalore district, Tamil Nadu: Coastal disasters have frequently affected the long coastline of Cuddalore district in the past few decades {tsunami in the Indian Ocean (2004) and cyclones Nisha (2008) and Thane (2011)}, causing extensive damage to assets and ecology and affecting the lives and livelihoods of coastal fisherfolk and farmers. A significant part of the coastal zone of Cuddalore district is low lying with a gentle slope, resulting in widespread inundation of saline water. The district collector of Cuddalore

Table 1. **Physico-chemical analysis of water and soil in the proposed mangrove plantation sites in Chengalpattu district, Tamil Nadu**

S. no.	Sampling site	Soil texture	Salinity (ppt)	pH	Dissolved oxygen (mg/l)	Total dissolved salts (mg/l)
1	Muttukadu (12°48'09.9"N 80°14'31.4"E)	Silt-clay	33.20	7.96	3.5	21.2
2	Kovalam (12°47'02.2"N 80°14'04.0"E)	Silt-clay	31.32	7.75	3.2	20.0
3	Padur (12°49'50.5"N 80°14'09.6"E)	Silt-clay	28.41	7.56	2.5	18.1

granted permission to establish a mangrove plantation in the Gadilum estuary to reduce the impact of cyclones and shoreline erosion. Mangrove saplings raised in the nursery with proper care (watering, weeding and pest control) were planted near Echankadu, Nanamedu and Thazhanguda villages in the Cuddalore district. Orientation, training and capacity building on mangrove silviculture practices were provided to the villagers. The district collector and additional collector, Cuddalore, inaugurated the mangrove planting drive on 29 July 2022 during the launch of the Green Tamil Nadu Mission. A total of 15000 mangrove saplings (80 per cent *Rhizophora*; 20 per cent *Avicennia* sp.) were planted in the Gadilum estuary. The plantation sites were fenced with old fishing nets and the saplings' growth is being monitored periodically.

Krishna wildlife sanctuary, Andhra Pradesh: Mangrove saplings planted in 200 ha in 2018–19 near Basavanipalem have attained an average height of about 2.0 m. The natural regeneration of *Avicennia* saplings was also noticed in the restored site. The area receives tidal water, and the Yanadi tribal community and fishermen from the nearby villages collect crabs and shrimps from the restored area. The local community is actively engaged in monitoring and protecting the mangrove plantation.

Uppeteru estuary, Krishna district, Andhra Pradesh: During the current reporting period, an intertidal mangrove nursery was established near the Uppeteru estuary in Chinnagollapalem. Fourteen sunken beds (10 m x 1 m x 20 cm) were prepared in

July 2022 for raising mangrove saplings in the nursery. Clayey soil collected from the Uppeteru estuary was used to fill the nursery bags. A total of 25000 matured mangrove propagules of *Rhizophora apiculata* and *R. mucronata* collected from the mangrove wetlands of Krishna and Godavari were planted in the bags. The sunken beds were connected to the natural creek for the flow of tidal water for irrigation. During low tide, the saplings were irrigated manually. Periodic casualty replacement and grading were carried out to obtain healthy saplings. About 3000 nursery-raised mangrove saplings and 12000 mangrove propagules of *Rhizophora* sp. were planted in the intertidal areas in the Uppeteru estuary in August 2022. Also, 13000 nursery-raised mangrove saplings and 90000 mangrove seeds were planted in the intertidal area near Chinnagollapalem. The survival rate of nursery-raised saplings was about 90 per cent while that of direct sown mangrove seeds was about 60 per cent.

Pulicat Lake, Tirupati district, Andhra Pradesh: Pulicat Lake has extensive seagrass beds with lesser mangrove cover. Mangrove forests are found on the northern side of the lake, near Kondurupalem. The lake has three openings, one each near Kondurupalem and Rayadoruvu, respectively, in Vakadu Mandal (Tirupati district, Andhra Pradesh) and a third near Pazhaverkadu (Tiruvallur district, Tamil Nadu). Sand bar formations at the openings into the Pulicat Lake at Kondurupalem and Rayadoruvu affect the biodiversity in the region. However, the mouth in the south near Pazhaverkadu is being opened by continuous

dredging to regulate tidal water exchange into the lake; therefore, this site retains better biodiversity. Approximately 65000 people live in the region abutting the lake, depending either directly or indirectly on it for their livelihoods. Potential sites for planting mangroves were identified on the southern side of the lake near Irukkam Island (13°35'03.1"N; 80°07'34.7"E) (near Pazhaverkadu), where natural mangrove vegetation is scarce. About 15000 nursery-raised mangrove saplings of *Rhizophora* sp. and *Avicennia* sp. (0.5 m in height) were planted in 3 ha with 1 m x 1 m spacing in May 2023 with the active participation of the local panchayat and the community.

Non-mangrove coastal bioshield: In Chinnagollapalem, about 135000 *Casuarina* saplings and 5000 palmyra seeds were planted in sandy areas to provide both environmental and economic benefits to the local community. *Casuarina* saplings were planted in two phases, August and November 2022, that attained heights of about 3 m and 90 cm, respectively, with survival rates of 95 per cent and 75 per cent, respectively. Fencing to prevent grazing and regular watering are being carried out to ensure higher survival rate.

Mangroves in Thane creek, Navi Mumbai: A preliminary stakeholder meeting (NGOs, the local community and the state forest department) was organized for the conservation and management of mangroves in Thane creek. The activities implemented in the mangrove restoration project in Thane creek between 2015 and 2021 were discussed with the stakeholders. The meeting provided an opportunity for stakeholders to come

together and understand the challenges faced in the conservation and management of mangroves. The meeting also highlighted the importance of community engagement in the conservation efforts. Following this, the Forest Department involved the local community in the conservation of the wetlands in the Thane creek area.

101.2 Seagrass Restoration in Pulicat Lake, Tirupati District, Andhra Pradesh

Water quality plays a significant role in the successful establishment of coastal vegetation such as seagrass and mangroves. Atmospheric temperature (AT), water temperature (WT), salinity, pH, dissolved oxygen (DO) and total dissolved salts (TDSs) were recorded at five sampling locations in Pulicat Lake. Data analysis showed that salinity in the lake was above 7.5 ppt while the DO was 5.3 mg/l, suggesting that the analyzed sites were suitable for planting mangroves and seagrass bed restoration (Fig. 1).

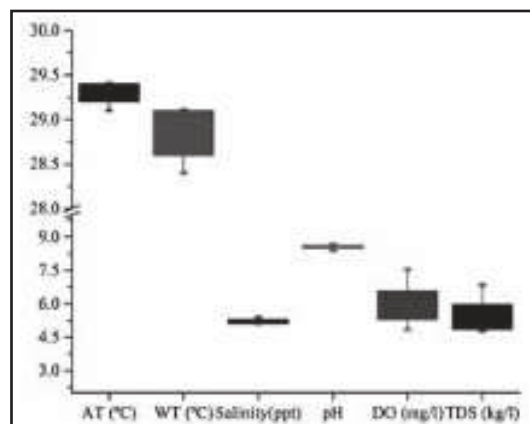


Figure 1. **Water quality parameters at Pulicat Lake.**

Assessing carbon sequestration rate of seagrass meadows in Pulicat Lake:

Like mangroves, seagrass ecosystems provide numerous ecosystem services such as carbon sequestration and storage. Globally, it is estimated that this ecosystem stores nearly 140 Mg (megagram) of organic carbon per hectare in the top layers of the seabed (up to 40 times more efficient at capturing organic carbon than forest soils on land). Seagrass samples were collected from randomly selected quadrats (0.25 m x 0.25 m) for assessing species composition and above- (leaf and stem) and below-ground (root and rhizomes) biomass. In addition, sediment samples were collected from select locations using a 1 m long PVC core pipe and assessed for organic carbon. Above- and below-ground biomass and organic carbon content (including the soil) were estimated for four species, namely *Halophila ovalis*, *Halodule pinifolia*, *Halodule uninervis* and *Syringodium isoetifolium*. The total organic content in the stem, leaf and root of *H. ovalis* and associated soil varied between 70.01 and 232.76 g/m² while for *H. pinifolia*, it ranged from 227.56 to 325.01 g/m². However, the carbon content associated with *H. uninervis* ranged between 10.31 and 34.60 g/m², and for *S. isoetifolium*, it ranged between 23.31 and 128.27 g/m². The organic carbon in the sediment was significantly higher than in the above-ground components of all seagrass species, indicating the efficiency of the former in storing higher levels of carbon.

Restoration of seagrass in Pulicat Lake:

Though the seagrass ecosystems provide

multiple ecosystem services, there is continuous reduction in the extent of seagrass areas globally. More productive seagrass beds are found on the southern side of Pulicat Lake, while the northern region is shallow, and mudflats are exposed during summer. A survey of these sites was carried out, and denuded patches having potential for seagrass restoration were identified near Irukkam Island on the southern side of the lake.

Seagrass restoration was carried out using square-shaped bamboo slat frames (1 m x 2.5 cm). Coconut fibre ropes were tied to the bamboo frames at a spacing of 15 cm. Sprigs of *H. ovalis*, *H. uninervis* and *H. pinifolia* were collected from production sites. About 120 seagrass sprigs were tied at each corner of the square mesh in the bamboo slat frames. Initially, 25 bamboo slat frames netted with coconut rope were used for seagrass restoration. The frames with the transplanted seagrass sprigs were placed at the bottom of the lake (at a depth of 2–3 m) near Irukkam Island (13°35'03.1"N; 80°07'34.7"E) using casuarina pegs. The community from the island was trained in the collection of seagrass sprigs, preparation of frames, transplantation and anchoring of frames.

101.3 Integrated Mangrove Fishery Farming System

Aquafarmers stocked sea bass, crabs and shrimps in the Integrated Mangrove Fishery Farming System (IMFFS) established across 50 ha in Krishna district, Andhra Pradesh. Due to the outbreak of viral diseases in the mud crabs and shrimps, farmers preferred to stock

smaller numbers in their ponds. Many farmers stocked wild juveniles of sea bass collected from the estuaries.

In Tamil Nadu, integration of sea bass culture and crab fattening in IMFFS is a major livelihood intervention introduced among tribal fisherfolk in the backwaters of the Vellar-Coleroon estuary. During the reporting period, 238 kg of fish and crabs were harvested and earned INR 158200. Despite frequent rain and flooding, 3894 mangrove saplings grew between 3–3.5 feet. Both shell and fin fish diversity were surveyed. The results show high biodiversity, with 51 species of fin fish representing 32 families and 29 species of shellfish representing 14 families. In March 2023, 26 per cent sea bass mortality was reported. Histopathology and Polymerase Chain Reaction revealed infection by a Gram-negative bacterium, *Photobacterium damsela* subsp. *Piscicida*. Infected fish were treated by dipping in potassium permanganate solution and application of topical ointments to the wound surface, thereby reducing infection within a 1-week period.

101.4 Cage Culture

During the reporting period, farmers stocked sea bass and silver pompano (*Trachinotus blochii*) in the cages. Four cages were stocked with sea bass procured from RGCA and an additional four with wild fingerlings collected from the Krishna River estuary. Two cages were stocked with silver pompano provided by the Central Marine Fisheries Research Institute (CMFRI). The farmers use thrash fish as feed for the fish grown in cages.

Sub Programme Area 102

Fish for All Research and Training Centre

102.1 Marine Fishery Resource Enhancement and Management

Voluntary code of practice for flower shrimp management: A voluntary code of practice (CoP) was co-evolved for sustainable harvesting and management of flower shrimp (*Penaeus semisulcatus*) in the Palk Bay region. A series of awareness campaigns among 412 fisherfolk from 12 villages at various landing centres was conducted to introduce the CoP. This was followed by a consultation involving key stakeholders (more than 100 fisherfolk and fishermen association leaders from the Palk Bay region) at the Village Resource Centre (VRC), Thangachimadam. Previously, a study carried out in the Palk Bay region over 2 years indicated that compared to shrimp trawl nets, the 25 mm square mesh cod-end nets were more effective at reducing bycatch. Based on this, the 25 mm cod-end square mesh was provided to 75 selected fishermen and flower shrimp trawlers, and they have agreed to share the data regarding commercial catch, that will be useful in decision making in the future.

Reclamation of marine debris through community participation: The FRTC has initiated several activities to address the issue of marine pollution and its impact along the coast; the important actions include building awareness, providing training for upcycling and promoting items made from marine

debris, and gathering evidence to bring changes in public policy. This centre is jointly working with the fisherfolk to provide solutions for ghost gears removal from the marine environment. Additionally, app-based solutions are being integrated into the already existing Fisher Friend Mobile Application (FFMA) to report spotting of ghost gears in the sea. A 'Clean Seas Campaign' was conducted in selected coastal areas over 3 years to create awareness on the importance of marine debris management. To mark International Coastal Clean-Up Day (17 September 2022), coastal clean-up drives were conducted at beaches in Rameshwaram (Sangumal beach) and Poompuhar, and nearly 764 kg of debris comprising of fishing nets, ropes, plastic water bottles, footwear and so on were collected by 115 volunteers. The debris was analyzed and baseline data recorded to draft recommendations for mitigation in the future.

Ocean observatory system for real-time data measurement: The FRTC is a network partner of the Indian National Centre for Ocean Information Services (INCOIS), based in Hyderabad, to manage and monitor ocean observation tools {wave rider buoys (WRBs) and automatic weather station} deployed in coastal areas of Tamil Nadu and Puducherry to collect real-time information on ocean status. Established shore stations with all required facilities in three districts of Tamil Nadu and Puducherry (Panithittu in Puducherry, Muttom in Kanyakumari, and Tharuvaikulam in Tuticorin), are being monitored round the clock to record real-time critical ocean parameters

(sea surface temperature and current wave height) from WRBs. Regular maintenance of WRBs is done to ensure uninterrupted data flow, which is analyzed regularly for further decision-making. The WRBs withstood the Mandous cyclone (5–9 December 2022) and continuously recorded real-time data, which helped INCOIS develop an accurate cyclone forecast for the region.

The WRB data is transferred to INCOIS at hourly intervals for validation. Validated data from INCOIS is translated, value-added and disseminated through the FRTC communication network using multiple information communication technologies (ICTs) such as FFMA and also via audio advisories, the public address system, electronic display boards and a helpline for fisherfolk. During the reporting period, 450 audio advisories were generated in the vernacular language and disseminated daily to 2279 fisherfolk, and approximately 2633 fisherfolk accessed this information through the 24-h helpline facility. A total of 92 village-level awareness meetings were conducted in which 2250 fisherfolk were educated about ocean state, early warning services and their benefits in day-to-day fishing activities.

Fisher Friend Mobile Application: Three customized new versions of the FFMA with newly added features (auto-porting of Ocean State Forecast for 1200 landing centres from INCOIS, tracking the direction of the fish net during fishing, enhanced options for entry of new fishing ground and modification of ground already stored in the application) were released

via Google Play Store. The communication portal of the FFMA was upgraded with additional features and redesigned for ease of content management. A total of 182 village-level mass campaigns were conducted in 99 fishing villages, to provide orientation on the benefits of FFMA to 8643 fisherfolk (men: 7496; women: 1147) from 10 coastal states. Moreover, another 13814 fisherfolk registered for the FFMA, bringing the overall number of registered users to 98357. Stakeholder consultations on evolving strategies for FFMA sustainability were organized in Kanyakumari, Ramanathapuram, Puducherry, Thiruvananthapuram, Machillipattinam, Kakinada, Paradeep and Ganjam districts. A total of 280 primary and secondary stakeholders from the government, community-based organizations and private institutions jointly evolved a road map for FFMA sustainability.

To promote Srikakulam as a model district in the use of FFMA in Andhra Pradesh, a memorandum of understanding (MoU) was signed with the district administration in the presence of the minister for animal husbandry and fisheries (Andhra Pradesh), district collector (Srikakulam), the director of Agri-Business Centre of Excellence and other senior officials, political leaders and fisherfolk of Srikakulam. As a result of this partnership, the Department of Fisheries has initiated an awareness campaign in fishing villages to promote FFMA use among the fisherfolk.

FFMA disseminated instant messages to fisherfolk on the movement of Mandous

cyclone through its disaster-alert features based on the cyclone bulletin from INCOIS-Indian Meteorological Department, which supported fisherfolk in taking appropriate precautionary measures. More than 15 such alert messages were disseminated and high FFMA usage was noted, with 19504 views recorded over two days in cyclone-hit districts. Disaster alert and facilitation by the team via the helpline helped seven mechanized boats with 84 crew members from the Karaikal region to safely reach the harbour. Sample case studies from 30 FFMA top users have suggested that the information was instrumental for the fisherfolk in earning a higher income of INR 27.89 lakhs and in protecting the fishing gear and crafts worth INR 12.67 lakhs during the reporting period.

To provide information about fish catch and weather conditions in the deep seas, CAbC, Wayanad promoted the use of the FFMA in the coastal regions of Ernakulam district jointly with FRTC. Four training programmes were conducted for the fishermen to familiarize them with FFMA features, uses and benefits. Currently, more than 100 fishermen from Ernakulam district are using the mobile app.

102.2 Post-Harvest Fisheries Value Chain Development and Strengthening

Standardization of value-added fish products: Value addition for small pelagic fishes such as anchovies, silver bellies and paste shrimps (*Aecetus indicus*) have been initiated to reduce both distress sales and post-harvest loss. Five value-added products

(anchovy idli powder, anchovy sambal, anchovy tomato pickle, anchovy peanut snack and paste shrimp idli powder) have been developed and standardized to help meet the daily nutritional requirements of the target age groups (1–5 years, 6–14 years, adolescents and pregnant and lactating women). Sensory evaluation, quality and packaging stability studies were conducted, and the shelf life of all products determined. Nutritional labelling was also incorporated for all products.

Studies on establishing standard drying curves for small pelagic fishes: The coast around Poompuhar shows high landing of small pelagic fishes. A drying curve study was initiated to evaluate the drying efficiency of solar dryers when combined with the conventional sun drying method for the selected pelagic fishes. The moisture removal rate (fish drying rate), humidity and temperature were recorded, and drying curves were established for anchovies, silver bellies and sardines. Biochemical and microbial parameters of sun-dried and solar dryer-dried fishes were determined to assess nutritional quality and product safety. Preliminary data suggest that the solar drying method significantly reduces drying time (30 to 40 per cent faster moisture removal) relative to sun drying and also improves shelf life, retains product quality and nutritional parameters.

My district my product – dry fish: This programme was launched in Mudasalodai fishing village, Cuddalore district, in collaboration with NABARD under the Gram Vikas Nidhi initiative, to provide scientific

knowledge through demonstration and training on the use of various models of portable baby solar dryers to ensure quality dry fish production. The installed solar dryers (medium and small) along with fish processing equipments were handed over to fisherwomen involved in dry fish production. A Food Safety and Standards Authority of India (FSSAI) registration certificate valid for 5 years has been obtained for the *Mudasalodai Kadalmuthukal Magalir Suyaudavikuzhu*. So far, 770 kg of dry fish has been produced, generating an income of INR 182000, that is two to three-fold higher than by traditional drying. Two training programmes on entrepreneurial skill development and credit system management were organized for SHGs.

Winmeen Fisher Women Federation, Poompuhar: New executive committee members were selected in the annual general body (GB) meeting of the Winmeen Fisher Women Federation (WFWF) held in December 2022. Fifty fisherwomen were newly enrolled in WFWF during the reporting period, and the total membership is 263. In the GB meeting, the advantages and disadvantages of commercialization of fish products and increasing production scale to ensure regular supply by the woman-centric fish farmer producer organization (FFPO) were discussed. Further, 25 new joint liability groups (JLGs) were formed at Vanagiri village, involving 125 fish vendors in the federation, and credit linkage was established with Tamil Nadu State Apex Fisheries Co-operative Federation Limited. A loan amount of INR 18.75 lakhs in

total was sanctioned to procure and market fish. Three fisherwomen SHGs availed a loan of INR 7 lakhs to enhance production and marketing of fish value-added products. A market linkage study was conducted to understand the requirements of the retailers, distributors and consumers of these products. An online digital marketing option is being explored for a pan-India reach.

102.3 Culture Fisheries Resource Management

Promoting Integrated Fish Farming System: Data on fish, vegetable and chicken production, self-consumption and revenue generation for 30 fish farmers under the integrated fish farming system (IFFS) during the current year is given in Table 2.

Overall, on an average, farmers earned a revenue of INR 11381 during the reporting period. During the past year, the ponds were damaged due to the extreme rainfall (44 cm in about 24 h in Sirkazhi block) in November 2022.

Portable Fish Hatchery: A portable hatchery established at FRTC (supported by Indian Council of Agriculture Research National Bureau of Fish Genetic Resources [ICAR-

NBFGR]) initially faced issues with the availability of healthy male and female brooders from natural waters and increased fungal and bacterial outbreaks. In the subsequent cycle, these issues were addressed by collecting enough indigenous, healthy and matured brooders from natural waters, which were then stocked in farm ponds. Also, regular feeding of brooders with 28 per cent protein pellet feed was initiated and a water circulation setup arranged to ensure continuous water supply throughout the breeding process. Currently, the breeding setup is fully operational, and in February 2023, 5000 fingerlings produced from the hatchery were distributed to 20 fish farmers during a visit by the director of ICAR-NBFGR to FRTC. Based on requirements put forth by fish farmers, 6250 kg of fish feed and 50 cast nets worth INR 10 lakhs were distributed under the NBFGR Scheduled Caste Sub Plan (SCSP).

102.4 Training and Outreach – FRTC

In the current year, 36 structured training programmes and 16 awareness campaigns benefiting 1045 (468 men and 577 women) fisherfolk, farmers and students were conducted by FRTC (Table 3). Among the 115 fisherwomen trained on various post-

Table 2. **Total production and revenue generation details of Integrated fish farming system (2022–2023)**

Item	Total production (kg)	Self-consumption (kg)	Sale (INR)	Revenue (INR)
Fish	1254	300	954	250830
Vegetable	200	10	190	14640
Chicken	380	79	301	75960

harvest management practices, 57 of them from six groups have started the production of quality dry fish and value-added products, generating an income of INR 57350. Six training programmes on the culture of Indian major carp and breeding methods have increased the area under fish farming from 8.88 to 11.76 ha. These trainings supported the farmers to reduce mortality rate, control diseases and boost the survival and growth rates of Indian major carp.

Thirty-three master fisherfolk and fisheries officials nominated by the district administration at Srikakulam district visited FRTC in August 2022 and received hands-on training in fish processing, post-harvest and sustainable fishing technologies. In March 2023, 19 fisherwomen from Kerala visited FRTC for a two-day training on post-harvest management, fish processing, hygienic dry fish production and value addition.

Village resource centres and village knowledge centres: In the current year, VRC and village knowledge centre (VKC)

were accessed by 1310 members at Poompuhar (men: 218; women: 235), Thangachimadam (men: 174; women: 164) and Panithittu (men: 284; women: 235). One hundred and thirty-one information modules on health, education, government programmes and employment opportunities were disseminated through notice boards, the public address system and WhatsApp groups. Five ICT-based awareness programmes were organised for 240 women focusing on women's health, education, livelihood opportunities and nutrition. An online consultation on 'Issues, Challenges, and Opportunities for Women in Small-Scale Fisheries' organised on World Fisheries Day, November 2022, was attended by 133 fishers. On this occasion, women involved in small-scale fisheries: as producers, head loaders, backwater fisherwomen, seaweed collectors, shore seine operators, dry fish producers and salt pan workers shared their occupational challenges. Experts offered solutions to issues raised by fisherwomen. A needs assessment was

Table 3. List of training programmes organized by FRTC (2022–2023)

S. no.	Training topics	No. of programmes	Participants		
			Men	Women	Total
1	Marine biodiversity conservation and sustainable fisheries	8	125	305	430
2	Square mesh for responsible fishing	5	113	30	143
3	Culture of Indian major carp and its breeding methods	6	79	8	87
4	Post-harvest management	8	11	183	194
5	Sea bass nursery and cage farming	2	9	21	30
6	Disease management in mud crab	1	6	17	23
7	Improving feeding efficiency in Indian major carp	1	4	13	17
8	Sea safety navigation and Global Positioning System (GPS)	5	121	0	121
Total		36	468	577	1045

carried out with 51 women seaweed collectors from the Chinnapalam and Pampan villages of Ramanathapuram district to provide demand driven knowledge services.

Cluster-Based Business Organization: The FRTC was recognized as a 'Cluster-Based Business Organization' (CBBO) under the Central Sector Scheme of NFDB, Ministry of Fisheries, Government of India, to promote three fish farmers producer organizations in Mayiladuthurai and Nagapattinam districts of Tamil Nadu, and in Puducherry. The baseline survey, staff orientation, cluster identification, awareness meetings and appointment of the Board of Directors were completed.

Awareness on the use of fortified salt: Awareness programmes were organised among 2123 individuals (men: 88; women: 2035) on the use of fortified salts to address iron and iodine micro-nutrient deficiencies. A documentary on the benefits of using fortified salt was screened, 37500 kg of fortified salt was distributed to 4650 households in nine hamlets.

Sub Programme Area 103

Remote Sensing and Geographical Information Systems

103.1 GIS-based Pest Forewarning and Yield Forecasting

Forewarning for pests: The Pest-Disease Advance Notification and Need-Based

Agriculture Information (PANNAI) application has been extended to 100 farmers in Pudukottai district, Tamil Nadu. Further, it is planned to scale-up to 2000 farmers in Pudukottai and Nagapattinam districts.

Yield forecasting: A study has been carried out to assess the grain yield of paddy in Meeratunillai and Onagudi villages of Pudukottai district, using synthetic aperture radar (SAR) data. The study revealed that the yield of paddy is approximately 25 kg/100 sq.m suggesting 88 per cent accuracy in measurement in comparison with the average yield of crops in Tamil Nadu in 2021. This model has the potential for replication in other areas, provided there is sufficient ground reference data available for assessing crop yield.

103.2 Quantification of Above-Ground Biomass Using Google Earth Engine

A study has been conducted to assess the above-ground biomass (AGB), spatial and temporal changes and impact of afforestation in Auroville city (Viluppuram district) over the past five decades using the Google Earth Engine cloud computing platform and machine learning (ML) algorithm in partnership with support from Google and Indian Institute of Technology-Tirupati. Remote sensing images from Global Ecosystem Dynamics Investigation (GEDI), Landsat/Sentinel, Phased Array L-Band Synthetic Aperture Radar (PALSAR), along with ML modelling algorithms were used to analyse vegetation indices, forest structure and AGB. Also, the

classification techniques were employed to understand the landscape composition.

103.3 Mangrove Community Zonation and Biophysical Characterization of the Tamil Nadu and Puducherry Coasts

Mangrove community zonation maps of the Tamil Nadu coast were prepared using Linear Imaging Self-Scanning Sensor (LISS IV) satellite imagery, covering about 5400 ha of mangroves across Tamil Nadu and Puducherry for updating the National Mangrove Atlas 2008. The study showed that there has been an increase of approximately 1400 ha in mangrove cover between 2008 and 2018 in Tamil Nadu. This increase in the extent of mangroves can be attributed to natural regeneration as well as to the restoration of degraded mangroves due to the joint efforts of the Tamil Nadu State Forest Department and MSSRF. This updated mangrove atlas will provide valuable information to policymakers and forest managers for effective management of the mangrove ecosystem in Tamil Nadu and Puducherry.

103.4 Vulnerability Assessment and Impact of Sea-Level Rise

A vulnerability assessment was carried out in the Muthupet mangrove wetland (Tamil Nadu), comprising an area of about 370 sq km, using multicriteria analysis to assess the health of the mangrove ecosystem and the potential impact of climate change. Various thematic layers, including sea-level rise, land use/land cover, slope, temperature and precipitation

were used for analysis. The overall data suggest that approximately 29.03 sq km of mangrove wetland are highly vulnerable and 173.28 sq km are moderately vulnerable.

Similar vulnerability assessment of coastal areas in Kakinada and B. R. Ambedkar Konaseema districts (Andhra Pradesh) was carried out using Landsat satellite images for the years 1990, 2000, 2010 and 2020. Digital elevation model (DEM) was derived from Shuttle Radar Topography Mission (SRTM) at 30 m resolution using Earth Resources Data Analysis System (ERDAS) software. The potential areas for inundation by seawater were identified from SRTM by computing the predicted rise in sea level at 0.5, 1.0 and 2.0 m using the bath-tub method. The simulated DEM maps showed that substantial areas will be inundated by the predicted sea-level rise (Table 4).

Table 4. *Predicted sea-level rise in Kakinada and B. R. Ambedkar Konaseema districts of Andhra Pradesh*

S. no.	Predicted sea-level rise (m)	Area of inundation (sq km)
1	0.50	23.79
2	1.0	30.05
3	2.0	39.59

The total length of the shoreline of these two districts is about 226 km. Of this, about 103 km is currently showing erosion and about 123 km is under accretion. Within the eroding coast, a length of about 32.7 km is highly affected and in regions with accretion, about 10.6 km show a higher accretion rate (Fig. 2).

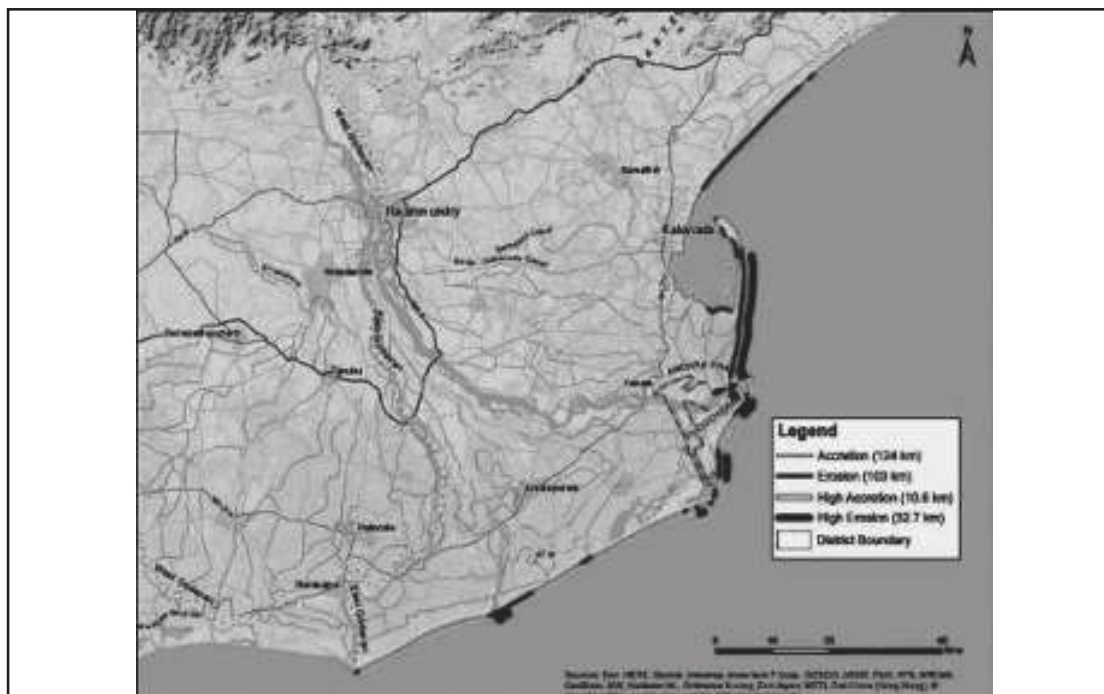


Figure. 2. *Mapping of erosion and accretion in the coasts of Kakinada and B. R. Ambedkar Konaseema districts.*

103.5 Identification of Suitable Areas for Seagrass and Mangrove Restoration at Pulicat Lake, Andhra Pradesh

Suitable restoration sites for seagrass and mangroves were mapped using a combination of underwater cameras, global positioning system–based surveys and remote sensing techniques. The study potentially identified an area of 150 ha for seagrass restoration and 80 ha for mangrove restoration within the defined study area.

103.6 Water Security and Climate Adaptation in Rural India: GIS Component

Phase two of the Water Security and Climate Adaptation (WASCA) project was launched in

Dharmapuri to prepare Gram Panchayat (GP) based planning in nine districts in four states (Tamil Nadu, Kerala, Andhra Pradesh and Telangana) and Union Territory of Andaman Islands.

The thematic maps on land use/land cover, lineament, soil erosion, salt-affected areas, geology and geomorphology were collected from state agencies and Bhuvan (Indian Geo-platform of Indian Space Research Organization) for spatial analysis along with a set of non-spatial data. Capacity building for GIS plan preparation has commenced in the specified project districts, where officials are being trained to collect primary and secondary data and prepare GIS-based work plans

under the Mahatma Gandhi National Rural Employment Guarantee Act (MGNERGA). An action plan has been developed for piloting in the GPs within the specified study areas with the support of district officials. The detailed report on this initiative is available in section 402.3 of this Annual Report.

In addition, a study was conducted to assess water availability in the Nallavur sub-basin in Villupuram district using the SWAT (Soil & Water Assessment Tool) hydrological model combined with remote sensing.

Rainfall volume estimated was 48,341 ha-m, of which the expected surface runoff 17,496 ha-m (34 per cent of average annual precipitation). The groundwater availability and evapotranspiration were 4 and 31 per cent respectively. Other water losses include lateral flow, revamp from the aquifer, drinking water, industrial uses, etc that constitute 31 per cent of total precipitation. The estimated water availability in the catchment was 3268 ha-m, which is 6 per cent of total annual rainfall volume.

Key highlights

- Mangrove plantations restored in an additional area of 20 ha at three new locations in Tamil Nadu and 10 ha of non-mangrove plantation in Andhra Pradesh.
- Restoration of seagrass has been initiated in a pilot scale at Pulicat Lake.
- 13814 fisherfolk registered in FFMA, bringing the overall number of registered users to 98357 fishers.
- Vulnerability maps for sea-level rise using remote sensing data are developed in two coastal districts of Andhra Pradesh.

BIODIVERSITY

The Biodiversity programme continued its focus on the conservation of natural resources with the participation of local communities, thereby enhancing sustainable livelihoods in three biodiversity hotspots. In Kolli Hills, promotion of agroforestry and millets has been taken up with the objective of increasing income, enhancing nutrition, ensuring livelihoods and sustainability of the environment among Malayali tribal farm families. The Biju Patnaik Tribal Agrobiodiversity Centre (BPTAbC) focussed on Bio-village development activities by promoting millets cultivation, seed production in millets and paddy landraces, production and marketing of value-added products from rice and millets and ex-situ conservation of medicinal plant diversity of Eastern Ghats. The community agro-biodiversity conservation activities in Community Agrobiodiversity Centre (CAbC), Wayanad are categorized under three major subheads: conservation of agro-biodiversity; conservation of rare, endangered and threatened plant species, outreach programmes of the M.S. Swaminathan Botanic Garden; and soil and water conservation programmes.

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Sub Programme Area 201

Community Conservation Programme at Kolli Hills

The Community Conservation Programme involves active participation and engagement of local communities in *in-situ* conservation efforts. The programme focuses on biodiversity conservation, sustainable resource management, community empowerment and livelihood enhancement. The Community Conservation Centre promoted a multistorey agroforestry system with horticulture crops, trees and small millet, with the objectives of enhancing the nutrition status of tribal families, increasing income, ensuring livelihoods and sustainability of the environment.

201.1 Integrated Tribal Livelihood Enhancement through Agroforestry

Integrated tribal livelihood improvement activities have been progressing in Kolli Hills among 500 select tribal households. Major activities carried out during the year included the promotion of bio-inputs and organic manure use, procurement and distribution of tree saplings, need-based training on basin formation and weeding, mulching, neem cake and neem oil application and life-saving irrigation.

This year, 24540 saplings of main tree crops (jack, mango and acid lime), 3800 saplings of nutri-dense plants (sapota, pomegranate, amla and guava), 26088 and 1.89 lakh saplings of border trees/crops such as silver oak and

Cumbu napier (CO4) slips, respectively, were planted by 500 tribal farm families in their Wadi farms. About 900 metric tonnes of farmyard manure, 12 metric tonnes of neem cake and 500 litres of neem oil were applied by Wadi farmers on 500 acres for improving soil health and managing pests and diseases. In addition, farmers were provided hands-on training on the application of bio-fertilizers, bio-pesticides and bio-fungicides. As a follow-up, they applied bio-inputs such as Azospirillum (250 kg), Azotobacter (250 kg), phosphobacteria (500 kg) and potash mobilizers (500 kg) in the 500 acres of Wadi farms.

The centre also organized awareness programmes on health, nutrition, the use of energy-efficient cooking stoves, the importance of nutrigardens in increasing dietary diversity. Millet, pineapple, banana and cassava were intercropped in the agroforestry system. Basin formation and weeding, fertilizer application, spraying and irrigation in this multicropping system generated over 12000-labour days of work.

Assessment of the survival rates of saplings indicates that farmers were able to maintain a higher survival rate (82.14 per cent in jackfruit, 81 per cent in mango and 81.86 per cent in acid lime) by adopting good management practices. Vegetables such as brinjal, radish, chilli and tomato grown in the north cluster of Kolli Hills as intercrop over 12 ha is generating an additional income. So far, 250 kg of brinjal, 530 kg of radish, 180 kg of chilli and 400 kg of tomato have been harvested. Finger millet is also promoted as inter-crop in the Wadi

farms to ensure household food and nutrition security. About 145 families followed the intercropping method in the Wadi covering over 17.20 ha and producing 21.5 tonnes of millets. One hundred energy-efficient cooking stoves were distributed to participants for drudgery reduction and to reduce air pollution. A home garden with six varieties of vegetables was established among the 500 Wadi farm families to cultivate diverse vegetables to meet their household requirement. Pepper and coffee seedlings were raised in the south (Arasampatti) and north (Melpusanikuli) clusters; 1.5 lakh pepper cuttings were marketed at the rate of INR 10 per cutting and 5000 coffee seedlings at the rate of INR 8 per seedling.

201.2 Promoting Millet Farmer Facilitators

The key components of a farmer-led extension strategy in millet-based farming systems are farmer-to-farmer knowledge exchange, participatory research and experimentation, farmer-led innovations, farmer field days as knowledge sharing events, capacity building and training, along with access to quality inputs and services, advocacy and policy support. The main objectives of the project are to identify millet farmer facilitators (MFFs) and create fellow farmers' groups to assess the effectiveness of their extension services in hilly and tribal areas. The project has been implemented in two locations: Kolli Hills in Tamil Nadu and Koraput in Odisha. Millet farmers from a few villages were selected based on their knowledge on millet cultivation and farming methods, mobilization skills, and

willingness to take up lead roles in the adoption and dissemination of novel methods and technology, and agricultural activities. Equal opportunities were given to both men and women farmers during the selection process.

Capacity-building and training programmes were organized on the use of mobile applications for marketing millets, enhancing leadership qualities, building linkages and using social media, which empowered the MFFs to function effectively in the field. In Kolli Hills, MFFs and group members were provided with 500 kg of millet seeds from seed banks for on-farm demonstrations. One hundred participatory trials were taken up with the following treatments: (i) improved practices (line sowing) versus farmer's practice (broadcasting) covering 15 ha (55 demonstrations); (ii) improved variety versus traditional variety covering 6 ha (25 demonstrations); and (iii) intercropping in 5 ha (20 demonstrations) covering a total area of 26 ha. Field-based enterprises were diversified by integrating apiary and backyard dairy, among select families. Farm families with milch animals obtained an average milk yield of 1350 litres of milk per year, which gave an additional income of INR 26400/year/family. Twenty beehive boxes along with bees were provided to 20 millet farmers, which generated an additional income of INR 1600 quarterly.

The establishment of two primary processing units of millets catered to the demands of 17 small settlements. Perumalsamy Millet Producer Group earned INR 48000 and Palapadi Millet Producer Group earned a net

income of INR 46500 between April 2022 to March 2023. MFFs organized a field day at Palapadi and Keeraikadu villages in a millet demonstration field. Sixty-five farmers participated (men: 29; women: 36) and shared their understanding of improved agronomic practices and reasons for yield differences between broadcasting and line transplanting methods (25 cm x 15 cm), and also between the cultivation of *Surutai kelvaraku* and CO 15 finger millet varieties.

201.3 Strengthening Groundnut Cultivation and Farmer Producer Organizations in Namakkal District

This project aimed to study issues related to groundnut cultivation and its potential among farmer-producer organizations (FPOs) in Namakkal district, one of the major groundnut-producing districts in Tamil Nadu. The study found that groundnut farmers faced several challenges such as low and unseasonal rainfall, poor soil fertility, increasing disease and pest attacks, low productivity, poor market access, increasing input costs, lack of access to credit from the formal sector, price fluctuations, middlemen exploitation and lack of market information. These challenges negatively impacted the area under cultivation of groundnut and the livelihoods of the farmers who cultivated it. To overcome these challenges, farmers were trained to adopt a range of improved agronomic practices to enhance productivity. This included the use of high-yielding varieties GIRNAR 4 and GIRNAR 5, seed treatment with bijamritham, and balanced nutrient management practices

with the use of macro, secondary and micronutrients to meet the specific needs of crops at different growth stages.

FPOs in Namakkal: The centre is providing handholding support to six FPOs in Namakkal district. The number of shareholders ranges between 500 and 1200. These FPOs support farmers in producing and procuring crops such as groundnut, gingelly, castor, maize and coconut. They are also involved in the direct marketing of edible oil, cane sugar, oil seeds, green gram and coconut. Nainamalai Farmers Producer Company coordinates with 50 producer groups with 700 members (400 groundnut-producing members and 300 non-FPO members). During the reporting period, the FPO marketed 8 tonnes of groundnut, 1.5 tonnes of gingelly and 0.5 tonnes of coconut. The share capital of the FPO was INR 12 lakhs and the turnover of the company in 2021–22 was INR 85 lakhs. This FPO owns an oil mill for value addition of groundnut, gingelly and coconut, and was involved in marketing of groundnut, gingelly, coconut oil, jaggery powder, green gram, black gram and Kolli Hills spices.

201.4 Millet Festival cum Seminar

A millet festival cum seminar was organized at Namakkal district with the support of the Indian Institute of Millet Research, Hyderabad, to raise awareness on the importance of millet consumption among a wide range of stakeholders. The deliberations focused on millet diversity, crop improvement and a package of practices, post-harvest processing, nutrition, value addition and marketing of

millet. An exhibition was also organized to showcase diversity in millets, value-added millet products and their nutritional benefits.

201.5 Co-designing of Collective Action on Forgotten Foods

A stakeholder consultation was organized over two days in January 2023 at Namakkal, Tamil Nadu. The objectives of the consultation were: (i) cataloguing forgotten foods (FF) (based on the priorities of farmers) and their consumption; (ii) documenting innovations developed through joint research by farmers and researchers; (iii) exploring the scope for value addition and creating market linkages for FF/neglected and underutilized spices; and (iv) understanding the scope for advocacy and policy influencing and campaigning to create an enabling policy environment to promote underutilized species. Throughout the consultation process, stakeholders from diverse backgrounds and sectors shared their insights, expertise and perspectives on underutilized species. The consultation emphasized inclusivity and collaboration among stakeholders. Through the stakeholder consultation, a comprehensive list of underutilized and traditional crops and food sources was compiled. These FF are well-known for their nutritional value, climate resilience, cultural significance and potential for enhancing livelihoods through value addition. This consultation recommended establishing a consortium involving governments, research institutions, farmer organizations and the private sector for creating an enabling environment for promoting FF crops.

201.6 Kolli Hills Agri-Bioresource Producer Company Limited (KHABPCOL)

The major objective of the Kolli Hills Agri-Bioresource Producer Company Limited (KHABPCOL) is to facilitate access to financial and non-financial support such as bank linkages, commodity marketing, value-added product development and marketing, and thereby strengthening the local economy. KHABPCOL has 583 small and marginal tribal farmers as shareholders. Under KHABPCOL, a rural mart is established to market pepper, clove, small millets, diverse fruits and groceries. During the year, 6 tonnes of pepper, 12 tonnes of small millet, 50 kg of clove, 11 tonnes of cashew nut and 25.25 tonnes of coffee were procured from 325 members and marketed through the rural mart. The annual turnover of KHABPCOL was INR 66.60 lakh in 2022–23, with a net profit of INR 2 lakh.

KHABPCOL in partnership with Large Area Multi-Purpose (LAMP) Society, introduced millets in the Public Distribution system for the first time in Tamil Nadu. This provides new avenues and opportunities for millet farmers to sell millet at a better price.

Sub Programme Area 202

Biju Patnaik Tribal Agrobiodiversity Centre, MSSRF, Jeypore

Promotion of millet cultivation under the Odisha Millet Mission (OMM), production of quality seeds of millet and paddy following

alternative system model and value-added products, integrated farming system, promotion of Bio-villages, enhancement of sustainable livelihoods through empowering tribal women, DBT KISAN Hub and awareness on biodiversity conservation were some of the major activities undertaken during the year 2022–2023.

202.1 Promotion Of Millet Through Odisha Millet Mission

The Government of Odisha extended support for the second phase of OMM (2022–23 to 2026–27) to promote improved agronomic practices for enhancing the cultivation of finger millet, little millet, sorghum and foxtail millet. This programme linked 1055 farmers from 66 villages across 13 Gram panchayats (GPs) and revived 671.4 ha under millet cultivation in the Kundra block of Koraput district.

During the reporting period, 17 training programmes were conducted on the system of millet intensification (SMI), line transplantation (LT), good agronomic practices, preparation and application of organic inputs and management of seed centres by reaching out to 368 farmers (men: 192; women: 176). Ten awareness campaigns on the conservation, cultivation and consumption of millet were organized. Finger millet was procured from 5850 households in 66 villages across 13 Gram Panchayats (GP) by facilitating registration through *mandi* (market yard). A harvest festival was organized to create awareness on the importance the barnyard millet and the conservation of landraces of

millet. Two land races were promoted under this demonstration.

The centre assisted 1055 farmers in accessing government subsidies worth INR 53.23 lakhs to adopt improved farming practices in millets. The centre also linked 916 farmers with local *mandis* and marketed 1452.2 tonnes of finger millet at the rate of INR 35.78/kg.

Bamandei Producer Company Ltd (BPCL), formed in 2019, has 642 shareholders with a total share capital of INR 2 lakhs. The BPCL has supported farmers in registering for M passes to procure finger millet in Kundra block for the past two years. This FPO received INR 9.77 lakhs as hosting charges for undertaking the activity, for the FY 2022–2023.

202.2 Every Village a Bio-Village Programme

Every Village a Bio-Village programme aims to achieve United Nations Sustainable Development Goals 1–8 and 12–15, with a specific focus on goal number 2, that is 'Zero Hunger'. The project has been implemented in twenty villages, organized into a cluster in Boipariguda and Kundra blocks of Koraput district. The specific interventions are the promotion of sustainable farming systems, nutrition gardens, integrated farming systems and also on- and off-farm activities.

Organic method of cultivation was demonstrated using indigenous landraces of paddy, (Bashanti, Raghusai, Hatidanta, Kalajeera, Machhakanta, Umuriachudi and Muktabali), involving 121 farmers over

24.6 ha. In addition, high-yielding varieties (HYVs), namely MTU-1001, 1153 and 1156 and Sahabhazi, were also demonstrated with 95 farmers covering an area of 28 ha during Kharif 2022. To encourage organic agricultural practices, preparation of organic inputs such as enriched farmyard manure (97 units), vermicompost pits (100 units), low-cost vermi beds (150 units), azolla (50 units) and organic formulations (38 units) such as (Jeevamruta, Amritjal, Handikhata, Neemastra) were promoted among farmers and to ensure the availability of quality inputs at low cost. The average grain yield for landraces was 3.35 tonnes/ha and the net return was INR 0.68 lakh/ha. Specifically for the aromatic rice variety Kalajeera, the average grain yield was 3.21 tonnes/ha with a net return of INR 1.12 lakh/ha recorded. In HYVs, the average yield was 4.99 tonnes/ha with a net return of INR 1.02 lakh/ha.

The demonstration of SMI and LT methods of cultivation using indigenous finger millet landraces, namely Bhalu mandia, Telugu mandia, Jam mandia and Bati mandia, along with two improved varieties KMR-204 and Arjun is being taken up over an area of 17.20 ha involving 75 farmers. Due to adoption of improved practices a 47.11 per cent higher yield was recorded compared to the earlier practices with an average benefit-to-cost ratio of 2.52.

Freshwater aquaculture activity was initiated in ten farmers' ponds in a participatory mode covering an area of 2.72 ha in the first week of September 2022. About 23000 fingerlings of catla, rohu and mrigal varieties of fish were

reared as a composite pisciculture. A total of 1210 kg of fish were harvested till April 2023. Four hundred and eighty kg was consumption or distributed to neighbours and relatives and the remaining 730 kg sold within the village at an average rate of INR 180/kg with a gross benefit of INR 1.31 lakhs.

The Nutrition Garden model is promoted because of the prevailing high malnutrition in the and low intake of plant-based diversified food. Fifteen model nutrition gardens (Swaminathan Poshan Bagicha) were demonstrated at individual household levels with an average land area of 0.04 ha in eight operational villages. The average yield per garden per household was 350 kg per year. Of this, the average household consumption was around 95 kg, the average sale of the marketable surplus was 150 kg and a gross income of INR 5323 was realised from each garden per year. Training and demonstrations were organized to build the capacity of 26 women SHGs members (average of 10 members/group), who were involved in income-generation activities through oyster and straw mushroom cultivation. The mushroom cultivation units harvested 810 kg of oyster mushrooms from 350 beds and earned a total income of INR 1.21 lakhs by selling surplus after home consumption. Thirteen farmers were involved in large-scale vegetable cultivation on 5.52 ha of land in a cluster approach. They harvested 14.40 tonnes of vegetables and received a total benefit of INR 4.03 lakhs.

To address the drudgery of women in millet processing, five millet pulverizers and rice

hulling mills each were provided to one SHGs in five villages. Over 95 per cent of households are accessing this facility and saving time and energy. The time saved, at least 2 hours per day, was utilized for other household and care work. Twenty custom hiring centres (CHCs) were also set up in 20 villages, creating timely access to farm machinery as a common asset to the respective village communities. Farm machinery available in the CHCs are winnowers (both power and manual), markers, sprayers, iron ploughs, cycle weeders, cono weeders, threshers, water pumps, sickles, drums, tubs and mats.

202.3 Quality Seed Production for Indigenous Varieties Paddy and Finger Millet

The regional office of MSSRF Jeypore in Koraput district was recognized as a Centre of Excellence (CoE) by the Ministry of Tribal Affairs, Government of India, in September 2021, with a focus on the conservation of landraces of paddy and finger millet. The project is operational in 23 tribal-dominated villages under two clusters, that is, Kundra and Boipariguda blocks. This covers 1190 households, out of which 971 belong to the schedule tribe (ST) category, 159 to the schedule caste (SC) category and 60 others.

Around 42 landraces of paddy, 16 landraces of finger millet and 5 varieties of other minor millets were collected from Rayagada, Malkangiri, Koraput and Nabarangpur districts. Varietal trials were conducted for both paddy and finger millet landraces during Kharif

2022. Eleven promising rice landraces were demonstrated in a farmer's field to observe the characteristics and performance of varieties by adopting DUS (Distinctness, Uniformity and Stability) standards. On Farmer's Field Day, of the 11 landraces demonstrated, the farmers chose Bashanti, Kudeichudi, Muktabali, Kalajeera, Raghusai, Machhakanta and Umuriachudi as their variety of choices based on various characters and perceptions. Similarly, 13 potential finger millet landraces were demonstrated as having high-quality agronomic parameters and better performance, and farmers selected Bhalu mandia, Telugu mandia, Jam mandia and Bati mandia as suitable varieties.

To demonstrate quality seed production, 112 demonstrations for paddy covering 21.60 ha and 110 demonstrations for finger millet covering 22 ha were conducted with the participation of 444 farmers during the Kharif season 2022. Sustainable agricultural practices such as integrated nutrient management (INM), integrated pest management (IPM) and integrated disease management (IDM) practices were adopted. The farmers also followed improved agricultural technologies such as SMI, LT and plot transplanting (PT). As a result, finger millet landrace Jam mandia recorded the highest yield (3.04 tonnes/ha) followed by Bati mandia (2.90 tonnes/ha), Bhalu mandia (2.68 tonnes/ha) and Telugu mandia (2.10 tonnes/ha).

Training programmes were organized for 570 farmers (men: 441; women: 129) on good agronomic practices, seed production technologies, SMI, LT, agronomic practices

such as INM, IPM and IDM, pre-and post-harvest technologies, preparation and application of organic formulations, seed treatment technology, use of cycle weeder, cono weeder, winnower and sprayer, and marketing of millets.

202.4 Crop Diversification Programme under Mega Lift Irrigation

Crop diversification was proposed as a strategy to overcome issues related to climate change, eroding soil fertility and malnutrition and reduced farm income. Paddy was the predominant crop, and to diversify to other crops, awareness was generated and training given to 916 farmers. It covered 818.93 ha of land in total; specifically, 524 farmers cultivated maize in 577 ha, 164 farmers cultivated finger millet in 128 ha, 54 farmers cultivated black gram in 38.48 ha, 39 farmers cultivated horse gram in 29.45 ha, 8 farmers cultivated niger in 6 ha, and 125 farmers cultivated different types of vegetables in 40 ha. Due to the crop diversification programme, the area under non-paddy crops has increased and farmers' income has also increased by 29.57 per cent.

Farmers have started to diversify to crops other than paddy as they received higher returns with other crops when compared with paddy. For example, maize-growing farmers harvested 5.6 tonnes/ha and received an incentive of INR 4500/ha from the government. Similarly, an incentive for the cultivation of finger millet was INR 4500/ha, INR 7000/ha for black gram, INR 2500/ha for horse gram and INR 15000/ha for vegetables.

202.5 Capacity-Building Programmes on Biodiversity Conservation

The centre conducted training and capacity-building programmes over two days in April 2022 to empower 113 Biodiversity Management Committee (BMC) members. The programme examined the status and threats to biodiversity in the Koraput region, conservation strategies, status and scope of non-timber forest produce, and community participation in forest fire control among others. Awareness programmes on the Odisha Forest Act, 1972, and Wildlife Protection Act, 1972 were organised. The centre was instrumental in drawing the attention of the Odisha Biodiversity Board on taking the necessary steps to declare Gupteswar and Deomali in Koraput district as Biodiversity Heritage Sites.

Sub Programme Area 203

Community Agro-biodiversity Centre, Wayanad

The biodiversity conservation activities of CAbC are categorized under three heads: (1) conservation of agro-biodiversity; (2) conservation of rare, endangered and threatened (RET) plant species, including outreach programmes of the M.S. Swaminathan Botanical Garden (MSSBG); and (3) soil and water conservation programmes.

The Community Agrobiodiversity Centre (CAbC) commemorated its 25th year of existence (silver jubilee) on 5–6 June 2022 by

organizing an 'International Consultation on Biodiversity, Climate Change and Adaptation'. During the workshop, the ongoing efforts of the CAbC in conserving agro-biodiversity were reviewed for strengthening ongoing activities on climate change and addressing malnutrition. The workshop also discussed the major milestones achieved by CAbC in the areas of rice genetic diversity conservation and sustainable utilization of medicinal plant wealth in the country was discussed.

203.1 Biodiversity Conservation

The centre initiated a short course on biodiversity, targeting students interested in understanding the current status of biodiversity including agro-biodiversity, conservation strategies, legal aspects of biodiversity, the link between cultural diversity and biodiversity, and ecosystem services among others. The course was designed as a 7-day residential programme at the graduate level.

During this reporting period, under the exploration of new species, two new angiosperms species, *Ixora lavanya* and *Christisonia flavirubens*, were identified from the Kerala section of southern Western Ghats. To conserve valuable plant genetic resources of the Western Ghats, CAbC has established the MSSBG with a vast germplasm collection of both cultivated and wild species of tubers, pulses, spices and bananas. MSSBG is maintaining germplasms of wild *Dioscorea* (9 species), traditional *Dioscorea* (40 varieties), *Colocasias* and *Alocasia* spp. (9 varieties), traditional turmeric (9 varieties), wild turmeric (4 species), wild pepper (5 species) and

cowpea (20 varieties). Over two decades 190 RET species, including herbs, shrubs, climbers and trees, across various parts of the Western Ghats have been conserved.

For the conservation of cultivated plant species/crop varieties, CAbC has adopted the 'seed village' approach for producing and distributing quality seeds of rice and pulses by adopting a participatory approach. Thirty such seed villages were established and supported to strengthen the existing informal seed systems. The establishment of Community Conservation Plots (CCPs) is another method to promote the participatory conservation of tubers and vegetable crops. The CCP at Kaniyambetta village is also maintained for on-farm conservation of ten traditional rice varieties, that is, *Adukkan*, *Chennellu*, *Chenthadi*, *Veliyan*, *Jeerakashala*, *Gandhakashala*, *Mullankaima*, *Kalladiaran*, *Chomala* and *Thondi*.

The Community Seed Fest is an annual event organized by MSSRF for creating awareness about quality seeds, creating a platform for sharing knowledge and information between farmers, exchanging seeds and attracting the attention of government officials and policymakers for creating an enabling environment for participatory seed systems. This year, over 5000 farmers attended the seed fest and talked about the challenges they face in both farming and marketing of their produce. As part of the community seed fest, MSSRF recognized the farmers conserving valuable plant genetic resources of agricultural, medicinal and nutritional

importance. This year, a team of experts visited the farmers' fields and assessed the diversity maintained on their farms. Three tribal farm families (Sri Balan Nellarachal, Sri Achappan Kottonada and Sri Ayyappan Pilakkavu) and a women's group were recognized for their contribution to the conservation of genetic resources. Special recognition was awarded to Padma Shri Cheruvayal Raman for conserving over 50 traditional landraces of rice varieties in Wayanad.

A bio-systematic study of selected species with high gum, resin and oil value, that are native to the Kerala section of the Western Ghats, has been completed. This study has mapped the distribution of nine select RET trees of commercial importance in the Kerala section of the Western Ghats, documented their phenological shifts (Fig. 1), assessed the quantity of economically important phytochemicals present in them and re-assessed their threat status based on IUCN criteria. Conservation efforts for these species

have been reprioritized based on the threat class under which the species fall.

The CAbC observed World Environment Day 2022, and also commemorated the 25th year celebration of CAbC by planting 50 seedlings of 15 species of RET trees from Western Ghats. A garden is being developed on the campus of a private medical college in Wayanad under the supervision of the MSSBG team with an *ex-situ* collection of 23 RET species of medicinal plants. A total of 23293 quality seedlings of medicinal, RET and ornamental species were multiplied in the MSSBG plant nursery, and revenue of INR 5.38 lakhs was generated through the sale of 12457 seedlings. An analysis revealed that RET plant seedlings are the most sought-after segment with stakeholders showing strong awareness and interest in protecting the rare plant species; this also reflects growing public awareness about this sector. Furthermore, the sale of a significant quantity of seedlings and the corresponding income highlights

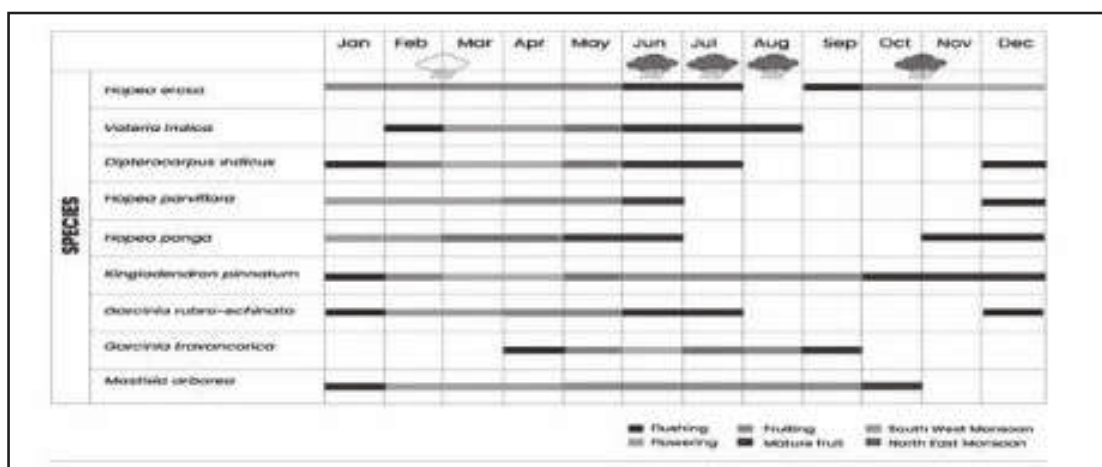


Fig. 1. Phenological calendar of species.

the sustained demand for medicinal plants among the farming community and the growing interest in seeking natural remedies, health benefits and traditional medicinal practices. During the reporting period, the MSSBG garden team received 1523 visitors, mainly college students from 44 institutions, and generated a revenue of INR 77710.

Depletion of mangrove forests along the western coast of India is a matter of concern. A participatory mangroves conservation programme has been initiated on Vypin Island, Ernakulum district; this programme aims to assess suitable locations for restoration, develop a local nursery and planting mangroves with the participation of local communities and other stakeholders.

Restoration of Pokkali Rice Cultivation: Pokkali rice is cultivated via a unique cropping system adopted in salinity-affected soils in coastal regions of Kerala. It is a community-based adaptation measure to cope with salinity and ensure food production while supporting the conservation of important flora and fauna associated with Pokkali rice fields. However, due to various reasons, including unattractive profits, farmers hesitate to engage in Pokkali cultivation. Considering the ecological importance of this cropping system, CAbC restored Pokkali cultivation in 80 ha by providing technical and material support for farmers during the reporting period. In the fallow season shrimps are reared in the Pokkali fields providing additional income while also reducing soil salinity.

To strengthen the resilience of ecosystems, and as part of a carbon-neutral initiative, the centre was involved in enhancing the tree cover by planting 750 fruit trees, over 6900 saplings of indigenous pepper and 300 saplings of nutmeg in 300 farms. Moreover, 2000 fruit seedlings were also planted on public lands and schools.

Building Climate-Resilient Socio-ecological Production Landscapes: To empower communities and impart knowledge and skills in the areas of climate change mitigation, adaptation and disaster preparedness at the local level, a programme focused on the socio-ecological production landscapes (SEPLs) and carbon neutrality was initiated in four GPs in Wayanad district, representing three different agroecological zones. The programme aimed at collecting data for vulnerability assessment, mapping flood and drought-prone areas, enhancing knowledge of farmers on rainfall patterns and increasing temperature, the coping mechanism adopted by them in addressing climate change-induced changes in soil and water conservation and ecosystem degradation, documenting best practices in climate adaptation and so on. The goals of the initiative are: (1) to develop a database on climate and ecosystem vulnerability information and adaptation strategies; and (2) to identify low carbon strategies, including biodiversity-friendly technologies and practices that can be implemented at the local level.

Soil and Water Conservation Programmes: The centre initiated a soil conservation programme to improve soil quality, arrest soil

deterioration and improve water resources in two low-rainfall locations in Wayanad district (Pannikkal and Chettipambra watersheds at Pulpally GP) over 300 ha in each site. A total of 512 farm families directly benefited from soil and water conservation activities. Construction of 1094 m³ earthen bund at Chettipambra and 1435 m³ bund at Pannikkal watershed, was completed during the reporting period. Water percolation pits (640 m³) were also dug in the Pannikkal watershed area.

The centre supported the following initiatives as part of a farmers' risk reduction strategy during extreme weather events and to foster conservation: 61 units (each measuring 10 cents on average and having other crops) involved in *in-situ* conservation of local plant species (banana and tubers); 36

micro-irrigation units (drip irrigation units, each covering an area of 0.5 acres) chiefly benefiting newly planted pepper, coffee and fodder cultivation; 12 organic plots engaged in the system of rice intensification (SRI) cultivation (each plot measuring 10 cents); 300 farmers' plots covered under crop insurance (mainly paddy, banana and vegetable plots); 16 units for mulching (each unit covering 0.5 acres) and so on.

Four training programmes on beekeeping and SRI were conducted for 80 farmers (men: 27; women: 53). Four exposure visits to model farms were organised with the participation of 65 farmers (men: 39; women: 26) to create awareness on climate-adaptive farming practices such as mixed cropping and crop-livestock integration.

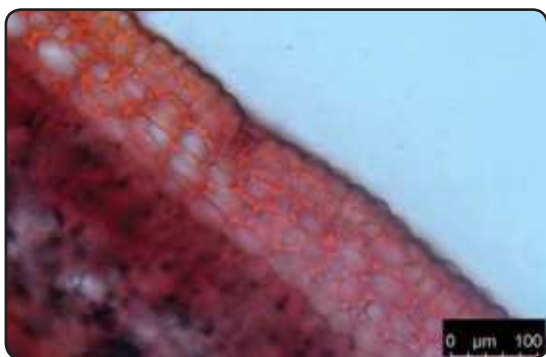
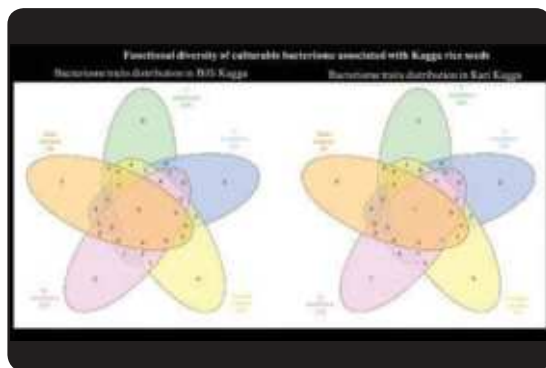
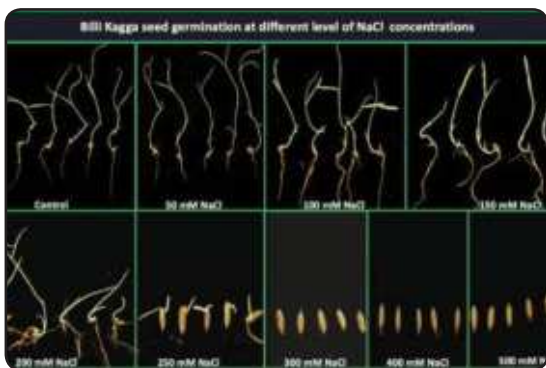
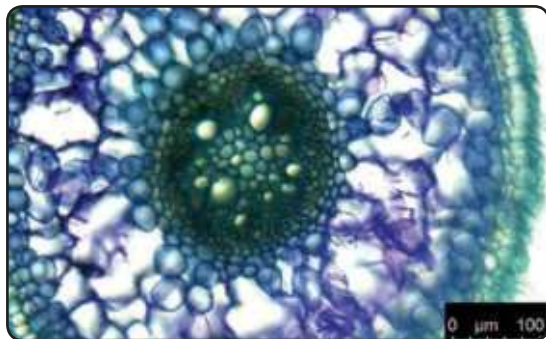
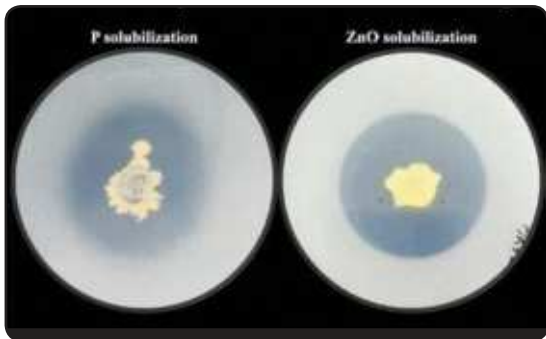
Key highlights

- Agroforestry model, a multi-storied mixed farming system with high-value horticultural trees, millets, fodder grass and vegetables was demonstrated as a crop diversification and intensification strategy in Kolli Hills.
- KHABPCOL procured pepper, millet, cloves, cashew nut and coffee from 325 smallholder tribal farmers and facilitated sales in the rural mart, leading to an annual turnover of INR 6.6 lakhs and a net return of INR 2 lakhs.
- Participatory research and the provision of quality seeds and farm machinery have helped millet farmers to increase their crop productivity by 47.11 per cent compared to conventional practices in Koraput.
- Fifteen model nutrition gardens (Swaminathan Poshan Bagicha) were demonstrated, harvesting 1.83 tonnes of fruits and vegetables, of which approximately half were self-consumed and the remaining 50 per cent was sold in the local market in Koraput.
- Two new angiosperms species, *Ixora lavanya* and *Christisonia flavirubens*, were reported from the Kerala section of the Southwestern ghats.
- Thirty seed villages providing paddy and pulses were established to strengthen informal seed systems in Wayanad.

BIOTECHNOLOGY

The Biotechnology Programme at MSSRF uses new-age technologies for understanding abiotic stress tolerance in plants; identification and promotion of locale-specific varieties to combat salinity stress; exploring seed and rhizosphere microbiomes; and demonstrating the role of organic and microbial consortia products to enhance crop yield and soil health. Adventitious root emergence in seedlings of the mangrove (Avicennia marina) was mapped and Echinochloa weed species in rice fields were identified using molecular markers and spikelet features. A new molecular marker was developed for the promoter region of sodium transporter OsHKT1;5. A new study examined changes in root architecture in C4 millet species under salinity. The milky and mature stage grain transcriptomes of aromatic rice Maniki Madhuri Joha is also reported. Culture conditions for eight vulnerable lichens spp., categorized as non-timber forest products (NTFPs), have been established. Mangrove rhizosphere-associated dimethylsulfoniopropionate (DMSP)-producing bacteria majorly belong to Alphaproteobacteria with Roseovarius sp. (53 per cent) and Yangia pacifica (32 per cent) contributing to the sulfur cycle in the mangrove ecosystems. Understanding the core microbiome composition of rice affected by sheath blight pathogen Rhizoctonia solani versus healthy plants, and seed core microbiome of Kagga paddy varieties is underway. In the ongoing farmer-centric Biotech-KISAN Hub programme, promoting improved agronomic practices for millet and spice cultivation were demonstrated and significant yield enhancement was recorded with vermicompost application and adoption of integrated nutrient management (INM) practices.

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Programme Area 301

Genetic Enhancement

Salinity is a major abiotic stress affecting agricultural soils worldwide. The biotechnology programme strives to primarily understand the basis of salinity tolerance in plant genetic resources. Adventitious root development in the mangrove species *Avicennia marina* has been mapped allometrically as well as microscopically at the seedling stage. As a continuation of the previous year's work, the characterization of *Echinochloa* weed accessions using a chloroplastic DNA marker and morphological traits has been completed. Sodium transporter *OsHKT1;5* (promoter and coding region) diversity has been mapped in a set of rice accessions for which sequence data is publicly available. Root growth traits in C3 crops versus C4 millet species have been mapped at the vegetative stage as a prelude to salinity tolerance-based studies.

301.1 Adventitious Root Development Strategies during Propagule Establishment in the Mangrove Species *Avicennia marina*

Seeds of crypto-viviparous *A. marina* show embryonic development and hypocotyl elongation on the parent tree before detachment. The primary radicle in *Avicennia* species shows premature developmental arrest within the seed. After detachment, propagules undergo 'obligatory dispersal', requiring an inundation-free period for rapid adventitious root development (emergence from hypocotyl) to facilitate seedling establishment against hydrodynamic forces (waves, currents). The plant axis elongates after the emergence of the first adventitious roots. In the present study, adventitious root allometric traits (diameter, number, length and root angle) in 4-month-old *A. marina* seedlings (grown in sand) were mapped and also examined microscopically. Based on root diameter

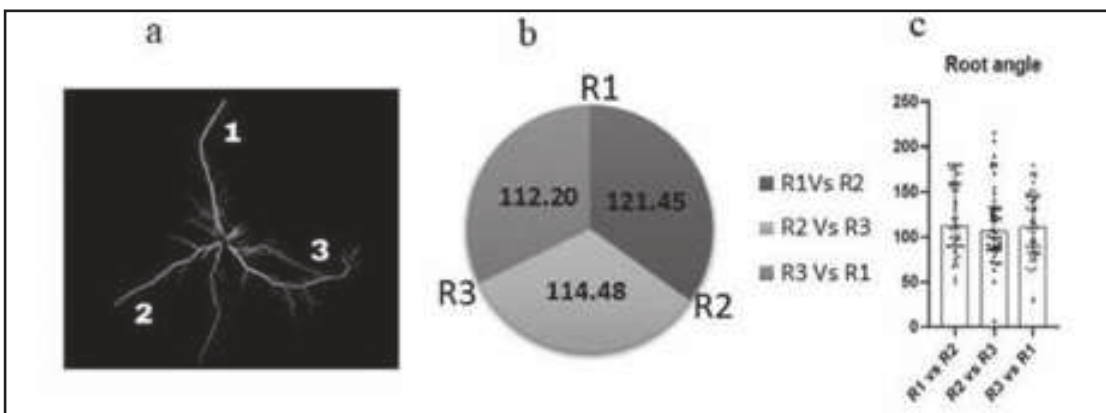


Figure. 1. a) Formation of a tripod-like structure by roots R1, R2 and R3 in 4-month-old seedlings of *A. marina*; b) angular orientation of roots R1, R2 and R3 (in degrees); c) graphical representation of the root angles ($n = 44$).

measurements, roots R1–R3 (diameter: $R1 > R2 \approx R3$) were identified and root angles (with respect to each other) were recorded. R1 is oriented in line with the growing plant axis. Further, roots R1–R3 form a triad (approximate angle = 120°), giving rise to an overall tripod architecture (Fig. 1). Anatomical measurements of root tissues (R1–R3) show that heterogeneous investments in root growth occur. Thus, the largest diameter root R1 may be crucial to seedling establishment, ensuring rapid access to nutrients and water. Lower growth investments in roots R2 and R3 (smaller diameter and vascular bundle area) may represent a growth trade-off strategy in reducing photosynthate allocation to the root but still achieving seedling stranding. The predetermined angular positioning of roots R1–R3 may be a mechanism to distribute the relatively heavy seedling weight (compared with that of other non-mangrove species) in a manner that can resist uprooting due to hydrodynamic wave action.

301.2 Identification of *Echinochloa* Weed Species in Rice Fields of Selected Districts of Tamil Nadu Using a Chloroplast DNA Marker

In 2021–22, preliminary polymerase chain reaction (PCR) optimization of *Echinochloa* weed species in rice fields was reported. This study was extended to samples collected from rice-growing fields in three districts of Tamil Nadu (as plants [12] or seeds [10]). Leaves from mature plants were used for DNA isolation (T0 generation), and dried seeds from the same plants were sown in pots containing

a 1:1 mixture of soil and farmyard manure to obtain small plantlets (T1 generation) to isolate genomic DNA. Two species of *Echinochloa* were identified in the fields, namely, 1 *E. oryzicola* accession (P1) and 21 *E. crus-galli* accessions. For 12 accessions, T0/T1 data were obtained, while for the rest, only T1 data was obtained. The identification process was based on the utilization of insertion/deletion (indel) generated for a chloroplastic DNA marker, specifically *trnT-L*. Additionally, spikelet length was used for species-specific identification. *E. oryzicola* exhibits a spikelet length of ≥ 4 mm while *E. crus-galli* shows a spikelet length of ≤ 4 mm. However, accession P1, which was identified as *E. oryzicola* based on the *trnT-L* marker, had a spikelet length that was statistically indistinguishable from *E. crus-galli* accessions. Accession P1 is classified as ‘inconsistent’, suggestive of paternal inheritance of chloroplastic DNA from *E. oryzicola*, unlike the typical maternal inheritance (from an unknown maternal donor) in *E. crus-galli*. Accession D4, on the other hand, displayed a 32-bp deletion (*trnT-L*) in the T0 generation but an insertion in the T1 generation, which may indicate heteroplasmic chloroplastic DNA inheritance.

301.3 Single-Nucleotide Polymorphism Diversity in the Promoter Region of the Sodium Transporter *OsHKT1;5* in *Oryza sativa*

OsHKT1;5 is a sodium transporter that is associated with salinity tolerance in cultivated rice, *Oryza sativa*. Previously, non-synonymous single-nucleotide polymorphisms

(SNPs) in the *OsHKT1;5* coding regions had been mapped and 10 haplotypes (SNP combinations) identified in the publicly available, re-sequenced 3000 rice genome dataset (3K-RG). In the present year, this study was extended to identify SNPs in the promoter region of *OsHKT1;5* (2.0 Kb upstream of *OsHKT1;5* on rice chromosome 1 [chromosomal coordinates: 11463430–11465430]; reverse strand) and 49 SNPs were identified. Further haplotype analysis, including the promoter SNPs (49), grouped 1955 rice accessions of the 3K-RG dataset into 15 haplotypic groups. Also, a *Bcl* I restriction site was identified in the promoter region of *OsHKT1;5* in the sequenced *O. sativa japonica* (International Rice Genome Sequencing Project; IRGSP 2.0). Based on the presence or absence of the *Bcl* I restriction site in the *OsHKT1;5* promoter region, a cleavage amplified polymorphic sequence (CAPS) marker (CAPs_ *HKT1;5B*) was developed and validated in a set of coastal rice landraces. This marker was absent in most of the salt-tolerant rice landrace accessions examined (Fig. 2). Furthermore, analysis of data in 3K-RGs

revealed that the *japonica* rice accessions mostly have the *Bcl* I restriction site whereas the *indica* rice accessions do not.

301.4 Molecular Analysis of Root Traits in Relation to Salinity Tolerance in C4 Crop Species

The new study will examine root function in C4 millet species (pearl millet, finger millet and barnyard millet) under salinity conditions using anatomical, physiological and molecular tools. It will also comparatively examine the sodium-specific transporter gene *HKT1;5* function in C4 millets and C3 species (barley) through cloning and heterologous expression approaches. Accessions of C3 and C4 species were subjected to salt treatment using hydroponics, and tissues were harvested and used for RNA isolation. Of the different RNA isolation protocols attempted, the cetyltrimethylammonium bromide-lithium chloride (CTAB-LiCl) protocol was found to reproducibly give RNA of good quality and was used to isolate RNA. *HKT1;5* cDNA isolation from the C3 and C4 species is on-going.

In a preliminary study, plant growth in C3 and C4 species over a defined time interval after sowing was mapped. Seeds were planted in plastic cups filled with vermiculite and soil mixture (1:2 ratio; 5 seeds per pot) and watered regularly. Plants were harvested at specific time intervals (20, 25, 30 and 35 days after sowing), and roots were carefully extracted from soil with minimum damage. Leaf length, individual root length, leaf and root number, second leaf width and length, and fresh/dry weights of leaves and roots were

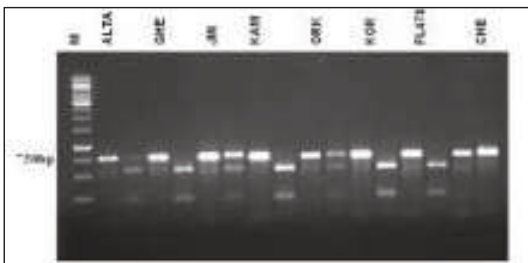


Figure 2. *Bcl* I restriction digestion profile of 800 bp fragment of *OsHKT1;5* promoters. Of 47 landraces examined, 7 show the presence of the *Bcl* I restriction site and are seen here (names marked on top). CHE: undigested positive control, M: 1 Kb ladder.

recorded. The second leaf was scanned at 600 dots/in. resolution for determination of leaf area. Statistical analysis of data is currently underway.

301.5 Grain Transcriptome of Aromatic Rice Landrace *Maniki Madhuri Joha* under Milky and Maturation Phases

Aroma in rice is an economically important trait; the principal compound imparting aroma in rice is 2-acetyl-1-pyrroline. A single recessive gene (*fgr*) on chromosome 8 of rice is associated with aroma/fragrance and is attributable to a truncated betaine aldehyde dehydrogenase (*BADH2*) ORF, with a majority of aromatic rice varieties showing an 8-bp deletion in the 7th exon. *Maniki Madhuri Joha*, an aromatic small-grain rice from Northeast India, was found to show similar 8-bp deletion in the 7th exon of *BADH2* based on sequencing data. In the present study, the transcriptome of *Maniki Madhuri Joha* was evaluated for differentially expressed genes at the early phase (milky endosperm formation) and maturation phase (dough stage) of seed development. Collectively, 25409 transcripts with 68202 isoforms were identified in both the milky and maturation phases of seed development. At the maturation phase, 8409 transcripts (9823 isoforms) were upregulated with an average increased 2.72-fold expression. A total of 7752 transcripts (8914 isoforms) were downregulated with an average reduced 0.23-fold expression in the maturation phase. In particular, *OsBADH2* and *OsBADH1* transcripts were upregulated in the maturation phase. Further, genes in

the brassinosteroid signalling involved in the determination of the embryonic axis were downregulated in the maturation phase while transcripts of sucrose branching enzymes (*SBE1*) and calcium-dependent protein kinase 23 (*OsCDPK23*) were upregulated in the same phase.

Sub Programme Area 302

Bioprospecting

Lichens (fungal species that form obligate symbiotic associations with algae or cyanobacterium to fulfill their nutritional requirements) are well known for being a rich source of secondary metabolites. They are slow-growing and low-biomass-producing fungi.

302.1 Bioprospecting of Secondary Compounds

Establishing Lichen Culture Protocols for the Biosynthesis of Compounds Imparting Food Flavour:

Over the past year, lichen fungal cultures for *Parmotrema tinctorum*, *P. reticulatum*, *Heterodermia leucomela*, *Physcia integrata* and vulnerable species such as *Diorygma junghuhnii*, *Glyphis cicatricosa*, *Graphis caesiella* and *G. scripta* were established. These lichens are classified as non-timber forest products (NTFPs) and used as food-flavouring agents (e.g., in biryani) and as raw material for industrial use. They are harvested for commercial purposes by the Paliyan tribes of the lower Palani Hills as part of their livelihood. *P. tinctorum* fungal culture

was found to biosynthesize food-flavouring secondary compounds atranorin and lecanoric acid.

Sub Programme Area 303

Microbial Diversity Assessment and Application

Diverse bacterial taxa associated with mangrove rhizospheric regions provide important ecosystem benefits that need to be quantified. In this context, plant growth functional properties of mangrove-associated dimethylsulfoniopropionate (DMSP)-synthesizing and -catabolizing bacterial communities have been characterized. Research on exploring the core microbiome of saline-tolerant traditional rice varieties as well as improved rice varieties is underway. Promoting the use of bioinoculants among small and marginal tribal farmers for millet cultivation enhanced yield and increased income. Finally, demonstration and on-farm trials using bioinoculants were undertaken on a large scale in select aspirational districts of Odisha and Kerala where the tribal population is high.

303.1 Microbial Community Profiling in a Mangrove Ecosystem

Diversity and Distribution of the Dimethylsulfoniopropionate-Synthesizing and -Catabolizing Isolates of the Mangrove Rhizosphere: Dimethylsulfoniopropionate (DMSP) is a globally important organosulfur compound, an important marine osmolyte

and a precursor producing the climate-active volatile gas dimethyl sulfide (DMS). In all, 32 isolates involved in DMSP synthesis and catabolism were isolated from the rhizosphere region of *A. marina* (16 isolates), *Rhizophora mucronata* (9 isolates), *Arthrocnemum indicum* (3 isolates) and saline brackish water (4 isolates). Partial sequencing of 16S rRNA from isolates revealed the predominance of *Proteobacteria* (10 per cent) involved in DMSP cycling in the mangrove ecosystems. Within *Proteobacteria*, most isolates belonged to *Alphaproteobacteria* (91 per cent), followed by *Gammaproteobacteria* (9 per cent). The dominant order within *Alphaproteobacteria* was *Rhodobacterales* (59 per cent) followed by *Hyphomicrobiales* (31 per cent). Within *Rhodobacterales*, most isolates belonged to the genus *Roseovarius* sp. (53 per cent), *Yangia pacifica* (32 per cent), *Pararhodobacter aggregans* (10 per cent) or *Pseudoceanicola aestuarii* (5 per cent). Within *Hyphomicrobiales*, most isolates belonged to the genus *Roseibium*, predominantly *R. aggregatum* (90 per cent), followed by *Pseudoaminobacter arsenicus* (10 per cent). *Gammaproteobacteria* were represented by three isolates, one each from the orders *Pseudomonadales* (*Pseudomonas khazarica*), *Oceanospirillales* (*Marinobacterium nitratireducens*) and *Aeromonadales* (*Oceanimonas baumannii*). Among 32 strains, 13 bacterial isolates showed the presence of the *dsyB* gene and belong to *Alphaproteobacteria* while 19 were involved in DMSP catabolism, of which 11 contained both *dmdA* and *dddP* while 7 possessed only *dddP* gene and 1 showed the presence of *dmdA*. These 32 bacterial strains were

also screened for indole-3-acetic-acid (IAA) production potential using Yeast Trypton Sea Salt (YTSS) broth medium supplemented with L-tryptophan (200 µg/ml), of which 19 isolates tested positive for IAA production, suggesting a role in plant growth promotion. Thus, the isolated DMSP metabolising bacteria not only potentially contribute to sulphur cycling and cloud condensation but also to plant growth promotion in the mangrove ecosystems.

303.2 Bioinoculants for Sustainable Agriculture

Deciphering the Rhizosphere Microbiome of Healthy and Rhizoctonia solani–Infected Rice Plants:

The microbiome, often called the second genome of plants, plays a pivotal role in plant growth and health. Beneficial microbes contribute to plant growth promotion, protect against phytopathogens and induce systemic tolerance to abiotic stresses. Sheath blight in rice is a serious disease caused by the soil-borne pathogen *Rhizoctonia solani*, which leads to yield loss of up to 50 per cent under conducive environments. The disease infestation is observed to be at varying degrees in the same field, and thus to understand the reasons for this the microbiome of the rhizosphere, roots, and nodes of infected and healthy rice plants from the same field were examined. Soil samples from the rhizospheres of sheath blight *R. solani*–infected rice as well as from healthy rice plants were collected from four different paddy fields of the north-eastern agro-climatic zone in Tamil Nadu. Culturable bacterial diversity was determined using 11 different media to facilitate the isolation of both

slow and fastidious isolates. Approximately 610 colonies were isolated from each infected and non-infected sample. Diverse colonies with distinct morphology were observed from all four non-infected samples compared with infected rhizosphere soils. The microbial community colonizing the non-infected as well as infected plants showed plant growth-promoting traits such as potassium, phosphate, zinc solubilization and IAA production. But a difference in the distribution of the beneficial bacterial association between the infected and healthy plants was observed. About 31 per cent of isolates held higher Plant Growth Promoting Rhizobacteria (PGPR) in healthy plants while it was only 17 per cent in infected plants. Similarly, 12 per cent of the isolates showed antagonistic activity against a broad spectrum of phytopathogens. The unculturable microbial community distribution was determined by the isolation of total DNA from the collected rhizosphere soil, roots and shoots after surface sterilization. The isolated total DNA was processed for amplicon sequencing of 16S rRNA targeting V3-V4 and internal transcribed spacer (ITS) regions (ITS1 and ITS4). Metagenomic analysis revealed a difference in the microbiome community between the infected and healthy plants. The comparative sequence analysis will lead to the identification of sub-communities that contribute to protection from phytopathogen infection, either through the induction of systemic resistance and/or by secondary metabolite production.

Brevibacillus laterosporus MSSRFT15 Whole Genome Sequencing: A rhizobacterial

isolate *Brevibacillus laterosporus* MSSRFT15 shows multi-beneficial plant growth-promoting traits and harbours genes for nitrogen metabolism, phosphorus metabolism, iron metabolism and acquisition. All of these contribute to plant growth promotion, biocontrol activities and rhizosphere colonization (Fig. 3). The whole genome sequence of isolate *B. laterosporus* MSSRFT15 consists of a single circular chromosome of 5165986 bp, with an average guanine-cytosine (GC) content of 41.4 per cent with no plasmid detected. A total of 5143 functional proteins were predicted in the genome of MSSRFT15, identified using the Clusters of Orthologous Groups (COGs) database. Pathways for secondary metabolite biosynthesis involved in biocontrol activity (blogroll, zwittermicin, basiliskamide, octapeptin, gramicidin, laterocidine, ulbactin, tauramamide and laterocidine) were identified. In addition, genes related to metal resistance (arsenic/cobalt/zinc/cadmium) and osmotic and temperature shock were also identified. The 1-cyclic-lactone-autoinducer gene involved in quorum sensing signalling was

detected in MSSRFT15 genome by anti-SMAH analysis.

303.3 Biotech-Krishi Innovation Science Application Network (Biotech-KISAN Hub)

State of Different Inputs and Their Impact on Finger Millet Productivity: As a part of the MSSRF-DBT-Biotech-Krishi Innovation Science Application Network (Biotech-KISAN hub) project, new agronomic practices and bioinputs were tested for improving grain yield of finger millet in three aspirational districts of Odisha: Koraput, Rayagada and Malkangiri at MSSRF Sub Hub 1 (MSSRF-Biju Patnaik Tribal Agro-biodiversity Centre [BPTAbC]), Jeypore. The demonstration trials were conducted at farmers' fields in 19 villages of the three aspirational districts for 2 consecutive years. The treatments were improved methods of cultivation: line transplanting (LT) and system of millet intensification (SMI) in monocropping and intercropping methods along with the application of bioinoculants consortia consisting of *Pseudomonas* and *Trichoderma*; Arbuscular mycorrhizal fungi (AMF); vermicompost and INM. A total of 944 demonstration trials were conducted (Koraput, 294; Rayagada, 313; Malkangiri, 337) with improved finger millet varieties KMR-204 and Arjun (Fig. 4). Among the different inputs used, maximum average grain yield was obtained from plots with vermicompost (28 q/ha), followed by INM (24 q/ha), bioinoculants consortia (19–20 q/ha) and AMF (17–18 q/ha), which were higher than that obtained using the existing farmers'

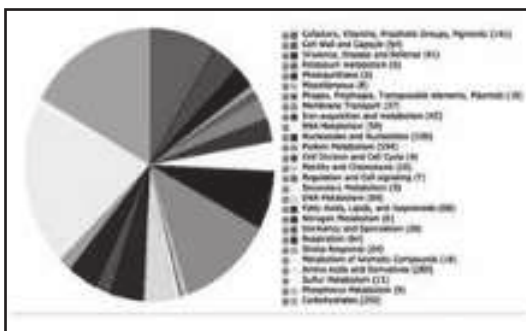


Figure.3. *Brevibacillus laterosporus* MSSRFT15, distribution of functional genes involved in cellular regulation predicted by whole genome sequence analysis.

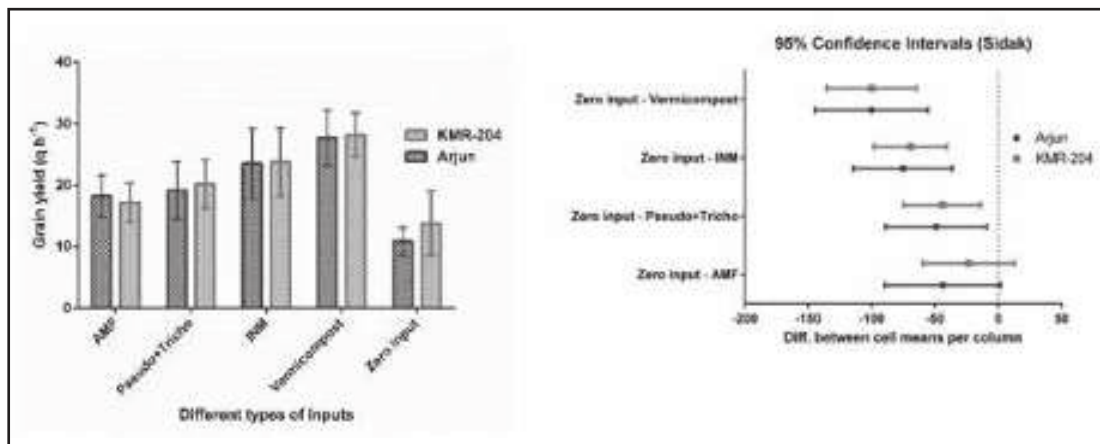


Figure 4. *Finger millet grain yield (q/ha) with different input applications in varieties Arjun and KMR-204 and level of significance at 95%.*

practices (11–14 q/ha). Significant finger millet grain yield enhancement was observed in the vermicompost application compared with other inputs. The vermicompost used in these trials was obtained by composting finger millet straw and other crop residues in vermibeds established in the farmers’ backyards. To promote vermicompost production, vermicompost kits were distributed to 750 farmers. Among the different inputs used, farmers got an increased net income of INR 71009/ha with vermicompost application and INR 60702/ha with INM when compared with INR 13760/ha using farmers’ practices.

Sub Programme Area 304

Biosaline Agriculture: Exploration of Seed Core Bacteriome of Salt-Tolerant *Kagga* Rice

The seed core bacteriome of two saline-tolerant traditional rice varieties – *Billi-Kagga*

and *Kari-Kagga* – were elucidated using culturable and unculturable approaches. Both rice varieties showed germination in concentrations up to 200 mM NaCl. Screening for culturable diversity associated with the *Kagga* seeds using 12 different media resulted in the isolation of 24 diverse bacteria isolates with distinct morphological characteristics from *Billi-Kagga* and 29 from *Kari-Kagga* seeds. Significant genetic diversity was observed among the isolates, which showed distinct polymorphic banding patterns in BOX-PCR. Among the 53 isolates screened for various plant growth-promoting functional traits, the following were observed: NaCl tolerance (27 per cent); phosphorous, potassium and zinc solubilization efficiency (47 per cent); and 1-aminocyclopropane-1-carboxylic acid (ACC) deaminase activity (25 per cent). The production of phytohormones, IAA (110–140 µg/ml) and gibberellic acid (90–35 µg/ml) was observed in ~40 per cent of the isolates. Overall, the cultural and functional diversity

revealed the existence of potential plant growth-promoting bacteria that has scope for application in saline soils for enhancing crop productivity and improving soil health. The unculturable diversity is also being explored by metagenomic approaches. Seed metagenomic DNA was extracted from these two *Kagga* varieties, and V3-V4 regions of 16S rRNA were amplified and analyzed using Illumina MiSeq. The raw sequence data was checked for base call quality; 123226 reads from *Billi-Kagga* and 148906 reads from *Kari-Kagga* seeds of length 301 bp produced base

call Q20 accuracy of ~99.74 per cent. The refraction curve shows diversity within both samples and preliminary analysis indicated a difference in alpha diversity richness and relative abundance. Principal component analysis (PCoA)-based beta-diversity also indicated a difference between the samples (Bray-Curtis metric). Comparative analysis of culturable 16S rRNA and operation taxonomic units (OTUs) of the sequenced amplicons needs to be completed to derive a correlation between community distribution in the two *Kagga* varieties.

Key highlights

- A new molecular marker was developed for targeting the promoter region of sodium transporter *OsHKT1;5*.
- *Echinochloa* weed species in rice fields were identified using chloroplast DNA markers and spikelet features.
- Characterized mangrove rhizosphere-associated dimethylsulfoniopropionate (DMSP) metabolising Alphaproteobacteria (*Roseovarius sp. and Yangia pacifica*) contribute to the sulphur cycle, cloud condensation and plant growth promotion in the mangrove ecosystems.
- The whole genome sequence of plant growth-promoting bacteria, *Brevibacillus laterosporus* MSSRFT15 was decoded.
- Integrated nutrient management practices in finger millet cultivation increased grain yield by three-fold.

ECOTECHNOLOGY

The Ecotechnology Programme Area focused on strengthening science–society linkages by adopting a sustainable livelihood approach and participatory technology development and dissemination framework. Seven producer organizations have directly facilitated access to different productive resources and services for over 10000 farmers and developed information and communication networks enabling access to information, knowledge resources and skills for 1.98 lakh farmers. The programme area specifically focused on climate information services and promotion of climate-smart agricultural technologies to build the adaptive capacity of small and marginal farmers, especially women farmers. A gender-responsive approach is integrated at the planning and implementation phases and in all interventions to ensure higher participation of vulnerable groups, especially women, marginal farmers and agricultural workers, and members belonging to socially marginalized communities. Digital tools are utilised to upscale technologies for planning and adoption, learning and capacity building, and delivering agro-advisories. Support is also provided to develop linkages with banks and line departments, with farmers and other stakeholders, to reach out to a maximum number of farmers at the district and state levels.

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Sub Programme Area 401

Sustainable Livelihoods and Grassroots Institutions

Collective power has been harnessed to access productive resources and services among small and marginal farmers and agricultural labourers for better livelihoods. Site-specific technologies have been introduced to strengthen sustainable agriculture and value-addition activities. As part of this, efforts have been made to mainstream such activities through farmers' collectives to ensure sustainability.

401.1 Coastal Agroecosystems: Mannadipet Commune, Puducherry

Three grassroots institutions have been operating at Mannadipet : *Innuyir Grama Sangham (IGS)*, IGS Producer Company Limited (IGSPCL) and *Pasumai Farmer Producer Company Limited (PFPCCL)*. The IGS, a women's collective, facilitates access to technology, credit, institutional support and markets to improve on-farm, non-farm and off-farm economic activities. Among these, credit plays a pivotal role in empowering women to take a lead in production and marketing. The E-Sakthi platform allows online grading of group performance to facilitate prompt disbursement of the next instalment of credit ensuring regular flow of credit for their activities. The IGS has 2890 farmer members and is organized into 277 self-help groups (SHGs). Last year, 46 groups were involved in enterprise development (28 on-farm, 8

off-farm and 10 non-farm enterprises), with a credit linkage of INR 102 lakhs. The second organization, IGSFPC, functions with 615 women shareholders from 50 villages in the Mannadipet commune, Puducherry. The total paid-up share capital is INR 615000. The shareholders of the company were organized into 147 joint liability groups (JLGs) and established credit linkages with nationalized banks. This facilitated access to a credit of INR 230 lakhs to purchase required farm inputs and adopt timely farm management practices, especially for the cultivation of paddy, vegetables and flowers. Besides credit linkages, the IGSPCL has organized 11 all-women plant clinics (PCs) to provide quality agro-advisories and suggest a package of practices such as growing bund crops/trap crops to mitigate pest infestations. The IGSPCL runs a neem seed kernel pulverizing unit and markets the powder as an organic amendment. During the reporting period, the annual turnover of IGSPCL was INR 52 lakhs. The third organization, PFPCCL, (550 men and women shareholders) initiated the aggregation of groundnut procurement and provided support in direct marketing. Marketing was carried out by establishing a business tie-up with private firms. 5.3 tonnes of groundnut were aggregated and marketed during the reporting period.

With respect to technology adoption in practising sustainable agriculture, intensifying pollinators and reducing natural pests have been the primary focus. On-farm demonstrations of this ecological intervention in lady's finger cultivation with marigold and sunflower as

inter- and border crops, respectively, continued in 12 farmers' fields with an equal number of control farmers. Compared with control plots, results reiterated the advantage of co-cropping in enhancing pollinator numbers by 30.43 per cent and increased pod yield by 15.05 per cent. This data was shared with farmers from four neighbouring villages. The practice of co-cropping was adopted by 37 farmers cultivating lady's finger. To strengthen the role of pollinators in crop production at the community level, a mass awareness campaign was held on World Bee Day 2023, aligning with the theme of 'Engaging in Pollinator-Friendly Agricultural Production'. To reinforce the significance of bees in the local agroecosystems and their contribution to agriculture, an art competition and training programme was organized in Puducherry in May 2023. Seventy-five men and 52 women farmers participated, using creativity to share knowledge about pollinators through traditional art, vernacular phrases or quotations.

Further, in partnership with Vigyan Prasar, Department of Science and Technology, Government of India, and National Institute of Disaster Management, Ministry of Home Affairs, a three-day 'training of trainers' programme on 'Disaster Management for Coastal Communities' was organized in December 2022. The programme supported the development of a cadre of 50 resource persons, who in turn will be responsible for creating awareness among local fisherfolk and farmers in their respective villages on relevant disasters pertaining to the region and their management.

401.2 Semi-arid Agroecosystems: Kannivadi, Dindigul District, Tamil Nadu

Three collectives are functioning in the Kannivadi region, namely Kulumai Producer Federation (KPF), Reddiarchatram Sustainable Agriculture Producer Company Limited (RESAPCOL) and Kulumai Milk Producers Company Limited (KMPCL), to strengthen on-farm, off-farm and non-farm livelihoods. In addition to facilitating access to technology and credit, these collectives promoted creation of knowledge resources, built capacity and promoted diverse learning, helped in development of innovative marketing strategies, and facilitated collective action to empower men and women farmers.

The KPF is a conglomeration of 342 SHGs (337 women SHGs and 5 men SHGs) from 65 villages in the Reddiarchatram block of the Dindigul district. Of the 4278 members, 75 per cent are rural landless agricultural labourers, 17 per cent are small and marginal farmers, and 8 per cent are labourers of other types. The KPF has facilitated credit links from commercial banks to 797 women members to the tune of INR 413 lakhs. This has been in for both off-farm and non-farm enterprises (small-scale dairy, buying goats, country chick rearing, tailoring and other petty businesses). The community bank of KPF, from its internal corpus fund provided credit services to the tune of INR 25.25 lakhs to 215 members to invest in off-farm enterprises, namely small-scale dairy and goat farms. The KPF has also established a training centre to teach tailoring skills with the support from National

Bank for Agriculture and Rural Development (NABARD). Apart from credit support, the federation facilitated insurance services for 2720 members.

The KMPCL is a subsidiary unit of KPF and has 900 women shareholders. It facilitates access to productive resources (e.g., regular veterinary advisories in partnership with a private digital service provider for effective dairy farming) and credit linkages with banks and acts as an aggregation centre for quality checking and provides support in direct marketing to milk processing companies. The KMPCL has also installed a bulk cooler facility for marketing chilled milk to increase shelf-life. Five hundred and eighty shareholders have been linked via mobile phone app to a private service provider to receive regular e-health advisories for cattle. KMPCL mobilized credit amounting to INR 225.75 lakhs for 250 members to strengthen dairy enterprises and achieved an annual turnover of INR 62.3 lakhs during last year. KMPCL received a cash award of INR 5 lakhs from Evangelical Social Action Forum, Kerala, for being the 'best performing FPC'.

The third institution, RESAPCOL, has been focusing on facilitating services and access to productive resources in agriculture to its shareholders: quality seeds for maize (312 ha) and cotton (210 ha), bio-inputs (13.42 tonnes), credit (INR 51.00 lakh), output marketing of maize (685 tonnes) and value-added products (INR 7.35 lakhs). The annual turnover of the company for the last year was approximately INR 237 lakhs. A cold storage facility with a

capacity of five tonnes was established with financial support from the Department of Agri-Business and Marketing. This is to support shareholders in delayed sale of vegetables, especially moringa and flowers, to obtain a higher price.

Under the Lifelong Learning for Farmers initiative, 8227 farmers from Dindigul and Karur districts were connected to the credit-linked learning activity and accessed credit worth INR 287.87 lakhs from commercial banks. To use this credit effectively in economic activities, mobile-based learning was facilitated among farmers. Eight hundred and fifty-six voice messages on different themes, namely agriculture (486), dairy (245), general communication (35) and FPO governance (90), were developed and disseminated. Two courses were also facilitated through print-based learning, in which 4000 farmers participated (60 per cent women). In addition, 75 short videos on farmer success stories were captured and shared for cross-learning. To promote the effective use of Kisan Credit Cards (KCCs), discussions were held with nationalized banks, and 1882 small and marginal farmers (men: 857; women: 982; persons with disability: 25) were linked to this scheme; they availed loans worth INR 658.52 lakhs to carry out farm operations. Under the convergence initiative, 1039 small and marginal farmers were linked to various government schemes to practice water-saving through harvesting infrastructures (farm ponds, field bunds) and micro-irrigation practices (drip, sprinkler and rain guns) in 632 ha of land.

Due to the changing rainfall patterns and seasonal droughts in the Dindigul region, moringa is a widely cultivated commercial crop and preferred by small farmers. Improving productivity through effective agricultural practices and establishing a processing centre to produce value-added products such as dried moringa leaf and soup powder were the two main activities promoted to strengthen farmers' adaptive capacity. Twenty-five farmers participated in the International Moringa Conference held at Karur in December 2022 to understand the importance of value addition for increased income as against selling fresh pods in nearby markets. Similarly, a value addition and processing unit was established to produce both virgin and cooking-quality oil and dried coconut powder in the Kuttanad region of Kerala.

Apart from moringa, a diverse range of vegetable crops are commonly cultivated for markets in the Dindigul region using groundwater under intensive cultivation. Farmers injudiciously use pesticides based on advice from agro-input dealers for pest and disease management. Currently, farmers do not have access to correct pest/disease diagnosis and the necessary knowledge and skill on non-chemical pest management measures. To encourage the adoption of safe pest/disease management practices, a cadre of 100 plant health monitors (PHMs) were trained to serve as resource persons in four vegetable-growing blocks, namely Reddiarchatram, Ottanchatram, Nilakottai and Natham (25 per block). Of the 100 PHMs, 40 per cent are women farmers. During the

reporting period, 80 training programmes were conducted covering modules such as diagnosis of crop pests and diseases, modes of spread, economic threshold levels for different pests and integrated pest management measures. PHMs act as local resource persons in supporting farmers in their respective villages in the initial diagnosis and link them with plant doctors. An end-line survey is planned to compare changes in knowledge, skills and adoption of pest management practices. PHMs are also shareholders in RESAPCOL to promote a regular exchange of knowledge and to increase cross-learning.

The impact of co-crop cultivation on pollinator abundance, diversity and possible enhanced pollination benefits were analysed based on the data from the last on-farm field experiments in moringa and mango. Insect pollinator visit was enhanced by 20 per cent, which resulted in increased productivity and improved pod/fruit quality by 30 per cent and 10 per cent, respectively. Pollinator abundance and diversity were significantly greater (50 per cent and 33 per cent, respectively) in the intervention fields than in the control fields. Twenty farmers have replicated the co-cropping system and 30 farmers have maintained field bunds with weeds to support insect pollinator species. Pest management in moringa is crucial, considering its economic importance and export potential. To design locale-specific management measures, a study on the relationship between pests and weather parameters, focusing on the duration of moringa flowering, was carried out. Budworm, ant and pod fly were found

to be major pests on moringa buds, flowers and pods, potentially causing a yield loss of up to 40 per cent. Regression analysis with weather parameters revealed that budworm and ant infestations were positively correlated with maximum temperature ($r = 0.459^{***}$ and 0.42^{**} , respectively at significance of five per cent level), while pod fly infestation was significantly correlated with relative humidity (evening) ($r = 0.7^{***}$ at significance of five per cent level) and rainfall ($r = 0.517^{***}$ at significance of five per cent level).

401.3 Semi-arid Agroecosystems: Mailam Region, Villupuram District, Tamil Nadu

The Nallavur Farmer Producer Company Limited (NAFPCL) initiated seed production activities for paddy, black gram and groundnut as one of the business ventures. Twenty-five tonnes of paddy and 5 tonnes of black gram and groundnut each were produced in an area of 24 ha. The seeds were processed in the processing unit at NAFPC, established with financial support from the Department of Agriculture, Government of Tamil Nadu. As groundnut is commercially grown under large area in this region, to overcome productivity gap and fluctuating market prices, a business agreement was executed with a private company in Chennai for direct marketing and remunerative prices. As part of this agreement, groundnut varieties with high oleic acid content were introduced along with the promotion of good agricultural practices and a fair-trade certification for export. As a result, farmers received a 20 per cent higher premium price against sales to local traders and regulated market committees. Forty tonnes of groundnut

were exported this year. NAFPC successfully obtained the Fair-Trade Certification. The annual turnover for the year 2022–2023 was INR 49.05 lakhs. In addition, NAFPC has facilitated credit access to members to the tune of INR 168 lakhs for black gram and groundnut production and small-scale dairy operations.

401.4 Transforming India's Green Revolution by Research and Empowerment for Sustainable Food Supply, Sirkazhi Block, Mayiladuthurai District, Tamil Nadu

Following the assessment of coastal soil salinity-based vulnerability, field-based action has been taken to develop ecosystem-based water resource management planning and implementation processes in the Sirkazhi block of Mayiladuthurai district in Tamil Nadu. A comprehensive vulnerability assessment-based water resource management plan was prepared to effectively manage coastal soil salinity in partnership with the District Rural Development Agency. The plan was fine-tuned with the participation of the community and the Department of Rural Development, Tamil Nadu. The plan was approved after a series of awareness-raising and advocacy campaigns with government officials and local panchayats. As a result, 66 climate adaptation actions were finalized, including construction of check-dams to prevent saline water entry into agricultural fields due to increasing storm surges, large-scale tree plantation of saline-tolerant species in fallow and common lands, desiltation of existing ponds and construction of rainwater-harvesting structures to improve groundwater recharge and also community soak pits for

greywater management. The relevance of these actions was verified at the ground level with the support of panchayat officials. Currently, implementation of these measures is ongoing at the gram-panchayat level. While examining environmental and anthropogenic factors triggering the vulnerability of small farmers and agricultural workers, gender-based violence has emerged as a critical area that needs attention and concrete action, especially among women agricultural workers. Efforts have been made to chronicle the severity of the issue and raise it at a policy level for appropriate action.

401.5 Capacity Building of Producer Collectives

MSSRF, as a technical support agency for the Tamil Nadu Vazhndhu Kattuvom Project (TNVKP), guided the project district teams in region V (Tiruchirappalli, Madurai, Theni, Dindigul, Karur and Namakkal districts) in promoting four new producer collectives (PCs) and also provided support to seven existing PCs. MSSRF facilitated access to financial resources and enhanced market linkages for 5400 farmers, resulting in a total disbursement of INR 130 lakhs to PCs from TNVKP. All seven existing PCs received green auditing awards and cash prizes worth of INR 1.5 lakhs each and green auditing certification from the State Environmental Resource Agency, Government of Tamil Nadu. By executing 15 memoranda of understanding, MSSRF facilitated market linkages for the eleven (new and existing) PCs, which will provide increased market access for their products.

401.6 Status of Malnutrition in Tamil Nadu

A study on the malnutrition status among children in the state of Tamil Nadu was conducted in partnership with the United Nations Children's Fund. As part of the study, malnutrition hotspots were identified using unit-level data from the National Family Health Survey 2019–2021 (NFHS-5). The districts that recorded a higher percentage of child undernutrition and obesity and anaemia in women were identified to map the direct and underlying drivers. A high prevalence of undernutrition among adolescent girls and school-going children across all socio-economic levels suggests that a variety of complex and intricate factors influence the burden of macronutrient and micronutrient deficiency disorders. Despite various interventions and policy frameworks focusing on maternal nutrition, some of the major challenges are inadequate nutrition knowledge, ineffective translation of nutrition education into daily practices and inefficient convergence of associated stakeholders and refinement in the competence of existing programmes at the implementation level. Almost all interventions and policy frameworks focus on maternal nutrition and on children below the age of six years but not on adolescent girls and school-going children, as observed from primary data. However, as they will be future mothers, equal attention must be focused on developing suitable policies and interventions for this target groups. The study suggested that a unified and holistic approach is required to address malnutrition, with participation and

assistance from all stakeholders to evolve and implement programmes for higher success.

401.7 Gender and Community Seed Banks in India

A study has been undertaken to understand the role of informal, community-managed institutions in facilitating access to seeds of traditional crop varieties and conserving crop genetic resources, in partnership with the International Rice Research Institute. The study identified and mapped about 120 agencies working on community seed banks (CSBs) in India. It is interesting to note that, recently, some government agencies (State Biodiversity Boards of Goa and Arunachal Pradesh) have also adopted the CSB approach to promote traditional varieties that are not included in the formal seed system. Further, apart from the conservation of traditional seed varieties, few CSBs handle high-yielding varieties to ensure varietal replacement and seed quality. The drivers of establishment, the scope of operation, size, governance and management models, infrastructure and technical aspects vary among the CSBs examined.

Sub Programme Area 402

Climate Change and Agriculture

402.1 Climate Information Services

The Agro-Meteorological Field Unit (AMFU) at Kannivadi has developed 420 district-level and 1470 block-level bilingual weather forecast-based Agro-Advisory Service (AAS)

bulletins and one special advisory on extreme weather events (Cyclone Mandous). These advisories are distributed bi-weekly to farmers in six districts in the southern zone of Tamil Nadu, depending on the crop growth stage. Multiple tools are employed for dissemination. The primary tool has been the 'mKisan' portal, through which 619 agro-met advisory messages were broadcast to 129159 men and women farmers. To promote co-learning and exchange of information and address agriculture- and weather-based issues, 6 district-level WhatsApp groups among farmers and 14 block-level WhatsApp groups in all blocks of Dindigul district were created. During 2022–23, 1351 weather forecasts, agro-meteorological advisories and livestock care information were disseminated.

In addition to these measures, the India Meteorological Department has introduced two mobile apps (Meghdoot and Damini) to disseminate weather-based information to farmers. AMFU has been conducting regular capacity-building programmes and encouraging the use of these apps to adopt weather-based agriculture practices. Seven hundred and thirty-one farmers (men: 435; women: 296) were trained through 17 farmer awareness programmes on weather-responsive agricultural practices, pest and disease management in maize and cotton, organic farming practices, integrated farming systems and sustainable agricultural practices.

402.2 Enhancing Adaptive Capacity of Small Farmers

MSSRF, in collaboration with Orissa University

of Agriculture and Technology (OUAT), Assam Agricultural University (AAU), Indian Council of Agricultural Research – National Rice Research Institute (ICAR-NRRI), International Water Management Institute (IWMI) and the Norwegian Institute of Bioeconomy Research (NIBIO), is engaged in promoting climate-resilient agriculture. This is carried out by strengthening access to climate-smart agricultural (CSA) technologies and practices and providing institutional linkages and relevant knowledge and skills to adapt to the present climate crisis, associated risks and market dynamics. Key CSA technologies promoted include: varietal replacement with improved drought- and flood-tolerance varieties, direct seeding of rice, site-specific soil and nutrient management practices, use of integrated pest management tools and integrated farming system models. Through public-private partnerships, village-level seed banks were established in Assam to provide farmers' timely access to high-quality seeds of improved varieties during the season.

Providing access to locally relevant knowledge and information to manage climate risks has been facilitated through village knowledge centres (VKCs), both in physical and virtual modes, which have been instrumental in helping farmers adapt and manage climate change risks. VKCs serve as platforms that provide both men and women farmers access to valuable information, knowledge and skills, thus enabling them to make informed decisions. They also play a crucial role in disseminating location-specific content,

advisories and services through various digital modes, namely audio advisories (mobile phone-based), farmer helpline services, audio and video conferences, phone-in programmes and PCs. To upscale the model of VKCs in enabling CSA adoption across the state, a comprehensive training programme was organized for 32 Krishi Vigyan Kendra's (KVKs) in partnership with OUAT on relevant digital tools and content. During the reporting period, these initiatives successfully reached out to 15148 farmers, including 5244 women.

Significant results were recorded among farmers after the adoption of CSA technologies in their locations. Crop productivity increased by 20 to 30 per cent, methane emissions reduced by 30 per cent, quantity and cost of nitrogen fertilizer application reduced by 10 per cent with increased water productivity (40 per cent). Approximately 80 per cent of farmers in the project areas have received training in various CSA technologies, which helped to improve their knowledge, skills and strengthen institutional linkages for adopting these technologies. Over 30000 farmers benefitted from accessing knowledge through digital tools and 33 per cent were women.

Gender mainstreaming is a significant cross-cutting feature in CSA promotional activities. Gender mainstreaming in VKC operations and governance, promotion of women champion farmers and their active participation in the FPOs and providing necessary backward and forward linkages to input and output markets and entitlements were key areas of intervention. During the reporting period,

5244 women took part in various project interventions. The outcome study revealed changes in gender relations among the participating farmers. About 70 to 80 per cent of women gained enhanced knowledge and skills and thus actively participated in different activities of agricultural production, including marketing and decision-making related to agronomic practices aimed at reducing climate risks. Around 62 per cent of the women have adopted climate adaptation technologies and practices such as utilizing improved crop varieties, employing seed treatment methods, adopting innovative planting techniques, implementing efficient irrigation methods and managing soil and plant health effectively. As a result of these advancements, domestic and social violence against women has reduced, and women are receiving better recognition from their families and society. This recognition reflects changes in social gender norms, including increased women's mobility, interaction with outsiders, confidence in public speaking, engagement in marketing activities, establishing of linkages with institutions and recognition among relatives and friends. Likewise, women have developed stronger negotiation skills. This has led to increased involvement in agricultural decision-making processes. Currently, women manage more than 70 per cent of household financial transactions. Although decision-making processes involve both men and women, women's voices have gained prominence, and men are increasingly consulting them, both in agricultural operations and in domestic activities.

402.3 Climate Change and Water Resources Management

MSSRF continues to play the role of a technical support agency in implementing project WASCA (Water Security for Climate Adaptation in rural areas) in partnership with the Department of Rural Development, Government of Tamil Nadu, in two districts, Ramanathapuram and Tiruvannamalai. In addition to Tamil Nadu, WASCA has now extended operations to four more states with two different agro-ecologies in phase II, covering nine districts. The primary objective is to build the capacity of district official to undertake water resource management planning based on geographical information system (GIS) and adopting scientific principles in identifying key water challenges and relevant water actions (climate adaptation measures). Following a convergence strategy, these initiatives were mapped and integrated with major government-run programmes such as the Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS), Catch the Rain and other such line department schemes. In Ramanathapuram district, MSSRF facilitated piloting of 17 climate resilient measures (CRMs). Of these, 'Cascading of the Tanks' is an important CRM identified for demonstration in R S Mangalam block. This will allow for efficient surface water storage by renovating links between existing tanks and reducing surface runoff in the downstream direction. Additional financial resources were secured

from NABARD for its implementation in the field along with possible funding support from MGNREGS. Another suitable CRM for this coastal district is restoring the plantation of mangroves and non-mangroves. For this, nurseries with suitable tree species were established in Ramanathapuram district, and 30000 *Avicennia marina* and *Rhizophora* mangrove saplings and 25000 non-mangrove saplings were raised. Of these, 10000 saplings were planted by the State Forest Department and the District Rural Development Agency during the reporting period. As part of the WASCA project, the plantation sites for Green Mission, a flagship project of the state government of Tamil Nadu, were identified using spatial and non-spatial data. The Green Mission is an ambitious movement to achieve 33 per cent tree cover in the state. On the day of inauguration of this mission, 6000 non-mangrove tree saplings were also planted along a 2 km stretch of coastal shelter belt in Thiruppullani block, Ramanathapuram district. Over 500 women MGNREGS workers, school and college students, and volunteers planted saplings. Cross-learning visits were facilitated for the Rajasthan and Andhra Pradesh state officials for developing GIS-based planning and innovative CRMs such as the greening of hills, mini-forests, river bank stabilization, cascade of tanks, silvipasture, fallow land development etc. As a follow-up initiative, the Rajasthan state government has planned to replicate the mini-forest model on the river bank for stabilization. Similarly, in Tiruvannamalai district, 13 CRMs were

demonstrated. In 108 gram panchayats (GPs), the plan was implemented in saturation mode. MSSRF supported the district administration in the preparation of a coffee table book on 'NRM Works for Climate Adaptation under MGNREGA'. As of mid-June 2023, Ramanathapuram and Tiruvannamalai districts are ranked first and second respectively for uploading the maximum number of works in the D-29 form among other districts in the state.

In partnership with the respective district-level rural development agencies, capacity-building workshops on scientific planning of water resources management and implementation of water conservation methods in rural areas have been completed for 1289 GPs in Tamil Nadu. During December 2022, phase II of the WASCA project was initiated and MSSRF has been selected as Technical Support Agency for four states including Tamil Nadu and one Union Territory (Kerala, Andhra Pradesh, Telangana and Andaman and Nicobar Islands) covering 10 districts. The selected districts are Villupuram and Dharmapuri in Tamil Nadu, Palakkad and Kasaragod in Kerala, Ananthapur and Anakapalle in Andhra Pradesh, Narayanpet and Vikrabad in Telangana, and South and Central Andaman in Andaman and Nicobar Islands. The preparatory activities; developing a rapport with government officials, building the capacity of policymakers at both the state and district levels, understanding existing planning process and identifying works, and reviewing and comparing the frameworks developed by the different states were completed.

Sub Programme Area 403

Jamsetji Tata National Virtual Academy for Rural Prosperity

403.1 Transforming Public Libraries Lifelong Learning Centres

Final reports have been completed and shared with associated partners and organizations. Need-based information support has been extended to select libraries.

403.2 Village Resource Centres and Village Knowledge Centres

Village Resource Centres (VRCs) and Village Knowledge Centres (VKCs) continue to meet the knowledge needs of farmers through innovative information communication technology (ICT) tools. The VKC, a community-managed, village-level platform, delivers demand-driven, locale-specific, dynamic and static information and knowledge. It also builds the capacity of farmers through structured capacity-building programmes.

Currently, 5 VRCs and 13 VKCs are functional (physical setup), virtually connecting 650 villages. The operational focus areas are agriculture (57 per cent), animal husbandry (9 per cent), health and nutrition (9 per cent) and accessing entitlements (25 per cent). The main digital tools used are listed in Section 402.2. User-relevant content is key to adoption. This year, nearly 420 text-based content and 350 audio and 28 video-based content were developed. During the reporting

period, 24854 farmers (39 per cent) accessed information through VKCs, that organized 539 capacity-building programmes. Farmers preferred mobile-based voice mail, helplines and WhatsApp messages. Of this, information on animal husbandry, health and nutrition, and government schemes was utilized more by women, by personal visits VKCs. On the other hand, men accessed more information on crop management using ICT tools. The VKC management committee plays a vital role in ensuring its functioning and sustainability. One important revenue-generation source for the VKC is providing access to different paid online services of the Government of India (functioning as Common Service Centres). So far, 2865 users (31.37 per cent) accessed online services (e.g., PAN card, KCCs, employment renewal, family card update) and generated an average income of INR 1000 per centre. VKCs have established strong linkages with stakeholders and line departments and are approached to organize programmes on their behalf. The VKC-VRC concept has been replicated in Sri Lanka by a NGO partner and in Tanzania by the Agricultural Research Institute, Government of Tanzania.

The provision of timely advisory services through VKCs has had a positive impact on farmers, leading to improvement in knowledge and adoption of various agronomic technologies, helping to make informed decisions and increasing efficiency in the use of inputs. These positive effects are evident through increased crop productivity, reduced pesticide usage and input costs, and increased income. A study conducted among

paddy farmers who accessed information through VKCs revealed that 72 per cent reduced input costs, ranging from INR 500 to INR 1000 per acre. Moreover, 94 per cent of the farmers utilizing information from VKCs have expressed that paddy productivity has increased between 36.60 to 49.6 per cent. These improvements not only contribute to the economic well-being of farmers but also have positive implications for the use of sustainable agricultural practices and the environment.

Farm School: The farm school in Pasupathikovil village is an innovative strategy to promote farmer-to-farmer learning among smallholders, especially women farmers in the region. Hosted by a woman farmer, the school fosters the adoption of good agronomic practices in paddy-based cropping systems, including soil nutrient, pest and irrigation management practices. This year, 15 training programmes, involving 449 farmers (men: 221; women: 228), were conducted. Participating farmers shared knowledge, skills and technologies with 1700 farmers in the networks. Farmer feedback revealed that about 70 per cent of farmers who regularly attended the farm school training and demonstrations achieved higher yield in paddy (15 per cent) and black gram (20 per cent).

Video-Based Learning: Video-based learning (VBL) is another collective learning approach that enables individuals to acquire skills and knowledge. VBL complements existing agricultural extension services by extending beyond simply providing viewing content to encourage the community to actively

participate in co-creating new knowledge, co-learning and sharing their experiences. In collaboration with Access Agriculture, MSSRF has developed six farmer-friendly videos, translated 10 needs-based videos and collected 60 suitable videos from various stakeholders. These videos are then screened in villages based on the cropping season and farmers' needs at their convenient time. One hundred and fourteen VBL programmes were conducted in 39 villages across Tamil Nadu, Puducherry, Assam and Odisha. The videos have been viewed by 3192 farmers, including 1190 women. To assess the impact of the videos, pre- and post-evaluations were conducted for each screening. The collected data revealed significant benefits: 79 per cent of farmers reported an enhancement in their knowledge on specific subjects covered in the videos, and 57 per cent adopted the technologies in their fields after learning from the videos.

Plant Clinics: The PC is an innovative model, implemented in collaboration with the Centre for Agriculture and Biosciences International, New Delhi for the past 12 years, and has become a flagship initiative to address plant health issues faced by farmers. This programme has received widespread acceptance from farmers and stakeholders due to its ability to provide farmer-centric services quickly. As of now, 36 PCs are functioning in 158 villages, and 39 trained plant doctors, including 19 women, periodically conduct PCs. To extend the services to several villages, a mobile PC was launched with advanced digital infrastructure for diagnosing plant health issues.

During the reporting year, 266 PC sessions, including 58 online sessions covering 91 villages and 4268 farmers (855 women), diagnosed 4276 affected crop samples. As part of the initiative, 65 need-based and location-specific content in the form of a Pest Decision Management Guide (PMDG) factsheet were developed. As a result, 83 per cent of farmers adopted the advisories. Of this, 62 per cent realized an increase in income between

INR 5000–8000 per acre, with an average reduction in input cost ranging from INR 550 to INR 1200 per acre, depending on the crop. Moreover, 68 per cent farmers stated that they had gained knowledge on plant health over the years, allowing them to take proactive management actions. Most importantly, about 58 per cent farmers who attended PCs now opt for bio-inputs and reduced usage of red-labelled pesticides.

Key highlights

- Seven farmer producer organizations together facilitated direct access to productive resources and services (technology, institutional links, credit, knowledge, input and output markets) to over 10000 small farmers (over 40 per cent women).
- 1.98 lakh farmers gained access to information, knowledge resources and skills to improve agricultural production through digital tools.
- A farmer-led- seed production value chain model for black gram, ground nut and paddy was demonstrated by a Farmer Producer Organization.
- A cadre of 100 plant health monitors were created to advise farmers on plant health information for both diagnosis and adoption levels.
- From a gender perspective, 62 per cent of the women have adopted climate adaptation technologies and practices, acquired stronger negotiation skills, received recognition at the household and societal levels and participated in decision-making for agricultural production.

AGRICULTURE, NUTRITION AND HEALTH

The Agriculture, Nutrition and Health Programme at MSSRF follows the concept of Farming System for Nutrition including nutrition garden as an important strategy to increase dietary diversity. The focus has been on leveraging agriculture for nutrition and health through research and demonstration at the community level and connecting with different stakeholders. In Odisha, the Biju Patnaik Tribal Agrobiodiversity Centre (BPTAbC), Jeypore made efforts to strengthen livelihoods, enhance food and nutrition security, and improve household dietary diversity of small and marginal farmers through a nutrition-sensitive farming system. A Science, Technology and Innovation Hub is continuing to upscale sustainable technological solutions in Koraput district. This year, the Community Agrobiodiversity Centre (CAbC), Wayanad district of Kerala focussed on strengthening the existing nutrition garden and in-situ community conservation plots, piloted protected vegetable cultivation using rain shelters. Nutri-gardens established in four districts of India; Tirur in Tamil Nadu, Kanpur Dehat in Uttar Pradesh, Koraput in Odisha and Palghat in Maharashtra are being maintained.

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Sub Programme Area 501

Biju Patnaik Tribal Agrobiodiversity Centre, MSSRF, Jeypore

501.1 Nutrition-Sensitive Farming System for strengthening Livelihoods and Enhancing Food and Nutrition Security

The Farming System for Nutrition (FSN) model has been implemented in 47 villages in Boipariguda block in Koraput district covering 1575 households. Three cluster-level community seed banks were promoted to ensure the continuous availability of quality seed materials for the cultivation of nutri-dense crops. Seeds of local landraces of paddy, finger millet, pulses, oil seeds and vegetables, along with improved varieties of paddy (high-protein and nutrient-rich varieties- CR Dhan 310 and CR Dhan 311), finger millet (Chilika and KMR 204) and vegetables were stored in the seed bank. A management committee comprising of 11 members (of which 5 are women) was formed to operate the seed banks in the respective villages.

Twenty-two millet processing units were installed this year to address drudgery in processing of small millets and to promote value-added products as an enterprise. These units are owned and operated by women SHGs in their respective villages. The main outcomes of the interventions included substantial reduction in drudgery, time saving, increased income and 30 per

cent increased household millet consumption. Pulse processing units were established in two cluster villages managed by men farmer groups. Fifty cycle weeders were provided to 35 villages to reduce the drudgery of women involved in the weeding of field crops. One hundred and eight community hunger fighters (CHF) continued monitoring and documenting changes in household nutritional status. The knowledge and skill of the CHFs as upgraded with respect to drinking water, sanitation and backyard poultry management through exposure visits.

As a step towards strengthening local food systems and enhancing crop productivity, 204 farmers (including 47 women) and 10 volunteers were trained on improved crop production technologies in rice, finger millet and maize. Thirty-two farmers (men: 25; women: 7) were trained on organic farming, 60 farmers (men: 6; women: 54) on oyster mushroom production, 143 farmers (men: 81; women: 62) on fish production technology and 128 farmers (men: 84; women: 44) on fruit and vegetable cultivation. An FSN demonstration model established in 0.32 ha at the BPTAbC, Jeypore created awareness among 4000 farmers.

A research project undertaken to study the impact of FSN model has transformed the local food system by making significant increases in area under cultivation, production and productivity of nutri-dense crops such as finger millet, horse gram, maize and pigeon pea. This in turn has increased household consumption and improved dietary diversity. Under the FSN

model, the total area under cultivation has increased by 13.5 per cent (408.28 ha) from the baseline of 302.43 ha in 2021–22. Major crops cultivated by the farmers, irrespective of land types are paddy, finger millet, little millet, horse gram, niger, maize and pigeon pea. Between the baseline and endline periods, there has been no change in the area under paddy cultivation, while the number of households and the operational area under cultivation of finger millet (3.4 per cent), horse gram (6 per cent), maize and pigeon pea increased. There was also an increase in the number of households cultivating finger millet (17.4 per cent) and horse gram (37 per cent).

The average area under paddy cultivation was 0.58 ha, with a productivity of 2.89 tonnes per household. Out of 270 households that cultivate paddy, 98 per cent used the produce for self-consumption and the remaining was sold in the market. Similarly, for finger millet, the average area cultivated by a household was 0.26 ha, with an average productivity of 0.23 tonnes. One hundred and ninety-five households were cultivating finger millet in the project area, of which 95 per cent was for self-consumption with an average quantity of 70 kg per household per annum. Only four households cultivated pigeon pea in the uplands during kharif season. The average pigeon pea yield was 122.5 kg/ha. Of this, 94 per cent was self-consumed and the remaining was sold. In addition, 39 households cultivated pigeon pea in their backyards/home gardens. Twenty-one households cultivated horse gram in uplands during the kharif season and average productivity was 0.61 tonnes/

ha. All the households used the product for home consumption, and the average amount consumed was 12 kg per annum.

The home garden supported the local community and ensured adequate availability of diverse food groups, including leafy greens, other vegetables, roots and tubers, pulses, fruits, eggs, meat and fish over nine months. The FSN programme also helped in earning a revenue of over INR 5000 from vegetables, eggs and fish. The average household dietary diversity score increased from six to seven. The percentage of households with low dietary diversity decreased from 48.6 to 19.0 per cent, whereas those with medium and high dietary diversity respectively increased from 33.4 to 50.8 per cent and from 18.0 to 30.2 per cent. Ninety-five per cent of targeted households have a better understanding of nutrition-sensitive agriculture, and 70 per cent have adopted nutrition-sensitive agricultural practices.

501.2 Promotion of Nutrition Gardens to Improve Dietary Diversity of Rural and Tribal Households in Koraput District

Promoting home gardens in 75 villages of Boipariguda block in Koraput district has been on-going since 2021. To address micro-nutrient deficiencies or hidden hunger, the project envisaged establishing nutrition gardens with fruits and vegetables. Seeds/saplings of fruit-bearing species (papaya, drumstick, guava, lemon, banana and mango) along with seasonal vegetables (*Amaranthus*, coriander, spinach, pumpkin, bitter gourd, bottle gourd, ridge gourd, runner bean, cucumber, cluster

bean, brinjal, tomato and lady's finger) were distributed to 1274 households. Two cluster-level nurseries, managed by the women SHGs were established to ensure availability of quality seedlings/saplings. The seedlings of chilli, brinjal, tomato, cabbage and cauliflower and saplings of papaya and moringa were raised and distributed to farmers. So far, around 920 households from 17 villages, six Integrated Child Development Service (ICDS) centres and seven schools have purchased seedlings from the nursery. The SHGs earned INR 15000 and 8000 respectively from the two community nurseries in a short span of six months.

Twenty model nutrition gardens have been established with green leafy vegetables, root and tubers, and other as demonstration units. Also, nutrition gardens were established in 18 schools and 25 ICDS centres. Twelve cluster-level nutrition awareness programmes were organized, in which 732 farmers (men: 385; women: 347) from 75 villages participated. Seven training programmes on management of nutrition gardens were conducted for 297 farmers (men: 171; women: 126). Residential training and exposure visits for nutrition gardening, nursery management and innovative technologies in horticulture were organized for 33 farmers (men: 28; women: 5) over four days. Three exposure visits to model farms were also organized. Three cluster-level programmes were organized during World Breast Feeding Week, National Nutrition Week and National Nutrition month to raise awareness in 16 cluster villages.

501.3 Science, Technology and Innovation Hub for Upscaling Sustainable Technological Solutions for Food and Nutrition Security

The main objectives of this hub were to build the capacity of farmers on improved farming methods and to provide access to quality seeds, thereby improving millet and paddy productivity. Farmers from 2840 households in 34 villages from three selected blocks (Boipariguda, Koraput and Kundra, Koraput district) were supported in this initiative. Since February 2021, these activities were on-going in collaboration with the Indian Council for Agricultural Research (ICAR) - Indian Institute of Soil and Water Conservation (IISWC), Sunabeda, Koraput and the Institute of Life Sciences, Bhubaneswar as knowledge partners.

Improved cultivation practices being implemented include seed treatment, raising nurseries, line transplantation, system of millet intensification, mechanical weeding using cycle weeders and application of foliar spray for cultivation of millets and paddy over 643 and 759 ha respectively by 970 farmers. Millet productivity under improved farming methods ranged between 0.15 and 0.26 tonnes/ha, with an average productivity of 0.15 tonnes/ha. Similarly, paddy productivity varied across varieties: the average productivity of *Lacktimachi*, a traditional paddy variety, was 2.2 tonnes/ha, *Kalajeera*, another traditional variety, was 2.6 tonnes/ha and 4.6 tonnes/ha from a high-yielding paddy variety, Arjel.

To diversify the cropping system, cultivation of off-season vegetables was promoted among 1032 farmers in 382.4 ha and 878 nutrition gardens were also established. Depending on area and crops, farmers earned a net profit between INR 7207 to 17230. During the reporting period, 600 kg of *Trichoderma viride* and 258 kg of *Rhizobium* sp were produced and distributed among 600 farmers for seed treatment of paddy, millet, green gram and black gram and for soil application. The farmers were also trained on bioinputs for seed treatment and soil application.

Soil samples were collected from 988 fields at a depth of 0–20 cm for field crops (millets, paddy, vegetables) and at a depth of 20–40 cm for tree crops. Land levelling, trench and field bunds were demonstrated over 161 ha in project villages in Koraput district. An agri-horticulture model was promoted over 60 ha in 34 villages of Kundra, Koraput and Boipariguda blocks. During the project period, 178 field training programmes were carried out for 6444 farmers (men: 2588; women: 3856) on the themes of soil and water conservation, water management, establishment of nutrition garden, seed treatment, raising nurseries and transplanting.

501.4 Rice Fallow Management in Odisha

To achieve self-sufficiency in pulses production and ensure food and nutritional security, the Department of Agriculture and Farmers' Empowerment, Government of Odisha, has launched a new initiative titled 'Comprehensive Project on Rice Fallow Management in Odisha'. A cluster approach has been adopted

to build their capacity on improved agronomic practices (including use of bioinputs) and extension approaches (demonstrations, exposure visits and hands-on training) in Koraput, Malkangiri and Nayagarh districts of Odisha.

An awareness programme on the importance of pulses and training on crop production technologies was provided to 6645 farmers. In addition, 2127 farmers participated in farmers' field day and crop-cutting experiments (CCEs) and 385 participated in the training programme on post-harvest technology of pulses. The CCEs were conducted in demonstration plots and also on farmers' plots, to compare the performance of both traditional and improved varieties of green gram and black gram production.

In Nayagarh district, with improved agronomic practices for green gram, productivity was over 50 per cent higher for the improved variety IPM 205-7 (Virat) (851 kg/ha) compared with the farmer's variety (425 kg/ha). Similarly, IPM 410-3 (Sikha) showed a 49 per cent higher yield than farmer's variety. A higher number of root nodules were observed in IPM 205-7 (Virat) compared to IPM 410-3 (Sikha) and farmer's variety. Sowing time also impacted productivity. Farmers who sowed the seeds prior to mid-December obtained higher yields. In Koraput district, IPM 205-7 (Virat) recorded an average yield of 820 kg/ha followed by IPM 410-3 (Sikha: 640 kg/ha) compared with farmer's variety (570 kg/ha). Similarly, black gram variety PU-10 recorded an average yield of 780 kg/ha. In Malkangiri district, green gram variety IPM 410-3 (Sikha) performed well with

an average yield of 700 kg/ha compared to IPM 205-7 (Virat: 600 kg/ha). Average yield of the black gram variety PU-10 was 520 kg/ha.

Sub Programme Area 502

Community Agrobiodiversity Centre, MSSRF, Wayanad

502.1 Food, Nutrition and Livelihood Interventions

Conservation of tuber diversity: To conserve and cultivate native tuber diversity as well as increase food and livelihood security, an *in-situ* community conservation plot (40 cents land) with 18 varieties of *Dioscorea* is jointly maintained by five farmers at Madamkundu tribal colony, Wayanad. This has led to increased household consumption and gross income (INR 34000) during the reporting year. The conservation plot also ensures quality seeds of tubers for the local community.

Nutrition education and nutrition garden: To promote nutrition education among rural households and strengthen backyard nutrition garden, 250 households (25 households in each of the 10 project villages) in Wayanad district were supported with seeds/seedlings of 18 varieties of vegetables initially for household consumption alone. However, during the reporting period, two groups in a project village involved in vegetable cultivation at a common location marketed surplus vegetables and earned an average group income of INR 4000. The group also expressed interest in engaging in vegetable cultivation on a larger scale. On World Food Day 2022,

a seminar on importance of dietary diversity to address 'hidden hunger' was organised at the CAbC that was attended by 53 farmers (men: 25; women: 28 and school children: 47).

Strengthening homestead gardens: Tribal and marginal households in Kaniyambetta (90) and Noolpuzha (60) panchayats were provided with vegetables seeds/bulbs (tomato, brinjal, okra, chillies and tubers) along with vermicompost in Wayanad district. Due to space constraints, vegetables were cultivated either in grow bags or along the borders of the house. The vegetables and tubers grown in the garden resulted in the consumption of a minimum of 25 kg/month per household. However, increasingly, farmers are facing threats from deer, monkeys and wild boar in the region affecting vegetable production.

Rain shelters for round-the-year vegetable production: Farmers opt for protected cultivation of vegetables, ornamental plants and nurseries for pepper due to increasing climate risks and threat from wildlife. Farmers' groups, including women's group cultivated seasonal vegetables in seven rain shelters {two new and five existing: (10 m x 5 m)}. Training on nursery management was provided to the farmers. Two hundred and thirty-eight kilograms of vegetables was harvested five rain shelters. Vegetables such as long bean, tomato, chilli, okra, brinjal and amaranth were cultivated in the rain shelters.

502.2 Education, Communication and Training

Training and capacity-building programmes

Table 1. *Training programmes conducted at the CABc, Wayanad*

S no.	Training programmes	No. of days	No. of participants	
			Men	Women
1	Mushroom production	1	–	12
2	Bamboo craft production	14	–	10
3	Honeybee-keeping	1	12	9
4	Umbrella making	2	3	33
5	Skill training for SC/ST on farm machinery	21	25	14

shown in (Table 1) were conducted for farmers and the tribal/rural community during the reporting year.

Infrastructure for learning: Twenty anganwadi centres each in Wayanad and Idukki districts and seven in Ernakulam district were upgraded by providing teaching aids, toys, learning materials, wall paintings to promote infrastructure for better learning. These initiatives helped to make learning more engaging and relevant for students. Sixty hamlet-level creative workshops were conducted that benefitted 120 students (boys: 72; girls: 48) from ten Adivasi hamlets. These creative workshops helped them to come up with new ideas and solutions and build confidence.

Wayanad Community Seed Fest 2023: The Wayanad Community Seed Fest held in March 2023 focused on the agricultural heritage of Wayanad and was attended by 1501 members (men: 410; women: 670; school students: 421). Issues related to tribal health and nutrition, and the role of millets and underutilized crops for nutritional security were discussed. Conservation of traditional biodiversity, especially agro-biodiversity has

been identified as vital for ensuring food and nutrition security for the growing population.

Skill training for SC/ST on farm machinery:

To improve skills of SC/ST communities, a three-week state-level training programme on farm machine repair and operation was organized. Thirty-nine participants (men: 25; women: 14) were trained to use 36 types of farm machines. The training was conducted by visits to farmers' fields, research institutions and industrial centres where these skills are necessary for production and processing. At the end of the training programme, the ICAR-Indian Institute of Spices Research, Calicut, provided agricultural implements/tools (spade and pickaxes) to the trainees. The participants were also linked to the State Training Institute at Thiruvananthapuram and to the Wayanad District Tractor Owners' Association, for potential employment opportunities.

Other skill training programmes: Awareness on non-wood forest products-based livelihoods, specifically honey and tubers was conducted for 53 farmers. Training on the management of waste in public places was provided, and two plastic bailing and waste management units were established by the panchayat-

level *Haritha Karma Sena*. Eight Adivasi women from Wayanad were trained on tailoring and have established a tailoring unit. Farmer entrepreneur groups were trained in cocoa processing and value addition, poultry farming and value addition of dairy products. Seventy-nine plant clinic sessions were conducted by trained plant doctors; they addressed 291 cases of pests and diseases in spices, plantation crops and vegetables and supported 1093 farmers. Six hundred farmers (including two women’s groups) were trained in the production of bio-inputs (*jeevamurtham*, nutrient mix and neem oil). One hundred dairy farmers were trained in the production of organic cattle feed and in fodder development (Table 2).

Rural entrepreneurship development programmes: A rural entrepreneurship

programme was implemented in 34 villages (14 in Ernakulum and 10 each in Idukki and Wayanad districts) to build the capacity of farmers and fishing communities, improve their socio-economic condition and enhance community resilience to natural disasters and climate change. CAbC promoted multiple strategies to enhance on-farm income by adopting good agricultural practices and creating off-farm livelihoods.

Technical support for women-led enterprises: Technical training and input support were provided to ‘Thejas’, a tailoring unit run by eight Paniya tribal women. The unit has been producing eco-friendly cloth bags, masks, file folders and pouches since 2020. To strengthen the unit, technical skills and input support were provided to the members to help upscale their production.

Table 2. *Income-generating ventures at the CAbC, Wayanad*

Training and capacity building	No. of people who attended the training	Ventures initiated	Gross income from enterprises (in INR)
Mushroom cultivation	83	4	12000/month
Nursery management	39	4	NA
Bamboo artefacts/handicrafts	8	1	NA
Goat rearing	60	60	5000/month
Paddy cultivation	62	3	NA
Bio-inputs	600	2	NA
Apiary	32	32	2500/household
Tailoring	25	5	25000/month
Dairy products unit	20	4	10000/month
Fish processing unit	10	2	NA
Agro products unit	10	2	NA
Plant clinic	1093	79	NA
Mini rice mill	54	1	NA

Table 3. *Handholding for women-led enterprises (Supported by CAbC, wayanad)*

Income-generating venture	Year of initiation	No. of women	Income earned (per member) during the year (INR)
Dairy products (4 units)	2022	20	24000
Tailoring (8 units)	2022	30	60000
Food processing (3 units)	2022	6	30000
Pickle and curry masala production (3 units)	2021	9	36000
Cloth bag unit	2021	6	38400

Community enterprises: During the year, CAbC supported the establishment of community enterprises led by women and initiated 19 units (dairy products unit: 4; tailoring unit: 8; food processing unit: 3; pickle and curry masala unit: 3; cloth bag unit, 1). The Centre provided training, technical and financial support, machinery for establishing women-led community enterprises. The activity has enhanced the skills of 104 women members (Table 3).

502.4 Investments in Public Welfare

Six public wells and two common ponds were renovated in six villages (Varapuzha, Chedamangalam, Edavanakkad, Kuzhuppily, Nayarambalam and Vadakkekara) in Ernakulam district, and two common ponds in Wayanad district. Two hundred solar streetlights were installed in both Wayanad and Idukki districts in places such as rural village roads, at road junctions, deep curve roads, areas prone to wild animal attacks and thefts. Six government schools were provided drinking water facilities in six villages (Wayanad: Vellamunda, Muttila and Edavaka villages; Idukki: Parathod, Mannamkandom and Papadumpara villages).

Sub Programme Area 503

Model Nutri-gardens for food-based nutrition security

MSSRF has established gardens of nutri-rich plants in partnership with the Krishi Vigyan Kendras (KVKs) at Kanpur Dehat, Uttar Pradesh; Palghar, Maharashtra; KVK Tiruvallur, Tamil Nadu; and also at MSSRF regional centre, Jeypore, Odisha. The aim is to achieve food-based nutrition security for malnourished tribal and rural households, increase the capacity of small and marginal farm families to cultivate nutri-rich plants and create nutritional awareness through 'community hunger fighters' in the focus districts. During this year, training programmes on vegetable cultivation for consumption (land preparation, planting methods, nursery techniques, nutrient and water management for quality vegetable production) were conducted for small and marginal farm families (members of farmer SHGs) with the help of master trainers. Nutrition awareness programmes are also being conducted for the participants identified by the Integrated Child Development

Services (ICDS) officials and anganwadi workers. As part of this programme, the National Institute of Nutrition, Hyderabad, has carried out a nutrition survey in all four focus

districts to assess the project implementation process and the perceptions and practices among farmers. Final report compilation is underway.

Key highlights

- Twenty two millet processing units established to reduce the drudgery of women in processing millets in 22 villages in Odisha.
- 204 farmers and 10 volunteers were trained to strengthen the local food systems and enhancing crop productivity adopting improved crop production technologies in rice, finger millet and maize.
- Community conservation plot (40 cents land) with 18 varieties of *Dioscorea* are being jointly maintained by five farmers in Wayanad, leading to increased household consumption and also gross income.
- 920 and 250 nutri-gardens were established in Odisha and Wayanad respectively to improve household dietary diversity
- Four model nutri gardens are being promoted as model gardens showcasing locale specific nutri rich plant species in four districts of India with high rates of malnutrition.

Climate Change

The Climate Change Programme at MSSRF undertakes policy and research work on various aspects of climate change. With a strong interdisciplinary focus, guided by a commitment to equity and climate justice, the programme generates knowledge and policy outputs related to climate change to assist policy influencers and policymakers at the state and central governments and in other developing countries. The Climate Change Group have been part of the Government of India delegation to the Conference of Parties (COP27) of the United Nations Framework Convention on Climate Change (UNFCCC) and also the approval session of the Sixth Assessment Cycle Synthesis Report of the Intergovernmental Panel on Climate Change (IPCC).

Sub Programme Area 601

Policy Interventions

The Climate Change Programme at MSSRF, in collaboration with the energy and climate group at the National Institute of Advanced Studies (NIAS), Bengaluru, conducted a pivotal global study that illustrated the grossly inequitable nature of mitigation pathway scenarios outlined in the Sixth Assessment Report (AR6) of the Intergovernmental Panel on Climate Change (IPCC). The results of this study present critical insights into IPCC AR6 scenarios and their implications for climate policymaking. Analysis of the regional trends underlying the globally modelled scenarios indicates that the scenarios make no explicit assumptions about global equity, and they, in fact, project existing global inequities far into the future. IPCC AR6 scenarios disregard both the historical responsibility of the global North for carbon emissions and the future energy needs of the global South required to meet developmental goals. The study reveals that these scenarios place the burden of climate change mitigation squarely on developing countries, while developed countries continue to increase their energy consumption unhindered by constraints on the use of fossil fuels. Per capita gross domestic product (GDP), consumption and energy use remain significantly high in developed countries, even as most developing regions are projected to stay at very low-income levels, and also consumption of goods and services, and energy in these regions.

The study also reveals that higher levels of energy consumption in developed countries are facilitated by higher per capita fossil fuel consumption in these regions, even into 2050, with developing countries providing the carbon sinks for their unchecked fossil fuel emissions. Uniformly, across scenarios, developed countries that have already exhausted their fair share of the carbon budget are projected to use higher shares of even the remaining carbon budget. The study was presented at the COP27 and garnered significant attention from the climate policy fraternity. The preprint of the study is currently available and is expected to be published shortly.

Under the ongoing Global Environment Facility-Government of India-United Nations Development Programme (GEF-Gol-UNDP) NATCOM project on “Equity and CBDR-RC in the context of 2 °C warming - Implications for India”, MSSRF, in collaboration with the energy and climate group at NIAS, Bengaluru, revamped the Climate Equity Monitor, a research and information portal for assessing equity in climate action related to climate mitigation, energy and resource consumption, and climate policy, covering all countries. The revamped website highlights storylines on ongoing global climate policy narratives and policy negotiations, non-fossil fuel installed capacity and updated nationally determined contributions (NDCs) with an interactive, user-friendly website interface. Climate Equity Monitor is the first portal of its kind from the Global South that presents and analyzes the climate policies, climate actions and resource consumption of developed and developing

countries from the perspective of equity, climate justice and the principle of common but differentiated responsibilities and respective capabilities.

Detailed policy briefs, along with research analysis and notes, were prepared for the negotiation agenda items of the UNFCCC at COP27 (Sharm-el-Sheikh, Egypt, November 2022). This was part of the analysis for the GEF-Gol-UNDP NATCOM project 'Global Contextualisation and Inter-country comparisons in the Third National Communication'. The briefs covered, inter alia, issues ranging from global mitigation and adaptation policies, policy aspects of climate science, climate policy in agriculture, loss and damage, climate finance and issues related to equity and climate justice.

Policy and research support was provided to the Ministry of Environment, Forests and Climate Change (MoEFCC) by the Climate Change Programme in reviewing the final government draft of the Summary of Policy Makers (SPM) and also the Synthesis Report during the 58th Session of the IPCC AR6 SYR Approval Session. Policy and technical briefs were submitted to the MoEFCC on various aspects of climate policy, including carbon budgets, mitigation pathways and the operationalization of international equity in climate policy based on the principle of fair access to global carbon budgets. The latter has now been incorporated as an integral part of the climate policy of the Government of India, and the Climate Change Programme at MSSRF has played a central role in the

evolution of this policy. To support India's policy standpoint, a brochure titled 'Global Carbon Budgets: Frequently Asked Questions' and a policy brief titled 'Equity Assessment of Global Mitigation Pathways in the IPCC Sixth Assessment Report' were prepared and widely disseminated during COP27. A brochure on the Climate Equity Monitor was also prepared and distributed at COP27.

Modelling the Impact of Aridification on Crop Production: Paddy Cultivation in the Cauvery Delta

The study, conducted under the Google Artificial Intelligence (AI) for Social Good Programme funded by Google Research India Lab, is focused on utilizing high-resolution satellite imagery, remote sensing data and machine learning (ML) techniques to achieve its goals. Advanced ML methods, including deep learning structures such as convolutional neural networks (CNNs), are used in the interpretation of satellite imagery and remote sensing data. The main goal is to construct proficient deep neural network-based models for precisely classifying satellite images. Using these models, crop types can be accurately predicted, pertinent biophysical and climatic parameters estimated, and crop production determined at finer spatiotemporal resolutions than with conventional ground-based surveys.

Specifically, the study will provide quantitative predictions related to key aspects of agricultural practices and crop management. These aspects include crop cover mapping, estimation of sowing and harvesting dates,

yield estimation and measurements of evapotranspiration. These predicted outcomes can provide valuable insights into the potential impact of aridification on paddy yields in the Cauvery Delta. The study uses different types of satellite images and machine learning models to complete three main tasks: identifying sections of paddy crop plots, predicting paddy growth stages, and forecasting crop yields. In our modelling, we used combinations of images and models for each task. Using this approach optimum results were obtained for each task. This method of using tailored models and images for each task was key to getting the most accurate results possible. These top-performing results showcase the potential of our approach for future use of these models.

For the modelling studies conducted on annotated data, the UNet-3D model, a specific deep-learning architecture typically used for image segmentation tasks, was employed in conjunction with Sentinel-1 satellite data. This combination exhibited considerable proficiency in identifying image segments representing paddy crops of the delta, with an overall accuracy of 95.47 per cent and a high intersection over union (IoU) value of 90.27 per cent, signifying an overlap between the model's predictions and the actual annotated data. For predicting paddy phenology, specifically the sowing and harvesting dates, we relied on Sentinel-2 images and UNet-3D model along with the Fusion ConvLSTM and U-TAE models. The UNet-3D model demonstrated strong accuracy in predicting sowing dates with a mean absolute error (MAE) of just 1.53

days. When predicting harvesting dates, the Fusion ConvLSTM model resulted in an MAE of 10.91 days, whereas the U-TAE model showed a slightly smaller MAE of 9.75 days. These models were able to make accurate predictions with a mean absolute error of 1.53 days for sowing dates and mean absolute errors of 10.91 and 9.75 days for harvesting dates, respectively. On the other hand, for yield predictions, using the Sentinel-1-based UNet-2D and U-TAE models, both convolutional neural networks designed for analyzing image data, demonstrated potential. However, the results obtained from these models require further improvement.

During the reporting period, the primary task has been the deployment of prediction models for the comprehensive identification of crop types and the estimation of sowing and harvesting dates for paddy across the entire Cauvery delta. These models have been successfully implemented and have shown promising outcomes in identifying crop types and accurately predicting key agricultural timelines. Future efforts will refine these results and expand the implementation to wider applications.

Carbon Footprint of Field Crop Production: A National and Regional Life Cycle Analysis Approach

This project, funded by the National Innovations in Climate Resilient Agriculture of the Indian Council of Agricultural Research (ICAR)—Central Research Institute for Dryland Agriculture, aims to determine the carbon footprint, including direct and indirect emissions,

in the production of major field crops and milk. As part of the project, a consultation at MSSRF, Chennai, was organized on 7 October 2022; senior scientists from various ICAR institutions attended the programme. The MSSRF team presented the project outline based on which extensive discussions on various technical and theoretical aspects of the proposed study were held. The ICAR experts provided suggestions and inputs on the course in which the study was to proceed. Based on the discussions and inputs during the consultation, the first-phase work on developing the methodology to estimate greenhouse gas emissions from in-farm operations (direct emissions) has been completed. The methodology is currently being tested on one trial crop and will enable emission estimations to be disaggregated by

states and land-holding classes (marginal/small/semi-medium/medium/large). Once completed, this analysis will cover 13 major crops across all states in India and land-holding classes at state and district levels. As estimations at this level of disaggregation, even for direct emissions, are currently not available, the generated data will be an important contribution to the estimation of greenhouse gas emissions in Indian agriculture. As a next step, the methodology will be optimized to estimate emissions from outside farmgate operations and milk production. This unique study will provide estimates of direct and indirect emissions from agriculture, disaggregated by regions and operational land-holding categories, for all major crops.

Key highlights

- Integrated Assessment Models within the Sixth Assessment Report of the IPCC places the burden of climate change mitigation squarely on developing countries.
- The revamped Climate Equity Monitor portal highlights ongoing global climate policy narratives and negotiations and is cited in India's Long-Term Low Emissions Strategy submission under the Paris Agreement, to the UNFCCC.
- AI-based model being developed to identify crucial crop attributes from existing satellite images to precisely predict sowing and harvesting dates for paddy crops in the Cauvery Delta.
- The Climate Change Programme played a key role in mainstreaming the carbon budget perspective into the national climate policy.



Communication and Outreach

Communication and outreach were carried out through multiple engagement efforts, interactions, and platforms. The objective was to create more visibility for scientific work undertaken at MSSRF, through relevant communication tools. Efforts have been taken to build the communication skills of staff members. During the year, new social media handles (Twitter, Facebook and Instagram) were developed for Biju Patnaik Tribal Agrobiodiversity Centre, Jeypore to reach out to stakeholders in Odisha.

The MSSRF website (www.mssrf.org) was upgraded and social media platforms (LinkedIn, Facebook, Flickr, and Instagram) are being increasingly used for communicating about events and research highlights. The outcome stories reflecting MSSRF's research activities and developmental interventions can be accessed at <https://www.mssrf.org/our-stories/>. Online campaigns were organised to facilitate dialogue among relevant stakeholders. Increased media engagement resulted in higher hit statistics (45363 new visitors accessed 164185 webpages, and viewed 70578 sessions) during the year.

Media Resource Centre

Engagement with media persons is a continuous process for Communications, and the Media Resource Centre maintains a periodic dialogue with English and regional-language press to keep channels of communication open.

The database of accredited and non-accredited print, TV, radio, and social media journalists was updated in August 2022 and revised frequently during the year. Journalists were also added to the stakeholder database and continue to receive the MSSRF monthly e-newsletter with updates on research, news, and events. During the year, 19 press releases were sent out in English, Tamil, Malayalam, and Odia press. 299 news articles and feature stories were published in print, television, radio, and online media in several languages, and included state-level and national editions, plus international coverage.

As part of MSSRF's continued efforts to build the capacities of media persons a three-day media workshop was organized at Kaziranga, Assam in February 2023. Fourteen Assamese journalists were trained on Climate change and adaptation concepts linked with the project "RESILIENCE" implemented in Assam. Journalists were taken to field sites to demonstrate how ICT tools are used for pest and water management and shown how the plant clinic model works for farmers, also sprinklers for irrigation, and climate-smart seed systems used by small farmers. They were encouraged to interact with communities and learn first-hand, how new knowledge and innovation can support farmers to adapt to climate risks. Twenty news articles were published in Assamese and English on climate change and agriculture.

M. S. Swaminathan Papers: The Archives at National Centre for Biological Sciences

On 11 October 2022, the Archives at National

Centre for Biological Sciences (NCBS), Bengaluru, launched the opening of the M.S. Swaminathan Papers showcasing over 48000 archival objects spanning more than 80 years of the life and work of Prof. M. S. Swaminathan. The former Principal Scientific Adviser to the Government of India, Deputy Director General (Agricultural Extension) and Mr. N. Ram (Director, Kasturi and Sons Ltd.) recalled the role of Prof. Swaminathan as a plant geneticist, an agricultural scientist, a humanitarian, a communicator and as an institution builder. The Director of NCBS and Dr. Madhura Swaminathan, Chairperson, MSSRF, were also present on the occasion. The M.S. Swaminathan Papers at NCBS, donated by the trustees of MSSRF, is an important archival resource, recording events in modern Indian agricultural history and milestones in India's agricultural development.

The M.S. Swaminathan Papers are organized across two distinct accession groups and nine series in adherence to international archival description standards and in ways that preserve original order and provenance to the extent possible. These are in the form of research notes, correspondence, unpublished writings, media clippings, photographs, published works and administrative notes from dozens of institutions and committees, dating back to the early 1930s. The collection has been made possible with generous support from TNQ Technologies. The papers are organized in adherence to international archival description standards, and in ways that preserve original order and provenance

to the extent possible, and they are accessible by the general public on request.

Mina Swaminathan Media Fellowship for Gender and Development

The Mina Swaminathan Media Fellowship for Gender and Development was instituted by MSSRF in 2020-21 in recognition of Ms Mina Swaminathan's contribution to women, childcare, gender and development. The award is given to regional-language journalists based in Odisha, Kerala, and Tamil Nadu, working in the area of developmental journalism. The awardees for the year 2021-22 shared findings on 'Gender Transformative Approaches for Sustainable Food Systems' at a hybrid event held at MSSRF on 23 November 2022. The articles published in the local vernacular press (*Samayam Tamil*, *Mathruboomi*, *Your Story Tamil*, and *Sambad Odisha*) examined issues related to undernutrition and food systems witnessed through the gender lens. The Principal Secretary, Department of Agriculture and Food Production, Government of Odisha, released three Mina Swaminathan Insight Briefs on the occasion.

The current Mina Swaminathan Media Fellowship awardees (2022-23) - Ms Prativa Ghosh (*Prameya E-Paper*), Mr E Mohan (*BBC News Tamil*), and Mr K Rajendran (*Kairali News TV*) are working on the theme 'Gender and Millets: Linkages and Inequalities' are based in Odisha, Tamil Nadu, and Kerala, respectively. As the year 2023 is the International Year of Millets, the theme has been selected to inspire media fellows to investigate gender inequalities associated with

millet. A day-long workshop was organised for the awardees in March 2023 to provide orientation on issues related to millets. The workshop also facilitated interactions between media fellows and researchers based in Kolli Hills, Jeypore, and Wayanad centres of MSSRF.

Social Media Outreach

Social media platforms are an essential medium to communicate work and engage with organisations and individuals working in similar fields of research. The channels allow MSSRF to be part of prevailing discourses and participate in national/global conversations. Twitter, Facebook, and Instagram handle for the Biju Patnaik Agro-biodiversity Centre for focused engagement with Odisha stakeholders was started in April 2023.

Twitter is the most prominent platform for MSSRF, along with LinkedIn, Facebook, and Instagram. During 2022-2023, all four handles were used strategically to share evidence-based science and community engagement activities for wider reach. The communication team highlights research activities of MSSRF that align with special days of observance (UN days of observance, national days of significance, and other days of importance in the field of science). During 2022-2023, social media campaigns were organised to cover National Nutrition Week, World Food Day, Conference of Parties 27 on climate change, International Women's Day, and more. To mark the International Year of Millets 2023 (IYM 2023), Communications has been publishing daily posts on millets with the

hashtag #MSSRF_IYM2023. The strategy is to showcase MSSRF's Conservation, Cultivation, Commerce, and Consumption approach (4C approach); and share research findings, health facts about millets, cultural trivia, community awareness events, as well as millet recipes with nutritional values.

Social Media Analytics for 2022-2023:

- **Twitter:** Total number of tweets: 716; impressions: 961000; profile visits: 197435; mentions: 1213.
- **Facebook:** Reach: 120641 (increased by 111 per cent from previous year); page/profile visits: 8137 (increased by 145 per cent from previous year).
- **Instagram:** Reach: 10671 (increased by 193 per cent from previous year); page/profile visits: 2273 (increased by 51 per cent from previous year).
- **LinkedIn:** Organic impressions: 268082; new followers: 2439.

Bhoothalingam Library

The main objective of the Bhoothalingam Library is to offer individuals physical or digital access to information, in line with educational and research needs. The library boasts an extensive collection of printed materials, consisting of more than 19700 books, journals, theses, and reports. Additionally, it houses over 4500 archived issues of periodicals and a compilation of technical and annual reports from various organisations. More than 400 students from schools and colleges, and research scholars visited the library during 2022-23.

A range of services are offered to library users, including current awareness services, selective dissemination of information and Online Public Access and Catalogue (OPAC). Notably, the library has recently become a member of the British Council Library, granting patrons both physical and digital access to their resources. The OPAC section was expanded to link users to a wide range of open-access books, journals, and reports in the field of agriculture and allied subjects. The library has subscriptions to several prestigious journals, including Nature, New Scientist, Down to Earth, Economic and Political Weekly, and Indian Forester, among others. To facilitate easy online access to library resources, a new webpage was added in August 2022 to the MSSRF website.

The library also extends its services to Every Child as a Scientist (ECAS) programme organised by MSSRF for students of government schools in Tamil Nadu by establishing a dedicated subject gateway on the MSSRF library webpage. The gateway caters to books and magazines with relevant resources for scientific exploration and learning for school children from grades six to ten.

MSSRF e-Newsletter

The re-launched monthly newsletter reaches more than 2500 stakeholders nationally and internationally with updates on research, stakeholder engagement, news coverage, blogs, and more. The email marketing platform – Mailchimp, is being used for wider audience reach. Analytics from the platform shows that

the average opens are 644 with a click rate averaging 38 per cent, and clicks per unique opens at 88 per cent.

Capacity Strengthening

- In August 2022, a half-day seminar on how to systematically document outcome stories were organised. Link between outputs and outcomes, articulating narratives, and synthesizing evidence-based information for storytelling were covered.
- In April 2023, staff at the BPTAbC were oriented on the use of social media – specifically Twitter, Facebook, Instagram, and YouTube - to share research work, activities undertaken with communities, and stakeholder engagement efforts with wider audiences. They were oriented how to design graphics and collaterals with open access tools.

In January 2023, the Communications team facilitated three hands-on sessions in online mode with staff at MSSRF to strengthen English-language skills. Before the the workshop, an online pre assessment was carried out to gauge skills. Subsequently, trainers from the Thinkeng.com platform facilitated the workshop sessions at three levels: basic, mid-level, and advanced English.

Student Visits

More than 2200 school and college students from across India visited MSSRF, Chennai during 2022-23. During the visit a short film about MSSRF is screened and other activities at MSSRF are explained. Students also visit the Prof M S Swaminathan's Gallery, the

laboratories, the Touch and Smell Garden, and the Nutri-Rich Garden on campus.

Key Events

- On 28 April 2023, Lifestyle for Environment (LiFE) initiative was organised at MSSRF to create awareness and promote millets and backyard kitchen gardens among students, farmers, and Biodiversity Management Committee Members, in collaboration with the National Biodiversity Authority, Ministry of Environment, Forest and Climate Change, Government of India. Thiru. R Sakkarapani, Hon'ble Minister for Food and Civil Supplies, Consumer Protection and Price Control, Government of Tamil Nadu inaugurated the event. Other dignitaries at the inaugural function were Mr. Achalender Reddy IFS (Rtd), Chairperson – NBA, MoEFCC, Dr. Soumya Swaminathan, Chairperson, MSSRF, Dr. J. Radhakrishnan, Additional Chief Secretary, Co-operation, Food and Consumer Protection Department, Government of Tamil Nadu; Dr. B. Balaji IFS, Secretary, NBA and Dr. Shekar Kumar Niraj IFS, PCCF and Secretary, Tamil Nadu Biodiversity Board.
- In April 2023, a panel discussion titled 'Who Cares? Progress and Challenges for Early Childhood Development' was hosted by MSSRF on the occasion of Ms. Mina Swaminathan's birth anniversary at MSSRF. The panel discussion was moderated by Dr. Anjana Mangalagiri, Senior Fellow, Institute of Social Sciences, New Delhi. The panellists were Dr. Adarsh Sharma, former Director of the National Institute of Public Cooperation and Child Development, New Delhi, Dr. Sumitra Mishra, Executive Director of Mobile Creches, New Delhi, Dr. Manzoor Ahmed, Professor Emeritus, BRAC University, Dhaka, and Chair of the Bangladesh Early Childhood Development Network, Dhaka, Bangladesh, and Dr. R. Sujatha, Consultant, SDG - UNICEF India with Planning & Development Department, Government of Tamil Nadu.
- In March 2023, International Women's Day was celebrated with the theme DigitALL: Innovation and technology for Gender Equality. MSSRF invited women from rural and fishing backgrounds to share first-hand experience of how technological innovations had improved their lives and livelihoods.
- In February 2023, to mark National Science Day, 200 students from Greater Chennai Corporation schools in Taramani, Thiruvanniyur, Velachery, and Maduvinkarai, and 25 students from Government High School, Vanagiri, Poompuhar, Mayiladuthurai district participated in the hybrid event organised at MSSRF under the Every Child A Scientist programme.
- In November 2022, side events during COP27 at Sharm-el-Shiekh, Egypt, was hosted by Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India, where MSSRF and

NIAS Bangalore organised a session on Climate Equity, Carbon Budgets, and IPCC AR6 scenarios in November 2022, talked about mitigation from the global South perspective.

- In October 2022, MSSRF organised a seminar on Resilient Food Systems and Rural Women to commemorate both the International Day of Rural Women and World Food Day, recognising and appreciating the contribution of women farmers and fisherwomen towards sustainable food systems in India.
- In October 2022, a breakout session was hosted by MSSRF at the Borlaug International Dialogue at World Food Prize Foundation, Des Moines, United States. The session was moderated by Dr Madhura Swaminathan, Chairperson, MSSRF, and panellists included Dr T. Jayaraman, Senior Fellow, Climate Change - MSSRF, India; Dr Sreeja Jaiswal, Humboldt International Climate Protection Post-doctoral Fellow, University of Heidelberg, Germany; Prof. K. C. Bansal, Secretary, National Academy of Agricultural Sciences, India, and Member, Board of Directors, Global Plant Council; and Prof. Channapatna Prakash, Dean, College of Arts and Sciences at Tuskegee University. The session explored the importance of small farmers in India and the role climate equity plays in their communities and was screened live for international audiences.
- Ms Kausalya Sakthivel - the first recipient of the Prof. Hema Ramachandran Fellowship

for Women Scientists in India completed her six-month fellowship on September 30, 2022. She delivered a presentation on 'Identification of *Echinochloa* Weed Species in Rice Fields for Selected Districts in Tamil Nadu using a Chloroplast DNA Marker and Examining the Incidence of Bispyribac Herbicide Resistance' at MSSRF in October 2022. The fellowship for the year 2023 was awarded to Ms D Ezhil. She is at present conducting research at MSSRF under the guidance of Dr V R Prabavathy, Director of Biotechnology. Mr G P Ramachandran, the spouse of Dr Hema Ramachandran. In August 2022, the MSSRF annual international consultation on Sustainable Development in Hill and Coastal Ecosystems was held in hybrid mode. Hon'ble Thiru Siva. V. Meyyanathan, Minister for Environment, Climate Change and Youth Welfare and Sports Development, Government of Tamil Nadu, inaugurated the conference and released the thirty-second MSSRF Annual Report. He also inaugurated the Every Child A Scientist Centre activities at MSSRF, Poompuhar, remotely. The annual conference had representation from UN Missions in India, international NGOs, the Ministry of Environment, Forest and Climate Change (MoEFCC), the Ministry of Agriculture and Farmers' Welfare, World Fish, NABARD, NBA, Protection of Plant Variety and Farmers' Rights Authority, Central and State Government representatives, and NGO and farmers' networks. Nearly 1300

members participated both virtually and in person during the three-day conference.

- In June 2022, Prof S Gowri, Vice-Chancellor University of Madras, gave the Millennium

Lecture on 'The Role of Online Media in Science Education and Development' as part of the MSSRF Millennium Lecture Series.

Key highlights

- M. S. Swaminathan Papers s launched at The Archives, National Centre for Biological Sciences, Bengaluru contain over 48000 archival objects spanning 80 years that document his agricultural research through correspondence, field notes, photographs, administrative documents, media clippings and more.
- A media workshop for regional journalists in Assam generated 20 field stories capturing the use of the Capacity strengthening workshop on climate-resilient agricultural technologies and practices for adaptation to climate risks by farmers. regional language journalists in Assam
- Social media engagement presence by the MSSRF team increased tangibly

Science Education: Every Child a Scientist initiative

The Every Child a Scientist (ECAS) programme at MSSRF aims to inculcate a scientific temper and make science accessible to middle school children in government aided schools. Initially implemented only at the MSSRF, Chennai office, this programme has now been expanded to Fish For All Training and Research Centre, MSSRF, Poompuhar.

ECAS, Chennai: In phase two of the ECAS, 259 middle-school students (grades VI–VIII) from Chennai Higher Secondary Schools (CHSS) at Taramani, Thiruvanmiyur, Velachery and Maduvinkarai participated in a two-week science learning session using digital e-learning modules. This initiative received administrative support from the Greater Chennai Corporation and Tamil Nadu State Education authorities. Science modules were developed at MSSRF based on the state school curriculum and delivered using digital smart boards, with audio-visual learning and hands-on practical sessions for an easy grasp of scientific concepts. Integration of practical laboratory-based techniques (ECAS lab and bench work in Biotechnology, Microbiology and Lichen laboratories at MSSRF) bridged the gap between theory and practice. Bilingual teaching contributed to easy assimilation

and understanding of science concepts. Awareness about and access to the internet and desktop systems facilitated and fostered self-learning among the students. Nutritious meals provided during the course curriculum were well received and also eased parental pressure. In addition, 200 students (who previously received training at MSSRF) and 10 teachers participated in the National Science Day celebrations on 28 February 2023 at MSSRF, Chennai, and displayed science models developed by them during the 2-week ECAS sessions.

ECAS, FRTC, Poompuhar: The ECAS programme at the FRTC was inaugurated by the Hon'ble Minister for Environment and Climate Change, via video conferencing in August 2022. Ten government schools within a 15 km radius of FRTC have been included in ECAS with permission from the District Education Office. Each batch has a scheduled 15 day programme with 25 students (Grade VI to VIII) per batch. In the previous year, 147 students (boys: 66; girls: 81) in six batches attended ECAS training sessions and certificates were distributed. In addition to modules based on school syllabus, new modules focusing on locale-specific practical concepts (e.g., fish and fisheries, fish processing, etc.) are being developed.

Publications

Books / Monographs/Manuals/Electronic Material

Carew-Reid, J., Peter-John Meynell, M. K. Goyal, S. B. Reddy Nakka, D. Koul, S. N. Pattanaik, Nagarajan Rajendiren, Mamata sahu, R. Ramasubramanian et al. 2023. *Climate Risk Assessment of Renuka Wetland, Himachal Pradesh*. New Delhi: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. <https://indianwetlands.in/wp-content/uploads/library/1675677956.pdf>

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Carew-Reid, J., Peter-John Meynell, M. K. Goyal, S. B. Reddy Nakka, D. Koul, S. N. Pattanaik, Nagarajan Rajendiren, Mamata sahu, R. Ramasubramanian et al. 2023. *Climate Risk Assessment of Point Calimere Wildlife and Bird Sanctuary, Tamil Nadu*. New Delhi: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. <https://indianwetlands.in/wp-content/uploads/library/1675677956.pdf>

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Award and Honors

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Fish for All Research and Training Centre, MSSRF, 2023. Women Connect Challenge Award for the ICT innovations in Post-harvest Fisheries, Reliance Foundation and USAID.

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New partnerships

- National Botanical Research Institute, Lucknow, (Council of Scientific and Industrial Research) and MSSRF-CAbC, Wayanad, signed the Memorandum of Understanding in August 2022, for collaborative research on rare endemic and threatened plants, wild ornamentals, other plant genetic resources, and to establish field germplasm banks.
- Extension for Community Healthcare Outcomes (ECHO) and MSSRF signed the MoU in February 2023 to provide need-based training to the rural communities associated with MSSRF by using distance learning platforms to improve and create workforce multiplication.

- Avinashilingam University Coimbatore and MSSRF signed the MoU in April 2023 to strengthen research collaboration on promoting nutrition and health, with a focus on medicinal plants, under-utilized and wild foods, and associated traditional knowledge of tribal communities.
- University of Trans-Disciplinary Health Sciences and Technology, Bengaluru and MSSRF signed the MoU in May 2023, to develop collaborative interests in medicinal plants, traditional knowledge in the context of food, health, and livelihood security for tribal populations.
- Council on Energy, Environment, and Water (CEEW), New Delhi and MSSRF signed the MoU in June 2023, to strengthen research, analysis, stakeholder engagement on sustainability issues and to promote scalable solutions, shape narratives, policies, and practices for an equitable future.

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(Social Science)

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Doctoral Fellow

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Dr. B. Kavitha, *Research Associate*

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Mr. A. Jeevanandham, *Watershed Expert*

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Theni

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Mr. G. Murugan, *Devp. Assistant*

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Mr. P. Silambarasan, *Devp. Assistant*
 Ms. S. Sujitha, *Devp. Assistant*
 Mr. A. Gopal, *Driver*

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 Mr. M. Karunamoorthi, *Associate Scientist**
 Mr. R. Arun Siddharth, *Watershed Expert**
 Mr. M. Balasubramanian, *Watershed Expert**

Villupuram

Mr. P. Nandeesa, *Devp. Coordinator*
 Mr. R. Kumaragurubaran, *Associate Scientist*
 Mr. K. Rubesh, *Associate Scientist*
 Mr. M. Balasubramanian, *Watershed Expert*
 Ms. G. Viji, *Technical Assistant*
 Ms. M. Priyadarshini, *Field Assistant*
 Mr. V. Vimal Raj, *Technical Assistant**

AGRICULTURE, NUTRITION AND HEALTH

Chennai

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Ernakulam

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 Ms. P.R. Chaithara, *Devp. Associate*
 Mr. M.P. Shajan, *Devp. Assistant*
 Mr. V.P. Distin, *Devp. Assistant*
 Mr. Ajin Vincent, *Devp. Assistant*
 Ms. Mary Sumy, *Devp. Assistant*
 Mr. K.P. Prejeesh, *Accountant*

Idukki

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 Ms. Jisna Michael, *Devp. Assistant*
 Ms. Krishendhu Shaji, *Devp. Assistant*

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Jeypore

Mr. Akshaya Kumar Panda, *Devp. Coordinator*
 Mr. Tripati Khura, *Devp. Assistant*
 Mr. Purna Chandra Samantray, *Devp. Assistant*
 Mr. Max Aurthor Gill, *Devp. Assistant*
 Mr. Ghasi Takri, *Devp. Assistant*
 Mr. Haribandhu Harijan, *Devp. Assistant*
 Ms. Sweta Sheloni Khura, *Devp. Assistant*
 Mr. Sita Prasad Senapati, *Devp. Assistant*
 Mr. Antarjyami Bisoi, *Devp. Assistant*
 Ms. Banasri Pattnaik, *Devp. Assistant*
 Mr. Naresh Chandra Patro, *Devp. Assistant**
 Mr. Malaya Kumar Nayak, *Devp. Assistant**
 Mr. S. Raju, *Social Scientist**

Kuttanad

Mr. P. Prajeesh, *Sr. Scientist*
 Mr. Jibin Thomas, *Devp. Associate*
 Ms. Parvathy Radhakrishnan, *Project Fellow**

Nayaragh

Mr. Suryamani Panda, *Devp. Associate*
 Mr. Ramesh Chandra Dakua, *Devp. Assistant*
 Mr. Bharata Mahala, *Field Assistant*
 Mr. Narayan Mahapatra, *Field Assistant*
 Mr. Susanta Kumar Martha, *Field Assistant*

Thiruvananthapuram

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Wayanad

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 Mr. N. Gopalakrishnan, *Devp. Coordinator*
 Ms. Gayathri Kalathil Sajeev, *Devp. Coordinator*
 Mr. Vipindas, *Devp. Coordinator*
 Mr. V.A. Abdulla Habeeb, *Devp. Associate*
 Ms. Anjaly C. Bose, *Project Associate*

Mr. P.M. Noushique, *Devp. Associate*
Ms. E. Radha, *Devp. Assistant*
Mr. A. Anoop, *Devp. Assistant*
Mr. Sujith Marath, *Devp. Assistant*
Ms. Bindu Joseph, *Devp. Assistant*
Mr. M.K. Bineesh, *Junior Manager*
Mr. Alphin K. Francis, *Technical Assistant*
Ms. M.A. Shyamili, *Assistant - Accounts*
Mr. P.K. Namsheed, *Young Professionals II**

CLIMATE CHANGE

Dr. T. Jayaraman, Senior Fellow

Mr. R. Goutham, *Project Associate*
Mr. Sandeep Mahato, *Project Associate*
Mr. Charu Chandra Devshali,
Research Associate
Ms. Shubhangi, *Research Assistant**
Mr. L. Isaac, *Research Associate**

COMMUNICATION & LIBRARY AND INFORMATION SERVICES

Ms. Sangeetha Rajeesh, Director

Dr. N. Parasuraman, *Principal Archivist and Knowledge Manager*
Ms. Laasya Shekhar, *Associate Manager**
Mr. Subhranshu Bhusan Sahoo, *Librarian*
Mr. G. Suresh Kumar, *Library Assistant*
Ms. R. Surya, *Executive*

HUMAN RESOURCE AND ADMINISTRATION

Mr. C.V. Parthasarathy, Manager

Mr. V. Raghu, Deputy Head - HR

Ms. A. Uma, *Sr. Executive- HR*
Mr. K. Suresh, *Office Assistant*

Ms. R. Malathy, *Executive Secretary*
Ms. Y. Dilhara Begam, *Sr. Secretary*
Mr. Govindarajan Dhandapani, *Head HR**

SUPPORT SERVICE

Mr. B. Sivakumar, *Electrician*
Mr. P. Muthukumar, *Electrician*
Mr. E. Thiruvengadam, *Electrician*
Mr. T. Krishnamoorthy, *Guest House Caretaker*
Mr. P. Balaji, *Driver*

ACCOUNTS

CA. Rajalekshmy S. Balasubramanian, Deputy Head

Ms. Nalina Muthukumaran, *Accountant*
Ms. R. Jayashree, *Accountant*
Ms. S. Kalaiyarasi, *Accountant*
Mr. R. Suban, *Accountant*
Ms. R. Selvarani, *Accountant*
Mr. M. Aravindha Mohan, *Accountant**
Mr. K. Saravanan, *Associate Manager**

INFORMATION TECHNOLOGY – Service

Mr. R. Rajamanikkam, *Manager*
Mr. R. Guru Prakash, *Sr. Executive*

CONSULTANT

Mr. Peeyush Priya
Dr. Sreeja Jaiswal
Ms. Noopur Varma
Dr. Priyadarshini Rajamani
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Ms. Juhi Chatterjee*
Mr. Manjeet Kumar Patel*
Mr. P. Sasikumar*
Mr. R. Srinivasan*

**left during the year*

List of Donors 2022-2023

Individual Donors - National

Mr. G.P. Ramachandran, Bangalore

Dr. Chandra Sekara Rao Anne, Florida, USA

Sources of Project Support

Programme Area 100: Coastal Systems Research

National

International

National Fisheries Development Board,
Hyderabad

Qualcomm, USA

Centre for Sustainable Conservation Action
and Protection of Ecosystems of the Seas,
Gujarat

Indian Council of Agricultural Research –
National Bureau of Fish Genetic Resources,
Lucknow

Indian National Centre for Ocean Information
Services, Hyderabad, Ministry of Earth
Sciences, Govt. of India

National Bank for Agriculture and Rural
Development, Mumbai and Chennai

HCL Foundation, New Delhi

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Govt. of India,

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LLP, Chennai

Indian Institute of Tropical Meteorology (IITM),
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Programme Area 200: Biodiversity

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Directorate of Agriculture and Food Production,
Govt. of Odisha, Bhubaneswar

NABARD, Chennai, Kalpetta and
Thiruvananthapuram, Namakkal.

Kerala Council for Science, Technology
and Environment, Govt. of Kerala,
Thiruvananthapuram

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Kerala Development and Innovation Strategic Council, Kerala

SBI Youth for India

Department of Science and Technology, Govt. of India, New Delhi

Ministry of Tribal Affairs, Govt. of India, New Delhi

Programme Area 300: Biotechnology

Biotechnology Industrial Research Assistance Council (BIRAC), Govt. of India, New Delhi

Larsen & Turbo Ltd, Chennai

Ministry of Science & Technology, Department of Biotechnology, New Delhi

Indo French Centre for the Promotion of Advanced Research, (CEFIPRA) New Delhi

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SAARC Development Fund, Thimpu, Bhutan

The World Food Prize Foundation, USA

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Programme Area 500: Agriculture, Nutrition and Health

National

International

Department of Agriculture and Farmers' Empowerment, Govt. of Odisha, Bhubaneswar

Agricultural Technology Management Agency (ATMA) Koraput

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Programme Area 600: Climate Change

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The Fairtrade Organisation, London

United Nations Development Programme, India

Ministry of Environment, Forest and Climate Change, Govt. of India, New Delhi

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FINANCIAL STATEMENT 2022-2023

M.S.SWAMINATHAN RESEARCH FOUNDATION

No.6, Third Cross Road, Taramani Institutional Area, Taramani, Chennai - 600 113

BALANCE SHEET AS AT 31st MARCH 2023

FOUNDATION				Figs in Rs. Lakhs			
LIABILITIES	Sch. No.	2022-23 Rs.	2021-22 Rs.	ASSETS	Sch. No.	2022-23 Rs.	2021-22 Rs.
OWN FUNDS				OWN ASSETS			
CORPUS FUNDS	1	167.76	167.26	FIXED ASSETS	5	422.86	397.34
ENDOWMENT FUNDS	2	4980.73	4975.73	INVESTMENTS	6	6322.78	6754.15
GENERAL FUND & OTHER FUNDS	3	3584.26	3625.97	CURRENT ASSETS			
CURRENT LIABILITIES	10	308.79	407.26	CASH & BANK BALANCES	7	1806.19	1442.69
				ADVANCES	8	406.89	379.68
				OTHER ASSETS	9	82.83	202.37
TOTAL [A]		9041.54	9176.22	TOTAL [A]		9146.86	9047.59

PROJECTS				Figs in Rs. Lakhs			
LIABILITIES	Sch. No.	2022-23 Rs.	2021-22 Rs.	ASSETS	Sch. No.	2022-23 Rs.	2021-22 Rs.
PROJECT FUNDS & OBLIGATIONS	4	842.39	1325.26	PROJECTS RECEIVABLES	9	216.51	150.04
CURRENT LIABILITIES	10	267.94	221.9	ADVANCES	8	152.68	308.03
				BANK BALANCES	7	741.15	1089.09
TOTAL [B]		1110.33	1547.16	TOTAL [B]		1110.34	1547.16
GRAND TOTAL [A]+[B]		10151.87	10723.38	GRAND TOTAL [A]+[B]		10151.89	10723.39

Provisional (Unaudited)

M.S.SWAMINATHAN RESEARCH FOUNDATION

No.6, Third Cross Road, Taramani Institutional Area, Taramani, Chennai - 600 113


INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31st MARCH 2023

EXPENDITURE	FOUNDATION				Figs in Rs. Lakhs	
	Sch. No.	2022-23 Rs.	2021-22 Rs.	INCOME	Sch. No.	2021-22 Rs.
SALARIES	15	445.45	427.99	INTEREST INCOME **	12	530.25
ENDOWMENT EXPENSES	16	93.09	47.43	DONATION	13	3.6
MEETINGS & OTHER RELATED EXPENSES	17	76.01	77.02	CONTRIBUTION RECEIPTS - CORE ACTIVITIES *	14	51.96
DEPRECIATION ON FIXED ASSETS	5	33.77	23.92	OTHER INCOME	15	
OTHER ADMINISTRATIVE EXPENSES	18	78.49	59.80	RENTAL RECEIPTS		14.3
10% OF ENDOWMENT INTEREST INCOME TRANSFERRED TO ENDOWMENT FUNDS		0	47.92	MISCELLANEOUS RECEIPTS		84.95
EXCESS OF INCOME OVER EXPENDITURE		-41.72	157.24			74.35
TRANSFERRED TO GENERAL FUND						
TOTAL		685	841	TOTAL		841

Provisional (Unaudited)

** Considering the insufficient surplus of income over expenditure for the current financial year, the regular plough back of 10% of endowment interest income to endowment corpus (implemented every year pursuant to Trustees resolution) has not been done during the year. The eligible amount to be reckoned for such adjustment as per consistent practice amounts to Rs. 37.81 Lakhs.

* Expenditures stated above includes the expenses incurred for the core activities


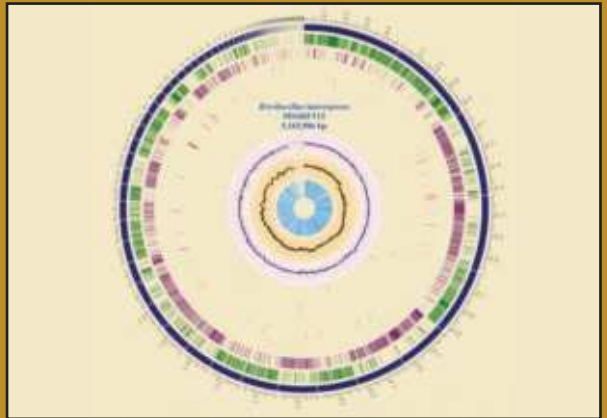


Celebrating **MSSRF**

Ms Mina Swaminathan's Birth Anniversary

Panel Discussion
Who Cares ?
Progress and Challenges for Early Childhood Development

April 3, 2023
MSSRE, Chennai

Address:
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Research Foundation
III Cross Road, Institutional Area
Taramani, Chennai 600 113, India

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