MSSRF

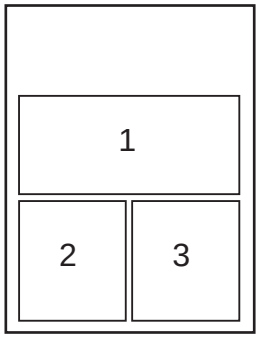
Science for Sustainable Development

M. S. SWAMINATHAN RESEARCH FOUNDATION

2021–2022

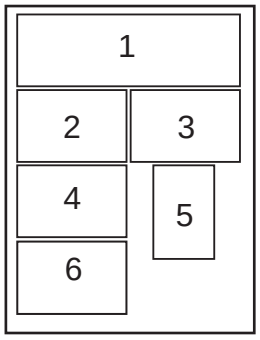
THIRTY-SECOND ANNUAL REPORT

CENTRE FOR RESEARCH ON SUSTAINABLE AGRICULTURAL AND RURAL DEVELOPMENT



Front Cover

1. Inauguration of the virtual consultation on 'Ensuring Food and Nutrition Security in the Context of Climate Change and the COVID-19 Pandemic' by Hon'ble Thiru M K Stalin, Chief Minister of Tamil Nadu, 6 August 2021
2. Hon'ble Thiru Anbil Mahesh Poyyamozhi, Minister for School Education, Government of Tamil Nadu, interacting with the Greater Chennai Corporation School Students during the inauguration programme of 'Every Child A Scientist' on 26 September 2021
3. Hon'ble Thiru Ma Subramanian, Minister for Health and Family Welfare, Government of Tamil Nadu visiting the Nutri-Rich plants and Awareness Garden near Thiruvanmiyur Railway Station, Chennai, 8 January 2022



Back Cover

1. Distribution of calendars with nutrition awareness messages to tribal farmers of Koraput district, Odisha
2. Climate literacy awareness programme to school students, Dindigul, Tamil Nadu
3. Exhibiting Rare, Endangered and Threatened tree species of Western Ghats at Community Agro-biodiversity Centre, MSSRF, Wayanad, Silver Jubilee celebration, 5-6 June 2022
4. Inauguration of community well at Kolli Hills, Tamil Nadu
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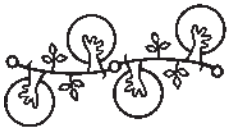
6. Land preparation for the cultivation of saline tolerant traditional paddy landrace Kagga, Kumta, Karnataka.

Thirty-Second Annual Report
2021 – 2022



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Chairperson's Foreword

The Foundation reached several important milestones last year: the Community Agro-biodiversity Centre at Wayanad completed 25 years, and the Fish for all Research and Training Centre (FRTC) at Poompuhar completed 12 years. It was heartening to see the recovery from the pandemic and the recognition gained by MSSRF. We also expanded the scale and scope of our work and formed new partnerships during the year.

We were honoured to have the Honourable Chief Minister of Tamil Nadu, Thiru M K Stalin, to inaugurate the consultation on 'Ensuring Food and Nutrition Security in the Context of Climate Change and the COVID-19 Pandemic' in August 2021 last year. The Chief Minister hailed the contributions of MSSRF and its founder, specifically in the area of anticipatory research on climate change, and sought close collaboration in order to develop scientifically sound strategies for climate change adaptation.

To commemorate its 12th year, the FRTC launched four new initiatives, including a portable carp hatchery, in partnership with ICAR-National Bureau of Fish Genetic Resources for the conservation of genetic fish resources in the Cauvery Delta region in January 2022. A "nutritional and fish quality laboratory" was opened and a new version (5.1) of the Fisher Friend Mobile Application (FFMA) launched. FFMA received the "Tech for Good" Award from the National Association of Software and Service Companies (NASSCOM) Foundation. The Fish for All Research and Training Centre received the "Best Performing Project Award" for the Integrated Mangrove Fishery Farming System to Enhance Adaptive Capacity of Fishing Community to Sea Level Rise from National Bank for Agriculture and Rural Development (NABARD), and Dr. S. Velvizhi from MSSRF received the K. Chidambaram Memorial Annual Award instituted by Fisheries Technocrafts Forum, Chennai. MSSRF has been selected for the Biodiversity Conservers Award (2022) by the Andhra Pradesh State Biodiversity Board.

In the Western Ghats, in collaborative studies, our scientists, Mr. P.M. Salim and Dr. N. Anil Kumar reported five new species of flowering plants: *Seidenfia manikathila*; *Henckelia viridiflora*; *Piper kurichiyarmalayanum*; *Neanotis prabhuii*; and *Chiloschista confusa*.

MSSRF provided scientific and policy inputs to the Ministry of Environment, Forests and Climate Change (MoEF&CC) in the approval process of the Sixth Assessment Report of the Intergovernmental Panel on Climate Change for all three Working Group Reports. Our Senior Fellow, Dr. T. Jayaraman, was a member of the Indian delegation at the COP26 negotiations at Glasgow. Prior to the conference, a unique website, the Climate Equity Monitor (www.climateequitymonitor.in), dedicated to issues of international equity in global climate governance was launched in collaboration with the National Institute for Advanced Studies, Bangalore.

With the objective of enhancing rural livelihoods by harnessing advancements in science and technology, the Ecotechnology programme reached more than 2.5 lakh households directly across the states of Andhra Pradesh, Assam, Jharkhand, Odisha, Rajasthan, Tamil Nadu

and Puducherry. Activities were upscaled by converging interventions with the Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS).

Technological innovations, especially in the application of Information and Communications Technology (ICT) to farm extension, continued. A new android-based PANNAI App was developed and farm-level agro-advisories disseminated to 1000 farmers. A decision support system for greening the hillocks of Tiruvannamalai district was prepared using the Geographic Information System (GIS) based thematic datasets overlaid on satellite images. MSSRF is engaged in using High-Resolution Satellite Imagery for modelling the impact of aridification on crop production especially the paddy cultivation in the Cauvery Delta.

The restoration of mangrove ecosystems has been extended in estuaries of Kovalam in Chennai and Gadilum in Cuddalore district of Tamil Nadu and also in Upputeru in the Krishna district and Pulicat lake of Andhra Pradesh. At the Biju Pattnaik Tribal Agro-biodiversity Centre, Koraput, a major Five Year Mission on "Reviving Millets in Farms and on Plates" was taken up. The use of improved finger millet seeds enhanced productivity by 40-45 percent.

The Community Conservation programme at Kolli Hills is extending the Multi-Storey Mixed Farm model to include agroforestry and small millet cultivation, and carefully monitoring its effects on income, nutrition and drudgery reduction. The Integrated Tribal Development Project at Kolli Hills has been recognized with the Best Performing Project Award by NABARD on its 41st Foundation day. We will be able to assess this NABARD model for tribal women and men in terms of provision of higher and more stable incomes, enhanced nutrition and reduced drudgery.

To commemorate the silver jubilee year of the Community Agrobiodiversity Centre, an International Consultation on 'Biodiversity, Climate Change and Adaptation' was organised. The meeting underlined the fact that sustainable climate adaptation strategies demand considerable socio-economic transformation in rural areas and among smallholders.

Studying salinity tolerance in crops continued to be a major focus of the Biotechnology programme. Studies based on split root experiments showed that salt uptake is affected not only by concentration of salinity in the medium but also by soil drainage of the salt in the mangrove Avicennia. Nutrient analysis of traditional saline tolerant *Kari Kagga* and *Bili Kagga* paddy varieties of coastal Karnataka showed higher zinc and iron content than in popular high yielding rice varieties.

The "Every Child A Scientist" (ECAS) programme was revived after the pandemic. A new "smart" facility to use the latest digital technologies to teach scientific concepts to young boys and girls from Government schools was inaugurated by Shri Anbil Mahesh Poyyamozhi, Minister for Education of the Government of Tamil Nadu.

Across the centres, an important initiative was to demonstrate the possibility of leveraging agriculture for nutrition and health through creation of nutri-gardens. Over 400 home nutrition gardens in Wayanad, Kerala, 278 in Jeypore, Odisha, 250 in Palghar, Maharashtra and 186 in Kanpur Dehat, Uttar Pradesh were set

up with locally suitable naturally fortified plants (such as papaya, cowpea, banana, Moringa and lemon).

Adapting to the COVID-19 pandemic, the communications team at MSSRF quickly adapted a hybrid (online and offline) mode for advocacy and outreach activities. Mina Swaminathan Media fellows were selected to work on the theme of 'Gender Transformative Approaches for Sustainable Food Systems'.

The demise of Ms. Mina Swaminathan, one of the first trustees and Distinguished Chair in Gender and Development at MSSRF, who initiated and mentored the integration of gender concerns in to all programme areas, has been a loss for the Foundation.

Our work has progressed, thanks to the many donors and supporters. I want to specially thank Mr. G.P. Ramachandran who instituted, in memory of his late wife, the Hema Ramachandran Fellowship for Women Scientists.

Dr. G. N. Hariharan, Dr. V. R. Prabavathy, Dr. R. Rengalakshmi, Dr. E.D. Israel Oliver King, Dr. Gayatri Venkataraman and Ms. Sangeetha Rajeesh coordinated the present content, Ms. Suni Sebastian provided and the printing of the Annual Report was carried out by AMM Prints, Chennai. The achievements reported here come from the hard work and commitment of our scientists, development workers, administrative staff and students.

I record my appreciation and gratitude to all of them.

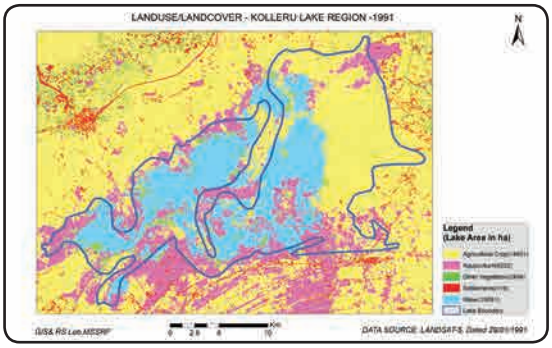
Programme Area 100

COASTAL SYSTEMS RESEARCH

Project activities of the Coastal Systems Research programme were initiated at the Kovalam estuary in Chennai and Gadilum estuary in Cuddalore, both in Tamil Nadu; Upputeru estuary near Chinnagollapalem in Krishna district; and Pulicat Lake, Andhra Pradesh, apart from continuing the mangrove conservation activities in Kosasthalaiyar (Kortalaiyar) estuary in Ennore, Tamil Nadu, and Sorlagondi Reserve Forest of Krishna Wildlife Sanctuary, Andhra Pradesh. The Fish for All Research and Training Centre (FRTC) commemorated its twelfth year in January 2022 by launching four new initiatives with key partners. Additionally, the centre's flagship programme, the Fisher Friend Mobile Application (FFMA), was recognized at the national level and won the 'Tech for Good Award' under the disaster management category from the National Association of Software and Service Companies (NASSCOM) Foundation.


M. S. SWAMINATHAN RESEARCH FOUNDATION
Fish for All Research and Training Centre, Kottilpattu


SOLAR FISH DRYER


LANDUSE/LANDCOVER - KOLLERU LAKE REGION -1991
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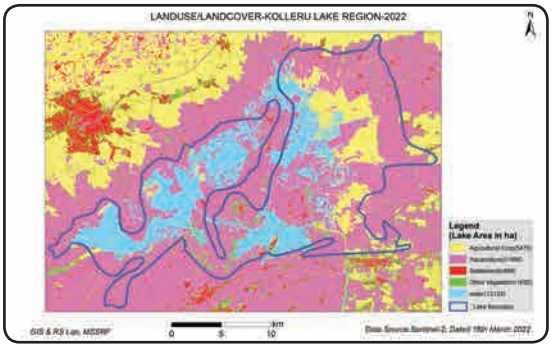
(Lake Area in ha)
GIS & RS Lab, MSSRF
DATA SOURCE: LANDSAT 5, Dated 28/01/1991


LANDUSE/LANDCOVER-KOLLERU LAKE REGION-2022
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(Lake Area in ha)
GIS & RS Lab, MSSRF


நண்டு கொழுப்பேற்றுதல்
CRAB FATTENING

Sub Programme Area 101

Mangrove and Non-mangrove Coastal Bioshields

101.1 Mangrove Restoration

***Koratalaiyar Estuary, Thiruvallur District, Tamil Nadu*:** The after-care management activities such as casualty replacement and desilting of canals were carried out in 15 ha of mangrove restored area near NTPC Tamil Nadu Electricity Corporation Limited in Koratalaiyar estuary. *Avicennia* plants attained a mean height of 1.25 m while *Rhizophora* plants attained 1.8 m. Pneumatophores and stilt roots were well established in *Avicennia* and *Rhizophora* respectively.

Kovalam Estuary, Tamil Nadu: Maps of sites suitable for mangrove plantation at Mutukkadu and Kovalam backwater areas have been prepared and submitted to the Public Works Department, Government of Tamil Nadu for approval. About 40,000 mangrove saplings of *Avicennia* and *Rhizophora* were raised in a nursery at Vedaranyam, Tamil Nadu.

Gadilum Estuary, Cuddalore, Tamil Nadu: Activities related to the project on 'Conservation and Sustainable Management of Coastal Ecosystems for Increased Resilience to Climate Change' have been initiated in Cuddalore district. Biophysical survey has been completed along the Gadilum and Pennayar river estuaries. About 20 ha of intertidal mudflats suitable for mangrove plantation have been identified, and the team has requested the district administration to permit the planting of mangroves in those locations. About 30,000 mangrove saplings of *Avicennia* and *Rhizophora* were raised in a nursery for planting.

Krishna Wildlife Sanctuary, Andhra Pradesh: The restored mangrove plants in 200 ha near Basavanipalem have attained an average height of 1.6 m, and the survival rate of the saplings is more than 75 per cent. Desilting of canals for free flow of tidal water and protection by community watchers have resulted in a better survival rate. Some of the plants have started bearing fruits. A national-level workshop was organized in Vijayawada in March 2022 to disseminate the climate adaptation activities to different stakeholders. The project activities were presented to the Adaptation Fund Board, National Implementation Entity (NIE). Countries Exchange Programme organized by the National Bank for Agriculture and Rural Development (NABARD) in which NIE representatives from the Dominican Republic, Federated States of Micronesia, United Republic of Tanzania, Niger, Indonesia, Benin, Costa Rica, Peru, Zimbabwe and Panama participated.

***Uppeteru Estuary near Chinnagollapalem Andhra Pradesh*:** A suitable site of 25 ha has been identified in Uppeteru estuary near Etimondi Pallipalem, a hamlet of Chinnagollapalem panchayat, Kruttivennumandal for the project on 'Establishment and Management of Mangroves and Shelterbelt Plantation along the Coast of Krishna district, Andhra Pradesh'.

The village panchayat passed a resolution, and based on their request, permission from the government has been obtained to carry out the plantation.

Vattambedu kuppam near Pulicat Lake, Nellore District, Andhra Pradesh: During 2021-2022, a project on 'Conservation and Sustainable Management of Coastal Ecosystems for Increased Resilience to Climate Change in the Pulicat Lake' was initiated. Pulicat Lake is the second largest salt water lake in India and is located on the Coromandel Coast of Andhra Pradesh and Tamil Nadu (Lat: 13°33'34.19" N; Long: 80°10'17.40" E). It extends 50 km north to south and has a width of 5–16 km west to east, spreadover 759 sq. km. A study was undertaken to assess the status of seagrasses, mangroves and other associated floral diversity (Table 1).

To understand the topography near Vattambedu kuppam a digital elevation model for the watershed of the lake was prepared using the CARTOSAT satellite images.

101.2 Integrated Mangrove Fishery Farming System and Cage Culture

Under the Integrated Mangrove Fishery Farming System (IMFFS), farmers are rearing shrimps and sea bass, but not crabs (due

Table 1: ***Floral biodiversity of Pulicat Lake***

S. No.	Name of the species	Family name	Occurrence
Seagrass			
1	*Halophyllum ovalis* (R.Br.) Hook.f.	Hydrocharitaceae	All over the island
2	*Halophila minor (Zoll.)*	Hydrocharitaceae	Venadu Island and Ramesh Land
3	*Halodule pinifolia* (Miki) Hortag.	Cymodoceaceae	Ramesh Land and north of Irukkam Island
4	*Syringodium isoetifolium* (Asch.) Dandy	Cymodoceaceae	Ramesh Land, north of Irukkam Island and Venadu island
Mangroves			
1	*Avicennia marina* (Forssk) Vierh	Avicenniaceae	West side of Venadu Island
2	*Excoecaria agallocha* L.	Euphorbiaceae	West side of Irukkam Island
3	*Lumnitzera racemosa* Willd.	Combretaceae	North side of Irukkam Island
Salt marshes			
1	*Suaeda monoica* (Forsk) ex. J. Gmeline	Chenopodiaceae	Elevated mud flats
2	*Suaeda maritima* L.	Chenopodiaceae	Elevated mud flats
3	*Suaeda nudiflora* Moq.	Chenopodiaceae	Elevated mud flats
4	*Sesuvium portulacastrum* L.	Chenopodiaceae	Elevated mud flats
5	*Salicornia brachiate* Rox.	Chenopodiaceae	Elevated mud flats
6	*Arthrocnemum indicum* (Wild) Moq.	Chenopodiaceae	Irukkam Island
7	*Aeluropus lagopoides* L.	Poaceae	Elevated mud flats
8	*Cressa cretica* L.	Convolulaceae	Elevated mud flats

to an outbreak of a disease). A team from MSSRF and the Centre for Advanced Studies in Marine Biology, Annamalai University, Parangipettai collected crab samples from the affected ponds and tested for pathogens. Crab mortality was attributable to the *sleeping disease of crabs* caused by the mud crab reovirus belonging to the family 'Reoviridae'. Sea bass was also grown by farmers adopting cage culture model in the region.

101.3 Greenhouse Gas Fluxes in the Mangrove Ecosystem

The greenhouse gas fluxes in the Pichavaram mangrove ecosystem have been continuously measured over eight years using an Eddy Covariance Flux tower. This is part of a collaborative project with the Indian Institute of Tropical Meteorology, Pune, under the MetFlux India project of the Ministry of Earth Sciences (MoES).

101.4 Assessing Socio-economic and Livelihood Status of Communities in the Kolleru Wildlife Sanctuary, Andhra Pradesh

A study was carried out to assess the socio-economic and livelihood status of the communities living around the Kolleru Lake. The study revealed that nearly 85 per cent of them depend on the lake resources either for fishing/aquaculture or for labour in aquaculture-related works. It is the largest freshwater lake in India and a wild life sanctuary is situated between 16°33" and 16°47"N and 80°40" and 81°24"E in the state of Andhra Pradesh. The lake was designated as a wetland of international importance in November 2002 under the international Ramsar Convention. A decadal assessment of land-use and land-cover showed that in 2001, the area under aquaculture was 24,299 ha, but in 2011 the area significantly reduced to 12,503 ha. However in 2022, it again increased to 21,995 ha. The reduction in 2011, was mainly due to the destruction of encroachments as per the Supreme Court directive. However, in the following years the encroachment is continuing, further degrading the ecosystem services.

Sub Programme Area 102

Fish for All Research and Training Centre

The FRTC in Poompuhar, Mayiladuthurai district of Tamil Nadu aims to bring a collective and holistic approach in resource management, sustainable livelihoods and preparedness for disaster. It functions as a training cum demonstration centre and specifically focuses on women, artisans, non-traditional fishers, fish vendors and fishing labourers among other producer groups.

102.1 Capture Fisheries Resource Management and Enhancement

Fisher Friend Mobile Application: The FFMA has received a high level of attention because of its unique features for making essential services available and accessible amongst small-scale fisher folk. For the year 2021, it was awarded the "Tech for Good" Award, organized

by the NASSCOM Foundation, in the category of Information and Communication Technology (ICT) for Disaster Management, based on four key criteria: ICT for innovations, social impact, scalability and sustainability.

An MoU was signed with the Department of Fisheries, Government of Odisha, for the integration of an offline alert system to protect the turtle congregation grounds from fisher folk entry, and to scale up FFMA across the Odisha coast. On 29 October 2021, FFMA 5.0, with a new feature 'No Fishing Zone Alert', was launched by Dr Arun Kumar Sahoo, Honourable Minister for Agriculture and Farmers Empowerment, Fisheries and Animal Resource Development, Odisha. This alert works offline by notifying the fisher folk when they enter turtle congregation areas and buffer zones of Dhamra, Rusikulya and Devi River mouths and Gahirmatha Marine Wildlife Sanctuary, where a fishing ban is enforced from November to May every year.

Based on the feedback from the key stakeholders and the fishing community, a total of three new versions (4.9, 5.0, 5.1) of FFMA and an additional intermediate version (5.01), with new and upgraded features of the FFMA, were launched. About 16,265 new users have downloaded the application in ten coastal states, that has increased the overall number of active users to 89,705. The total number of screen views for the application stands at 111 lakhs, and the number of screen views added during 2021-2022 is 31.45 lakhs.

A total of 118 fisher folk were identified as FFMA ambassadors; and 603 village-level awareness meetings were conducted, where more than 15,050 fisher folk were trained. Feedback (283) and case studies (55) captured the economic and livelihood benefits experienced by the users. These cases reflected economic benefits gained through various features of the FFMA as well as the time saved in decision-making. The feedback and surveys highlighted that the FFMA had been particularly useful in saving the lives of 69 per cent of respondents during disasters and also in safeguarding assets (boats/nets/equipment) worth Rs 6.80 crores. The case studies also highlighted the impact of this advanced information system on reduction in mental and physical strain among fisher folk. Three new District Level Advisory Committees were formed by involving the key stakeholders in Thoothukudi and Tirunelveli districts of Tamil Nadu and Thiruvananthapuram district of Kerala to evolve a road map for the sustainability of FFMA.

Monitoring of Wave Rider Buoys: The Ocean Observatory System Wave Rider Buoys (WRB) deployed in three locations in the Bay of Bengal in collaboration with the Indian National Centre for Ocean Information Services (INCOIS) performed well. The data generated from these WRBs is regularly communicated to INCOIS for validation. The validated data and advisories from INCOIS were disseminated to the fisherfolk on a daily basis. Multiple awareness strategies such as science exhibitions, display stalls in landing centres and announcements through public address systems were adopted for promoting the use of the scientific services of INCOIS

amongst the fisher folk. A total of 1.06 lakh fisher folk from 882 villages across states of Tamil Nadu, Puducherry and Andhra Pradesh received information on Ocean State Forecast (OSF), high wave alerts and potential fishing zones on a daily basis through mobile-based ICT applications such as FFMA, voice and text messages, district-wise WhatsApp groups among others. A total of 10,072 fisher folk availed the INCOIS–MSSRF 24/7 helpline facility for their queries. The helpline is available in Tamil, Telugu and Malayalam.

Artificial Reef for Enhancing Marine Bioresources: Two stakeholder consultations were conducted with the fisher folk and fisheries officials and a suitable site for reef deployment was identified in Poompuhar coastal waters. Based on a seafloor survey, a potential site at a depth of 14 km was identified (Lat.: 11°11'217"N; Long. 79°54'209"E), located 10 km away from the Poompuhar coast. Eighty artificial reefs (concrete structures) weighing 89 tons each were deployed.

Clean Sea Campaign: The FRTC is one of the partners of the Clean Sea Campaign (CSC) Initiative organized by the National Centre for Coastal Research, MoES, Government of India since 2019. In 2021-2022, beach cleanup events were organized at Poompuhar, Samiyarpettai and Sangumal locations of Mayiladuthurai, Cuddalore and Ramanathapuram districts respectively of Tamil Nadu. These beaches were prioritized because of their popularity amongst the local communities as well as their importance as attractive tourist destinations. A total of 1,052 kg of debris was collected by 208 volunteers and segregated and data on waste collected was shared with national database development on marine litter. The CSC not only created awareness about the significance of waste management on the beaches amongst the locals but it also enabled the collection of baseline data that categorizes waste based on type and volume.

102.2 Post-harvest Management

Fish Nutrition and Quality Analysis Lab: The FRTC has started a Nutritional and Quality Analysis Laboratory to analyse the proximate and microbial quality attributes of fresh and processed fish products. The purpose of setting up of the laboratory is to support the fisher folk in safe fish handling, hygiene and sanitation practices in line with the Food and Agriculture Organization's Codex standards. It provides four important services to the local community: (1) water quality analysis (salinity, pH, ammonia, dissolved oxygen, water hardness, alkalinity, nitrite content); (2) microbial analysis (*Escherichia coli*, *Salmonella*, *Staphylococci*, *Vibrio cholerae*, *Listeria monocytogenes* detection); (3) biochemical analysis (moisture, ash, protein, fat, peroxide value, free fatty acid); and (4) other services, such as nutritional labelling, packaging, shelf-life estimation, value-added products development and technological process standardization as per the Food Safety and Standards Authority of India.

***Value Addition and Commercialization of Anchovies*:** With the support of the Department of Science and Technology under the Women's fellowship programme,

value-addition studies on small pelagic fish anchovies was initiated to address issues such as post-harvest loss and to improve the commercial sale value of anchovies. The following value-added products have been developed (Table 2).

Drying curve studies for the selected pelagic fishes – silver bellies, anchovies and ribbon fishes was carried out using the solar fish dryer. Parameters such as drying time, moisture content, and biochemical and microbial parameters were standardized for the preparation of dry fish powder.

***Portable Solar Fish Dryers for Quality Dry Fish Production*:** A new scheme called 'My District My Product' was launched at Mudasalodai fishing village in Cuddalore district, Tamil Nadu in collaboration with NABARD under its Gram Vikas Nidhi programme. This scheme aims to produce quality dry fish using portable solar fish dryers. It also aims to provide training and demonstration of the different models of portable baby solar dryers. One medium solar dryer with a capacity to process 250 kg of catch and five baby solar dryers with a capacity of 50 kg each have been installed in Mudasalodai. The dry fish vendors in the villages were mobilized and organized into five groups, and trained in various methods of quality dry fish production and hygienic handling of fish products.

Winmeen Fish Producer Association: Three dry fish producing women's groups from the federation processed 2.54 tons of different fish species, produced 514 kg of hygienically dried fish products and earned an income of Rs 1.05 lakhs. Twenty five joint liability groups (JLGs) were formed at Vanagiri village involving 125 fish vendors. Credit linkage was established with the Tamil Nadu State Apex Fisheries Co-operative Federation Limited and a total credit of Rs 18.75 lakhs accessed to procure and sell fish in neighbouring market places in Sirkazhi, Mayiladuthurai and Kumbakonam.

102.3 Culture Fisheries Enhancement and Management

Portable Fish Hatchery: A portable carp fish hatchery was established at the FRTC with technical and financial support from the Indian Council of Agricultural Research (ICAR) - National Bureau of Fish Genetic Resources. The hatchery serves as a centre for the conservation of local fish genetic

Table 2: ***Details of Value-Added Anchovies Products***

Target group	Value-addition format	Nutrition delivery
1- to 5-year-old children	Stick/porridge powder	12 per cent protein per 100 g + other vital nutrients as per Recommended Daily Allowance(RDA)
6- to 14-year-old children	Extruded snack	16 per cent protein per 100g + other vital nutrients as per RDA
Adolescents Pregnant and lactating women	Paste/powder form to be added to any kind of food	20 per cent protein per 100g + other vital nutrients as per RDA

resources. Indian major carp brooders (both male and female) were sourced locally and reared in the farm pond for breeding. The breeding of carps in the portable fish hatchery was initiated in December 2021, and the first set of reared fingerlings were distributed to 15 fish farmers in Mayiladuthurai district. Training and front-line demonstrations were organized for the selected fish farmers on nursery pond preparation and methods of pond disinfection. A survey on the diversity and abundance of indigenous fish along the Cauvery Delta region has also been initiated. Another study has been initiated in four landing centres to assess the seasonal availability of indigenous fish species as well as brooders, species diversity and richness.

Rearing of Sea Bass in Mangroves in the Backwaters of Mudasalodai: Integrated aquaculture with mangroves has been started as a new livelihood model for the coastal fishing communities in Cuddalore district with the support of NABARD. An integrated aquaculture pond was designed in a mitochondrial pattern in 2.42 ha area in the backwaters of the Pichavaram-Coleroon estuarine complex. A total of 6,600 sea bass fingerlings were stocked in the fish pond integrated with mangroves. Feeding and sampling of sea bass is being done regularly by the fishing community members. In addition to earning income from the rearing of sea bass, the group members have also profited from the capture and sale of already available wild shell and fin fish species.

Mangrove Crab Fattening: To demonstrate crab fattening as a livelihood model for the Irula tribal community who depend on mangroves for their livelihood, a new self-help group (SHG) was formed with 15 members who were trained on mangrove plantation, deepening of water-logged areas, bund strengthening, collection of soft-shell crabs, crab fattening methods, moulting process and understanding of crab markets and economics. Two crab fattening pens of size 30 x 30 m were established and a total of 50 kg of crabs stocked for fattening.

102.4 Training and Capacity Building

Training Centre: In 2021–2022, a total of 41 training programmes were conducted on marine biodiversity conservation, sustainable fisheries, sustainable fishing gear operation, use of square mesh for responsible fishing, crab fattening, sea bass culture, quality dry fish production, integrated fish farming, integrated aquaculture–dairy with fisheries and poultry rearing with fisheries. A total of 1,965 fisher folk and farmers (1099 men and 866 women) were trained in these programmes.

Village Resource Centre: Two village resource centres (VRCs) and two village knowledge centres (VKCs) developed and disseminated 1,350 contents on health, education, government schemes and employment through notice boards, public address system, WhatsApp groups and online webinars. In addition, 9,109 helpline queries have been addressed on various issues such as OSF, cyclones, FFMA, marine conservation, Covid-19 pandemic and sea safety measures. A total of 21 audio conferences and 7 online webinars on insurance schemes, sustainable

fishing practices, marine fishery advisory services, vegetable cultivation practices, pest management in paddy cultivation, cattle care and management and nutrition awareness were conducted through VKCs and VRCs.

Sub Programme Area 103

Remote Sensing and Geographical Information Systems

103.1 Forewarning Model for Pest Management

The Pest-disease Advance Notification and Need-based Agriculture Information (PANNAI) App is a useful tool for farmers in the Vedaranyam region of Tamil Nadu to immediately connect and get expert's advice. Besides, pest and disease forewarning advisories, farmers have access to weather and market-related information using this App. The cadastral and field measurement books of the selected villages have been digitized using Geographic Information System (GIS) and shared with the community for planning and monitoring the farmlands as an initial step. The area under paddy cultivation and productivity are being mapped for Kadinalvayal village, Nagapattinam district of Tamil Nadu using Sentinel-1 Synthetic Aperture Radar (SAR) Data adopting machine learning algorithms.

103.2 Quantification of Above Ground Biomass in Pichavaram Mangroves Using Remote Sensing

The above-ground biomass (AGB) in Pichavaram mangroves has been quantified using machine learning algorithms and SAR satellite images which indicates 40 MgC/ha of AGB.

103.3 Mangrove Community Zonation and Biophysical Characterization

As part of the upgradation of the Mangrove Atlas Mission initiated by the Ministry of Environment, Forestry & Climate Change (MoEF&CC), the mangrove wetlands along the Tamil Nadu coast were mapped using LISS IV satellite images for the year 2019. Mangrove community zone maps are being prepared for the atlas at a scale of 1:25000, that can be used as a tool for planning and monitoring conservation programmes along the Tamil Nadu coast. The hybrid classification technique, a combination of supervised and unsupervised algorithms was adopted to process the satellite images. The study identified that 13 exclusive mangrove species occur in Tamil Nadu.

103.4 Decision Support System using GIS

A decision support system (DSS) for greening of hillocks was prepared for the Tiruvannamalai district of Tamil Nadu that has a series of isolated hillocks. Most of the hillocks are in a degraded state, leading to severe erosion as well as loss in critical ecosystems services. GIS-based thematic datasets for slope, soil type, land use, geologic features, rainfall, temperature and geomorphology were used along with satellite images of the district to develop a DSS for greening the hillocks. Ground verification of the DSS was carried out and fine-tuned for the application. Based

on this, a four hillock restoration projects have been initiated by the District Rural Department Agency, Tiruvannamalai. In addition, an android-based mobile application was developed and tested in field to ground-truth the works carried out under the Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS).

Programme Area 200

BIODIVERSITY

The programme Biodiversity aims to promote sustainable management of agrobiodiversity to enhance availability, access and also consumption of diverse and nutritious food by the tribal and rural communities. Integrated tribal development through Agroforestry initiatives and millet promotional efforts continued in Kolli Hills with the support of NABARD. A global manifesto on Forgotten Crops developed and disseminated. National Agricultural Science Fund of ICAR helped to assess effectiveness of the extension services in Kolli Hills and Koraput. Biju Patnaik Tribal Agro-biodiversity centre (BPTAbC) has promoted models on alternative seed system for millets and pulses, Integrated Farming System (IFS), 'Bio-Village', farmer-led extension strategy for ensuring food and nutrition, livelihood and social security of the tribal communities in the region. While Community Agrobiodiversity Centre (CAbC), Wayanad, contributed to the biodiversity conservation, outreach programmes of M.S. Swaminathan Botanical Garden, and education, communication and training.


VALUE ADDITION TRAINING ON MILLETS


A step towards progress

Sub Programme Area 201

Community Conservation Programme at Kolli Hills

During the year 2021-2022, Multi-Storey Mixed Farm (MSMF) development, millet-based on-farm demonstrations, impact survey, processing and value-addition activities were carried out. In particular, the project team focused on MSMF development in agroforestry and small millet promotion, with the objective of increasing sustainable income and enhancing nutrition among the tribal farm families, thus ensuring livelihoods and environmental sustainability.

201.1 Integrated Tribal Livelihood Enhancement through Agroforestry

The third-year of MSMF project activities were continued over 200 ha. To date, the project has distributed 33,000 saplings of fruit trees (jack, mango, acid lime), 8,000 saplings of nutri-dense species (sapota, pomegranate, amla, guava, drumstick etc.) and 32,000 saplings of border trees (Silver oak); further, 1,98,500 Napier CO4 grass slips for forage were planted by tribal families in their Wadi farms. About 900 metric tons of farmyard manure, 12 metric tons of neem cake and 500 litres of neem oil were applied by the farmers over 200 ha as part of soil-nutrient management and plant protection strategies. Bio-inputs such as *Azospirillum* (250 kg), *Azotobacter* (250 kg), phosphobacteria (500 kg) and potash mobilizer (500 kg) were supplied.

Substantial effort was made to conserve soil and water through development of compartmental bunds, trenches and V-bunds. Project participants were able to maintain a high survival rate for most of the seedlings: jackfruit (81.40 per cent), mango (80.50 per cent) and acid lime (80.51 per cent). Millet cultivation as intercrop was promoted in the Wadi farms to ensure food security for the farm families. About 180 families who intercropped millets on Wadi farms harvested 18 tons of millet, and of this, 80 per cent was consumed and the remaining sold at a rate of Rs 35/kg, providing additional income to the families in the initial stages of Wadi development. Forty-four training programmes were conducted on formation of producer groups, Wadi farms, on-farm and off-farm enterprises and value addition of products.

201.2 Enhancing Farmers' Income and Livelihoods through Millet-Based Farming Systems

The project is based in two tribal locations in India, namely Kolli Hills and Koraput blocks in the Eastern Ghats, in the states of Tamil Nadu and Odisha, respectively. Both these areas are known for biodiversity as well as cultural diversity.

The project team aimed to empower Millet Farmer Facilitators (MFF) by training them on the installation of the millet market App and its functioning, leadership qualities and building linkages with local stakeholders such as Departments of Agriculture, Horticulture and Veterinary Sciences, Krishi Vigyan Kendras (KVKs), Farmer Producer Organisations

(FPOs) and dissemination through social media platforms. Training programmes on the use of finger millet and pulses seeders, queen honeybee rearing, collection of honey from beehive boxes, dairy farming, processing unit maintenance and machinery repairing, and use of threshers were conducted. Certificate training on millet value-added products was organized at the Indian Institute of Food Processing Technology, Thanjavur, that helped participants learn about steps involved in production of ragi malt with cocoa flavouring. An exposure visit organised for five farmers to participate in the Biodiversity Festival-cum-Seminar on Millets in Odisha. A total of 12 training programmes, seven for the farmers at Kolli Hills and five for the farmers in Koraput, were conducted during this period.

Each MFF has formed millet producer groups at their respective villages in Kolli Hills and Koraput. Two hundred farmers have formed ten groups, with 20 members in each group. These groups are encouraged by the MFFs to adopt improved agronomic practices, use high-yielding varieties, conserve traditional millet varieties, increase productivity on farm, maintain community seed banks and communicate messages to other farmers in villages. During the reporting period, in Kolli Hills, the MFFs and group members were provided 500 kg of millet seeds for on-farm demonstrations, and 230 kg of millet seeds were given to the neighbouring villages of Velikadu, Melamathi, Kelmathi and A. Keeraikadu, covering 27 ha and a total yield of 188.1 q of finger millet was obtained. Similarly, in Koraput, 108.25 q of millets were produced by the MFFs in three villages, namely Bagraguda, Talalimka and Aminguda. These MFFs facilitate sale of millet value-added products such as rusks, biscuits, bread, ragi malt (cocoa flavour) and ragi flour.

In Kolli Hills, 100 demonstrations were organized during the 2021 Kharif season on: technology (55); variety (25); and intercropping (20).

Technology demonstration trials: Demonstrations on line sowing (LS) versus broadcasting methods were conducted, wherein seeds of finger millet variety CO15 was used in 55 farmers' fields. The results of this study indicated that the average grain yield from farmers' practices was 8.24 q/ha while it was 11.57 q/ha with improved agronomical practices. Farmers obtained a 28.78 per cent higher yield by following the LS method of cultivation. The study also indicated that farmers received a net return of Rs 2138/ha using farmers' practices and Rs 10,885/ha by following the LS method of cultivation, which implies that they got 80.35 per cent additional income from the improved practices.

Varietal demonstrations trials: Demonstrations were conducted in 25 farmers' fields wherein the performance of the improved variety (CO15) over the traditional variety was tested. Farmers harvested 22.82 per cent higher yield and obtained 61.72 per cent additional income from the improved variety.

Intercropping was introduced in 20 farmers' fields, wherein the performance of millet and

pulses intercropping in a ratio of 4:2 versus traditional broadcasting methods was tested. In intercropping, the average millet grain yield was 8.7 q/ha and 0.81 q/ha for pulses while in the broadcasting method, the millet grain yield was 6.54 q/ha and 0.53 q/ha in pulses. Farmers received a net return of Rs 5,342/ha from the 4:2 ratio intercropping method and Rs 1,803/ha from the farmers' traditional method with an additional income of 66.24 per cent from the improved cultivation methods.

Milch Animal Rearing: In Kolli Hills, by rearing milch animals, farm families got an average of 1497 litres of milk between April, 2021–March, 2022 and an average income of Rs 3,503/ month per family.

Beekeeping: A total of 20 beehive boxes along with bees were procured and allocated to the millet farmers through MFFs. Each MFF monitored 4 boxes of beehives. The first harvest was done during the month of November and the yield continued upto March, with an average yield in both locations of 1.5 litres every 3 months. Honey was sold at Rs 2,000/litre in Kolli Hills.

Establishment of Primary Processing Units: Two primary processing units were established. Each unit consists of a thresher, a destoner, a pulverizer, utensils, a mini-van and necessary value-added materials. This facility catered to 15 small settlements in 2021-2022. The Perumalsamy Millet Producer group earned Rs 40,300 and the Palapadi Millet Producer group earned Rs 42,300 as net income, that was facilitated by MFFs. The increased participation of women in value-addition activities was seen in the locations.

201.3 Kolli Hills Agro Biodiversity Conservers' Federation

The members of Kolli Hills Agro Biodiversity Conservers' Federation (KHABCOFED) are producing millet value-added products under the label of Kolli Hills Nature products since 2001. About 16 value-added products such as little millet rice and flour, Italian millet rice and flour, Kodo millet rice, barnyard millet rice, ragi malt, Italian little millet upma mix, little millet bajji mix, Italian millet payasam mix, Italian millet laddu, ragi murukku and ragi flour, pearl millet rice and flour, are produced and marketed across Tamil Nadu. Last year, 3.1 tons of millet rice and value-added products were sold.

201.4 Kolli Hills Agri Bioresource Producers Company Limited

This activity started at Kolli Hills in January, 2016 and during the year 2021-2022, 8 tons of pepper, 2.5 tons of millets, 15 kg of clove, 5 tons of tamarind, 8.25 tons of cashew nut and 30.5 tons of coffee were procured from members for primary processing and sale. MSSRF joined hands with Food and Agriculture Organization – Global Fund for Agriculture and Innovation (FAO-GFAR), Asia Pacific Association for Agriculture Research Institution (APAARI), Asian Farmers Association (AFA) and Crops for the Future (CFF) that resulted in development of global manifesto on Forgotten Crops translated in to eight Indian languages for dissemination.

Sub Programme Area 202

Biju Patnaik Tribal Agro-biodiversity Centre (BPTAbC), Jeypore, Koraput, Odisha

Promotion of millet cultivation under the Odisha Millet Mission (OMM), production of millet seeds and value-added products, Integrated Farming System (IFS), Every Village a Bio-village, MSSRF-DBT-Biotech KISAN hub, biodiversity conservation on campus were among the activities undertaken during the year 2021–2022.

202.1 Odisha Millet Mission

A special programme for promotion of millets, 'Reviving Millets in Farms and on Plates', is being implemented since 2017–2018. The Government of India has taken this as a model to be implemented in other millet-growing states. During the last five years, 3,616 farmers from 1,149 villages under 14 gram panchayats were mobilized to cultivate finger millet in 1817.2 ha adopting improved agronomic practices and modern technologies such as the System of Millet Intensification (SMI) and LT. From the crop-cutting experiment, it was observed that the farmers received an average yield of 17.89 q/ha using SMI technology and 14.11 q/ha by following the LT method. The project resulted in sale of 1,210 tons of surplus finger millet after meeting out the requirement for household consumption. During the reporting period, 23 training programmes were conducted on SMI, LT, good agronomic practices, preparation and application of organic inputs and seed centre management, involving 335 farmers (261 men and 74 women). Bamandei Producer Company Ltd (BPCL), that was formed with 79 members in June 2019 under the OMM programme, now has 191 members with a total share capital and membership fees of Rs 77,500. The BPCL was entrusted with the responsibility of farmers' registration, creating M Pass and facilitating the procurement of finger millet in Kundra block for the past two years. About 1,069 tons of finger millets were procured by the FPO through the *mandi* from 1,156 farmers. The BPCL earned Rs 33.4 lakhs in the reporting year.

202.2 Alternative Seed System Model for Millets and Pulses

The project promoted 56 lead farmers in the project area, and they serve as para-extension workers in Ganjam and Koraput districts. Farmers were trained on improved seed production technologies covering a total area of 172 ha. A total of 318 q of certified seeds of finger millet cv. KMR-204 and Arjun were produced, of which 235 q were procured by the State Seed Production Corporation, Jeypore, at the rate of Rs.4,263/q and the rest sold locally and to other agencies. The KMR-204 variety gave an average yield of 21.9 q/ha, whereas the average yield of the Arjun variety was 19.95 q/ha.

202.3 Up-scaling Sustainable Technological Solutions and Replicable Models for Ensuring Food and Nutrition, Livelihood and Social Security

In a collaborative project involving ICAR-Indian Institute of Soil and Water Conservation (IISWC), Sunabeda, and the Institute of Life Sciences, Bhubaneswar, covers 34 villages in 11 gram panchayats in three selected blocks, namely Boipariguda, Koraput and Kundra. The area covers a population of around12,000 represented by 2,840 households. The project focus is primarily on people belonging to the Scheduled Tribe (ST),which accounts for 71.76 per cent of the population with 2,038 households.

To enhance household income and attain food and nutrition security, appropriate technological solutions were promoted. Finger millet cultivation was taken up in 138 ha with improved technologies (SMI and LT) involving 621 farmers. Farmers got an average yield of 16.96 q/ha from the local varieties whereas the average yield of the improved variety (KMR-204) was 28.16 q/ha under the LT method and 32.92 q/ha under the SMI method. Likewise, paddy cultivation was taken up by 272 farmers covering 80 ha following the LT method and improved agricultural practices. Farmers received an average yield of 28.05 q/ha from the local varieties (*Machhakanta*, *Bodikaburi*, *Sapuri*) whereas the average yield of the improved varieties (MTU-1001, 1153, 1156) was 39.02 q/ha under the LT method. Off-season vegetable cultivation was done in 54.80 ha with 160 farmers, and they received an average net income of Rs 5.8 lakhs/ha. A total of 367 farming system for nutrition gardens were established at the individual and group levels.

Production of Bio-inoculants (*Trichoderma viride* and *Rhizobium*) was initiated at the laboratory scale, and tested for its performance in pot cultures and on-farm field conditions. A business strategy and action plan on bio-input production and marketing at the community level was prepared through BPCL, Kundra. Marketing of finger millet seeds was carried out by Kolab Farmers' Producer Company Ltd., Koraput.

Soil samples were collected from 832 locations of operational villages. Field bunding covering approximately 40 ha in four villages is in progress; 13 ha of lands were planted with mango saplings, adopting an agroforestry model in three blocks of Koraput district. Alley cropping was carried out with millet and vegetable cultivation in 12 ha within the mango plantation. Promoted multi-tier cropping system in 35 ha was adopted by 157 farmers. 66 capacity-building programmes and three exposure visits were conducted for 2526 farm families.

202.4 Integrated Farming System (IFS) Model

The aqua-based IFS model consisting of pisciculture, duckery, horticulture and agriculture-based interventions were demonstrated in 18 farms. In addition, agriculture-based IFS models were adopted in 109 farms. A total of 100 households established nutrition gardens; 100 women's SHGs got involved in mushroom cultivation as an alternative livelihood activity; 114 landless households got involved in backyard

poultry rearing; and 100 landless households got involved in goat rearing. In addition, 100 vermicompost units have been established, and 50 women's SHGs got involved in value-addition activity for income generation.

202.5 'Every Village a Bio-Village' Programme

In the reporting year, demonstrations were conducted in Kharif 2021 with traditional varieties of paddy namely *Kalajeera*, *Machhakanta*, *Muktabali*, *Asamchudi* and *Hirakhandi* involving 59 farmers and covering an area of 24 ha.; and high-yielding varieties such as *MTU-1001*, *1153*, *1156* and *Sahabhagi*, with 80 farmers in 32 ha.

Green manuring with *Dhaincha* (*Sesbania aculeata*) was adopted in 20 ha of paddy fields involving 100 farmers. To promote organic agricultural practices, 90 units of enriched farmyard manure, 38 units of vermicompost production, 33 units of *azolla* and 33 units of organic formulations such as *jeevamruta*, *amrit jal*, *handi khata* and *neemastra* were facilitated. In the cultivation of traditional varieties, farmers harvested an average yield of 32.27 q/ha and obtained a net return of Rs 57,806/ha following low-input-based sustainable agriculture practices with a Benefit: Cost (B:C) ratio of 2.87. Among all the varieties, *Kalajeera* performed best with an average yield of 31.19 q/ha and a net return of Rs 85,735/ha with a B:C ratio of 3.97. For high-yielding varieties, namely *MTU-1001*, *1153*, *1156* and *Sahabhagi,* the average yield was 46.96 q/ha and net return was Rs 65,360/ha following low-input-based sustainable agriculture practices with a B:C ratio of 2.94.

Freshwater aquaculture ponds were initiated in nine farmers' ponds covering an area of 2.36 ha. The adjacent pond and dyke areas were used for paddy and vegetable cultivation during Kharif season and green gram, black gram and vegetable cultivation during the Rabi season. A total of 670 kg of fish were harvested, of which 166 kg were used for self-consumption and also distributed to neighbours and relatives while the remaining 504 kg was sold within the village at an average rate of Rs 175/kg, with a gross profit of Rs 83,850. Thirteen model nutrition gardens (*Swaminathan Poshan Bagicha*) were demonstrated with an average land size of 0.04 ha in eight operational villages.

Skills development training programmes on seed treatment, preparation and application of enriched farmyard manure, vermicompost, *azolla*, bio-pesticide management, integrated pest management, oyster and straw mushroom cultivation and value addition in tamarind were conducted and involved 1,630 farmers (536 men and 1,094 women). A total of 19 women SHGs with10 members each were involved in group-based oyster and straw mushroom cultivation. Eight women's SHGs under three producer groups were involved in value-addition activities for tamarind for which they received a working capital support of Rs 6 lakhs from Odisha Rural Development and Marketing Society (ORMAS). A total of 12 farmers carried out large-scale vegetable cultivation in 5.0 ha of land using the cluster approach.

202.6 Farmer-Led Extension Strategy to promote Millet-Based Farming System

The need-based technology interventions led by MFFs were selected and implemented in the selected farmers' fields, covering an area of 28 ha during Kharif season: Varietal demonstrations (improved variety versus traditional variety): 40 farmers; technological demonstrations (LS versus farmers' practices): five farmers and LT: 25 farmers and SMI: 25 farmers; Intercropping of millets with pulse crop (4:2 ratio): five farmers.

Through varietal demonstration farmers got 76 per cent higher yield and 63 per cent additional net income by cultivating the improved variety (KMR204) compared with the traditional variety. The adoption of SMI technologies resulted in 51 per cent higher yield and 46 per cent higher yield using the LT method.

A total of 20 beehive boxes along with swarms were allocated to the millet farmers through MFFs. An average of 1.35 litres of honey was harvested from each box during July–August 2021. Honey was sold at the rate of Rs 400/litre. Two millet-processing units each comprising of a thresher, a de-stoner, a pulverizer, utensils set and a micro-oven were established for value-added products such as ragi flour, bread, rusk and ragi malt. Three producer groups led by MFFs were linked with ORMAS, and each group received a working capital of Rs 2 lakhs for undertaking value addition of millet activities. ORMAS provides support in training on processing, packaging, branding and marketing of millet-based products. The members of these groups are also linked with the Kachela Farmers Producer Company Ltd.

202.7 Conservation Activity at the BPTAbC, Jeypore

The BPTAbC garden has nine sub-divisions representing the names of the nine major tribes of the undivided Koraput district, wherein 384 ethno-medicinal plants have been conserved. The garden is also embedded with *in-situ* conservation of 141 landraces of paddy, 45 landraces of millet and a wild food garden consisting of 62 species of wild fruits, leaves and tubers. During the reporting period, about 10,000 plants belonging to 47 species were propagated and supplied to schools, the Forest Department, NGOs, traditional healers and individuals. During the year, the garden had around 4,000 visitors.

In addition, seminars were organized on biodiversity conservation, safeguarding biodiversity, protection of biodiversity from forest fire, forest law (Odisha Forest Act, 1972, Wildlife Protection Act, 1972), Biodiversity Management Committee, NTFP management / Joint Forest Management, afforestation and nursery techniques.

202.8 Grassroots Institutions

***Convergence with ORMAS and Other Government Departments*:** To achieve the common goal of community development and women empowerment, the centre converged with government line departments such as ORMAS. It supported seven producer groups

formed by BPTAbC, financially and technically, to carry out work in the operational areas of Koraput district. Each group received Rs 2,05,000 as working capital to carry out their business activities. Likewise, ORMAS also supported an FPO named Kachela Farmers Producer Company Ltd. This support will be provided for a period of five years to strengthen the FPO and producer groups.

Sub Programme Area 203

Community Agrobiodiversity Centre, Wayanad

203.1 Biodiversity Conservation

Biodiversity conservation activities are centred around medicinal and aromatic rice, medicinal plants, and Rare, Endemic and Threatened (RET) species. The centre has been engaged in chronicling the homestead agrobiodiversity in different agro-ecological zones covering major districts in the Malabar region. It has maintained germplasm for valuable plant genetic resources, including varieties of cultivated and wild species of tubers, wild crop relatives, for example, Wild *Dioscorea* (9), Traditional *Dioscorea* (40), *Colocasia* and *Alocasia* spp (9), traditional turmeric (8), wild turmeric (4), traditional ginger (9), pepper (5) and cowpea (36). Besides, three community conservation plots were also established and maintained in the Madamkunnu tribal colony in Wayanad for the conservation of traditional germplasm varieties of seven crops, that is, *Dioscorea* (14), *Colocasia* (5), elephant foot yam (2), banana (8), ginger (4), turmeric (3) and arrowroot (2).

***Outreach Programmes of the M.S. Swaminathan Botanical Garden (MSSBG)*:** Conservation programmes at two sacred groves was taken up: Mapitacherry sacred grove, Kannur, and Sree Mariyamman Devi Kshethram, Wayanad. One hundred seedlings each of 20 RET tree species found in the Western Ghats were planted at the locations. A total of 190 RET species from the Southern Western Ghats were conserved in the RET nursery for safe guarding wild, edible species. Different field trips resulted in the collection of 5459 specimens of 33 plant species. Five new species of flowering plants were identified from the Western Ghats, that is, *Seidenfia manikathila* J. Mathew, P.M. Salim & Szlach; *Henckelia viridiflora* J. Mathew & P.M. Salim; *Piper kurichiyarmalayanum* J. Mathew & P.M. Salim; *Neanotis prabhuii* Sunil, Salim & Ratheesh; *Chiloschista confusa* M.J. Mathew, J. Mathew, P.M. Salim & Szlach. Revenue of Rs 6.6 lakhs has been generated through sale of nursery seedlings. The centre played a lead role in promoting Pokkali rice cultivation over 20 ha. A community mangrove nursery was also established at Elamkunnappuzha village in Ernakulam district. Ten solar street lights each in three villages of Wayanad and Idukki were also installed.

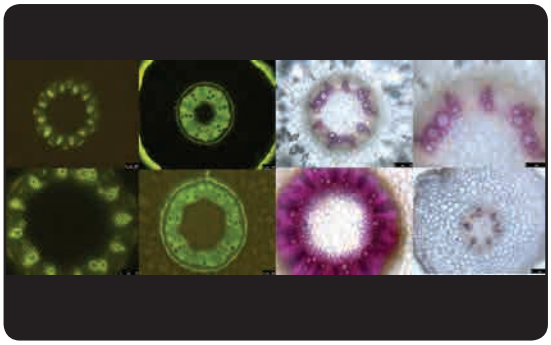
***Education, Communication and Training*:** A one week course on biodiversity was conducted for 20 graduate students to orient them towards biodiversity conservation and climate change. In association with the Asia-

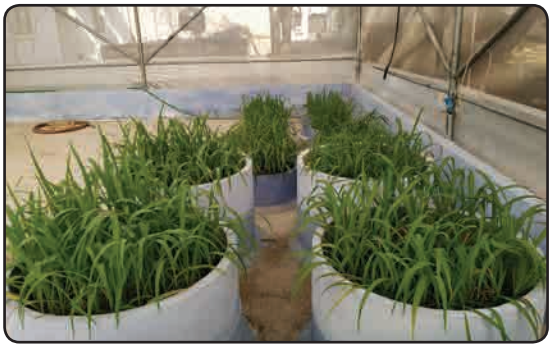
Pacific Network for Global Change Research, two cohorts consisting of 14 state-level participants from Kerala and 25 national-level participants from ten states were trained in river health monitoring and management. The modules prepared for this training included major and minor bio-indicators of river health, catchment area health, biota health, flood plain health, flow health and river channel health. As a follow-up, four participants were selected for conducting the training and awareness sessions at their respective locations.

Programme Area 300

BIOTECHNOLOGY

The Biotechnology Programme at MSSRF uses state-of-the-art technologies for understanding abiotic stress tolerance in plants; selection and promotion of locale-specific varieties to combat salinity stress; bioprospecting secondary compounds from lichens; mapping locally relevant, diverse nutri-rich species; promoting their cultivation and consumption; and developing microbial consortia products to enhance crop yield and improve soil health. Root traits in the mangrove species Avicennia marina *under heterogeneous salinity were studied and molecular markers were used to distinguish Echinochloa weed species that occur in paddy fields. DNA markers were used to confirm the species-level genetic identity of Kagga paddy varieties. Diversity of dimethylsulfoniopropionate (DMSP) producing halophilic bacteria from the mangrove rhizosphere harbouring the gene coding for an enzyme, 1-aminocyclopropane-1-carboxylic acid deaminase were studied. A consortium of micronutrient-mobilizing Plant Growth Promoting Rhizobacteria (PGPR) were screened for the ability to confer enhanced iron and zinc uptake in rice grains. The MSSRF DBT-Biotech-KISAN Hub is a farmer-centric programme promoting improved agronomic practices for enhancing productivity in millets and spices in the aspirational districts of Koraput, Malkangiri and Rayagada in Odisha, and Wayanad in Kerala, respectively. Nutri-gardens containing locale-specific nutri-rich plant species were established to disseminate the importance of dietary diversification in addressing malnutrition among different urban and rural target groups. 'Every Child A Scientist' (ECAS) initiative was revived after the Covid-19 pandemic with upgraded digital learning tools to inculcate scientific temper among students studying in government schools.*





Sub Programme Area 301

Genetic Enhancement

As soils become increasingly salinized due to natural as well as anthropogenic causes, it is imperative to understand how plant species respond to salinity. Responses to salinity are complex in plants and governed by many genes. In this subtheme, root responses to heterogeneous salinity have been mapped in the seedlings of the true mangrove species *A. marina*. In addition, a new initiative identifies *Echinochloa* species that occur in paddy fields as weeds by utilizing DNA markers, to screen them for the emergence of herbicide-resistant traits.

301.1 Root Responses to Heterogeneous Salinity in *Avicennia marina*

Under salinity, plants need to optimize nutrient and water uptake at the expense of excess salt in the soil, which may or may not be distributed heterogeneously. The mangrove species *A. marina* occurs at the intertidal interface (in conditions of high-to-intermediate salinity) and has many mechanisms to deal with excessive sodium in the soil. It is an obligate halophyte, implying requirement of minimum salinity for completing its life cycle. However, dwarfing of *A. marina* in hypersaline inland sites occurs because of lack of freshwater inputs. This suggests that *A. marina* requires freshwater sources to dilute 'excessive' salinity for optimal growth. A split-root system (SRS) experimental set-up was used to assess *A. marina* growth under heterogeneous salinity.

Three-month old *A. marina* seedlings were separated into two approximately equal halves, with each half positioned in a split-root pot, so that the two root halves could be exposed, at the same time, to different millimolar (mM) sodium chloride (NaCl) concentrations: (1) 0–0 mM, (2) 0–150 mM and (3) 150–150 mM. After an initial acclimatization period, defined concentrations of NaCl solution (mentioned above) were used to irrigate the roots and the salinity of the soil monitored by recording soil electrical conductivity (EC). Physiological parameters were recorded prior to and after salinity treatments.

In addition, tissue fresh and dry weights as well as tissue ion content {sodium (Na^+), potassium (K^+) and calcium (Ca^{2+})} were estimated after harvest. The study showed that salt uptake in *A. marina* is impacted not only by the concentration of salinity in the medium but also by soil drainage. Lack of an adequate salinity drainage mechanism for excess salinity may be a contributing factor for reduced plant growth and reduced sodium content in all tissues.

301.2 Molecular Identification of *Echinochloa* Weed Species in Rice Fields

The genus *Echinochloa* has more than fifty species and is considered to be a pernicious weed, reducing yield in several economically important crop species. Rapid growth, prolific seed production, short seed dormancy

period and wide ecogeographic adaptability are all factors that have contributed to *Echinochloa* species emerging as a serious weed, predominantly in paddy fields. Annual *E. crus-galli (L.)* Beauv and *E. colona (L.)* link are included in the list of 'top-five worst weeds' of agricultural crops. As these weed species closely resemble rice, they are often called 'crop mimics' and pose a problem, especially in direct-seeded rice.

With a view to identifying the species of *Echinochloa* weed in rice fields, twelve *Echinochloa* weed plants were collected from rice fields in the districts of Ramanathapuram and Coimbatore, Tamil Nadu, and the leaves used for DNA isolation (T_0 generation). Dried seeds from the same plants were sown in pots containing 1:1 mixture of soil and cow dung to obtain small plantlets (T_1 generation). Polymerase chain reaction (PCR) amplified fragments from the twelve samples (T_0 and T_1 generations) corresponding to the conserved *trnT-trnL* region in chloroplast DNA in *Echinochloa* species were sequenced. Based on this, two *Echinochloa* species that occur in farmers' rice fields were identified: *E. oryzicola* (1 sample) and *E. crusgalli* (11 samples). Further, with the use of this technique, it was possible to distinguish between the two species based on the presence of an insertion/deletion (indel) in the *trnT-trnL* region. *E. crusgalli* plants have a 33-bp deletion in the *trnT-L-F* region in comparison to *E. oryzicola* plants. Further, the results were consistent over both T_0 and T_1 generations.

Sub Programme Area 302

Bioprospecting

Lichens are considered as an important source of structurally distinct secondary compounds belonging to the polyketide family, and are used as food flavouring agents, dyes, cosmetics and in pharmaceuticals. They are extensively collected as non-timber forest product (NTFP) by the Paliyan tribal communities for their livelihood in the Lower Palani Hills, Western Ghats. MSSRF focuses on *in-situ* and *ex-situ* conservation of vulnerable lichens.

302.1 *In-situ* Conservation of Vulnerable Lichen Species

An assessment of lichen diversity using macroplots with nested microplots across different landscapes in the Kodaikanal block, Dindigul district, Tamil Nadu, recorded 570 lichen specimens. These belonged to 58 lichen species distributed in 12 genera and four families. The Paliyan tribal community residing in the hills collect foliose lichens as NTFP for their livelihood. Since lichens are extremely slow-growing in nature, their unsustainable collection has resulted in an alarming loss of these species in their natural habitat. To promote the *in-situ* conservation of lichens, awareness was created among the lichen collectors on its ecological functions.

302.2 *Ex-situ* Conservation of Vulnerable Lichen Species

Lichen mycobiont cultures for *Buellia* spp., *Haematomma puniceum*, *Lecanora achroa*,

Parmotrema reticulatum, *Parmotrema tinctorum*, *Parmelia* sp. and *Pyrenula corticata* were successfully established. The molecular identity of mycobiont cultures was confirmed by amplifying fungal-specific internal transcribed spacer (ITS) regions and compared with existing sequences at the National Centre for Biotechnology Information database. Optimized High pressure liquid chromatography gradient methods were developed for effective separation of secondary metabolites from vulnerable lichens and their mycobiont cultures. The metabolite profiles indicated the presence of two major unidentified compounds: an orcinol ($C_7H_8O_2$) identified as the main constituent, and 2,4-dihydroxy-3,6-dimethyl benzoic acid methyl ether ($C_{10}H_{12}O_4$) as an additional compound.

Sub Programme Area 303

Microbial Diversity

Diverse bacterial taxa associated with mangrove rhizospheric regions provide important ecosystem benefits that need to be quantified. In this context, mangrove-associated DMSP-synthesizing and -catabolizing bacterial communities have been characterized. Demonstration and on-farm trials using bio-inoculants are being undertaken on a large scale in select aspirational tribal districts of Odisha and Kerala.

303.1 Microbial Community Profiling in a Mangrove Ecosystem

1-Aminocyclopropane-1-Carboxylic Acid Deaminase Activity in Halophilic DMSP -Producing Bacteria

DMSP is an important marine osmolyte that helps microbial species withstand the negative water potential inherent in saline water. In the present study, the functional diversity of DMSP-synthesizing and -degrading bacterial communities that harbour 1-aminocyclopropane-1-carboxylic acid ACC deaminase (ACCd) coding genes in the Pichavaram mangroves of South India was explored. A total of 35 bacterial isolates obtained from the rhizosphere of *A. marina* and other mangroves were screened for the presence of the DMSP-synthesizing gene (*dsyB*) and also for the presence of the ACCd coding gene (*acdS*). Of the 35 isolates, seven showed the presence of both *acdS* and *dsyB* genes and could grow in medium containing NaCl of concentration greater than 4.7 per cent. Identification of species-level differences by partial 16S rRNA sequencing analysis assigned six strains to *Labrenzia aggregata* and one to *Pseudooceancola nitratireducens*. DMSP in these isolates is hypothesized to function as an osmolyte during high salinity, while the ACCd may act as a sink by decreasing plant ethylene levels.

303.2 Bio-inoculants for Sustainable Agriculture

Bio-fortification of Iron and Zinc in Rice Grain Using PGPR

The potential for utilizing PGPRs for rice grain biofortification was examined. Five potential bacterial isolates were screened for iron and

zinc mobilization in rice variety ADT37 under greenhouse experiments. Selected zinc- and iron-mobilizing PGPR isolates: *Bacillus safensis* MSSRFCCAD5, *Bacillus velezensis* MSSRFCCAD7, *Pseudomonas aeruginosa* MSSRFCCAP3, *Bacillus zhangzhouensis* MSSRFCCN83 and *Pseudomonas* sp. MSSRFCCD865 showed compatibility with the rice tested. A total of ten treatments were designed using aforementioned isolates as individual amendments as well as in combination. Among the treatments, the consortium of *B. safensis* MSSRFCCAD5, *B. velezensis* MSSRFCCAD7, *Pseudomonas* sp. MSSRFCCD865 conferred maximum average plant biomass of 0.97 g and shoot length of 70.7 cm, with a significantly higher 100 seed weight. The zinc content was highest in treatment with the consortium of *B. safensis* MSSRFCCAD5, *B. velezensis* MSSRFCCAD7; 30.44 ppm compared with control (20.97 ppm). Preliminary experiments showed that the consortium of bio-inoculants conferred significant zinc and iron bio-fortification in rice grain. However, further confirmation studies are required.

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

Establishment of MSSRF-DBT-Biotech-KISAN Hub

The KISAN hub interventions are being implemented in three aspirational districts of Odisha (Koraput, Malkangiri and Rayagada) and one aspirational district of Kerala (Wayanad) to promote eco-friendly technologies for improving farming practices, crop yield, sustainable use of soil and water, access to processing technologies for preparing value-added products and associated markets. During the reporting period, there was close coordination between the main hub at Chennai, Sub-hub I at MSSRF-BPTAbC, Jeypore (in partnership with ICAR-IISWC, Sunebada, Odisha) and Sub-hub II at MSSRF-CAbC, Wayanad (in partnership with ICAR- Indian Institute of Spices Research (IISR), Kozhikode, Kerala) to implement the identified agro-technologies. In the training facility at the main hub, mass production of arbuscular mycorrhizal fungi (AMF) in a poly house with the production scale of 500 kg AMF in 90 days was optimized. Two fermenters to mass multiply biofertilizers and biopesticides were set up with a production capacity of 50 litres each. 14 young professionals and two farmers were trained in the mass production of bio-inoculants.

MSSRF-BPTAbC Sub-hub I, in partnership with IISWC, is implementing assigned activities in six villages each in Koraput and Malkangiri and four villages in Rayagada districts. The key interventions are: (1) introduction of improved finger millet varieties – KMR 204 and Arjun; (2) use of improved methods of cultivation – LT and SMI in both monocropping and intercropping systems; (3) use of bio-inputs (*Trichoderma*/ *Pseudomonas*) and organic NPK biofertilizer consortium; (4) use of integrated nutrient management practices (mineral fertilizer NPK

with biofertilizers); and (5) soil-nutrient analysis and soil health cards. The soil-nutrient status in 751 farmers' fields was analysed and soil health cards were distributed. Fifty per cent of the soils are low in nitrogen and phosphorus with medium in potassium. Training on vermi composting and preparation of enriched FYM was conducted and 750 farmers have adopted composting using vermi-beds. Overall, 249 farmers (148 men and 101 women) participated in demonstrations trials over an area of 73 ha. The introduced agronomic practices provided a significantly higher average yield of 21 q/ha compared with traditional methods of cultivation (12.93 q/ha). Thus, the adoption of an improved package of practices for finger millet cultivation significantly increased farmers' net income by Rs 19618/ha, almost double compared to traditional farmer practices.

MSSRF-CAbC Sub Hub II in partnership with IISR promoted the following interventions: (1) cultivation of improved high yielding, pest and diseases resistant varieties of pepper, ginger, turmeric and coffee; (2) use of biocapsule formulations of bio-inoculants {*Trichoderma*, PGPR and ginger growth promoting bacteria (GRB 35)}; and (3) crop-specific micronutrient mixtures. By the adoption of high-yielding varieties and use of biocapsules and soil micronutrient mix, the yields for ginger and turmeric were enhanced to 175 q/ha and 202.5 q/ha, respectively, when compared with yields obtained using traditional practices. A total of 197 farmers (156 men and 41 women) from five villages participated in the trials.

Three MSSRF-DBT-Biotech-KISAN fellowship farmers each (two men and one women) were selected from four aspirational districts to serve as master trainers.

Impact of Organic Amendments on Soil Properties

Organic amendments are reported to improve soil quality and enhance nutrient availability to plants, leading to enhanced crop productivity. The effects of varying organic amendments (FYM, PGPR, AMF, waste paper, rice husk, vermicompost and control) on soil quality, rhizosphere and soil microbiomes, on grain yield of finger millet (landrace *Muruda Mandia*) was tested over three consecutive seasons at Jeypore, Odisha. All organic amendments conferred a significantly higher grain yield of 30–50 per cent. In particular, vermicompost-treated plots produced a maximum yield of 25.4 q/ha. Metagenomic profiling of finger millet rhizosphere over two growing seasons showed association of distinct taxonomic and functional microbiome groups compared with control fields, with dominance of the following phyla: Proteobacteria (10–35 per cent), Acidobacteria (15–25 per cent), Actinobacteria (15–20 per cent), Planctomycetes (5–15 per cent), Chloroflexi (5–15 per cent), Firmicutes (5–10 per cent), Bacteroidetes (1–5 per cent) and Verrucomicrobia (1–5 per cent). Comparative analysis detected 655 common Operational Taxonomical Units (OUT) in both treated and control plots, and 450 unique OTUs in amendments. The impact of these amendments on soil properties (physical, biological and chemical) is being tested.

Sub Programme Area 304

Biosaline Agriculture

MSSRF, in collaboration with the University of Agricultural Sciences, Dharwad and Karnataka State Agriculture Department are involved in the reclamation of saline agricultural soils in the Aghanashini estuarine region. The initiative addresses the adverse impacts of predicted sea-level change on livelihoods of coastal communities and to strengthen paddy cultivation by reintroducing purified seeds of saline tolerant landrace, Kagga.

304.1 Evaluation of Kagga Paddy Crosses (F_1 and F_2 Generation) and Seed Multiplication

As part of the programme for developing improved crop varieties for salinity tolerance, locally adapted saline-tolerant Kagga paddy was used as a donor parent for crossing with high-yielding varieties. Crosses were made between MGD101 or Jaya with Kari Kagga for desirable traits (high yield, number of panicles, plant height, salinity, flood tolerance and panicle length).

304.2 *In vitro* Seed Germination, Molecular Analysis and Micronutrient Content of Saline-Tolerant Kagga Paddy

Purified Kagga seed showed 85 per cent germination under *in vitro* conditions. The molecular identity of germinated seedlings (Kari Kagga and Bili Kagga) was confirmed by PCR amplification and sequencing of DNA-barcoded regions of the chloroplast ribulose 1,5-biphosphate carboxylase (*rbcL*) and maturase K (*matK*) markers. Molecular Evolutionary Genetics Analysis shows that both Kari Kagga and Bili Kagga are closely related and form a group distinct from *Oryza coarctata*, *O. glaberrima*, *O. barthi* and *O. longistaminata*. The quantities of iron and zinc in 15 selected rice germplasms was assessed and Kari Kagga, Bili Kagga and Pokkali had higher zinc and iron content than IR-64 and AVT-2-IET 2505.

Sub Programme Area 305

Nutri-gardens

MSSRF, in collaboration with KVKs at Palghar (Maharashtra), Tirur (Tamil Nadu), Kanpur Dehat (Uttar Pradesh) and Jeypore (MSSRF Campus, Odisha), has established gardens of nutri-rich plants to: (1) strengthen food-based approaches to eradicate malnutrition; (2) bring a nutrition focus to farming systems; and (3) create nutrition-related awareness among target (malnourished) sections through Community Hunger Fighters (CHFs). During the reporting period, in all the sites, mother nurseries and nutri-garden activities were continued. Thirty master trainers skilled in horticulture are imparting training to farmers, CHFs and farmer self-help groups (FSHG) on the importance of conservation, awareness of nutritional content and consumption of nutri-rich plants. Thirty nutrition awareness programmes were organised for anganwadi and agricultural extension workers, Integrated Child Development Scheme officials and small

and marginal farmers on the importance of nutrition and dietary requirements of pregnant and lactating women, children and adolescent girls. Building a cadre of CHFs (five local members/district) is an important strategy in this programme. Twenty FSHGs, with 25 members per group, were formed in each of the four sites. Propagation centres have also been established at the four sites with the aim of multiplying selected plant species. A selection of 25 nutri-rich plant species has been propagated and distributed to the members of the FSHGs.

MSSRF, in collaboration with the Rotary Club of Madras East and the Greater Chennai Corporation, established a nutri-garden near Thiruvanmiyur Railway Station, Chennai to promote an understanding of key nutri-rich plants among the urban community.

MSSRF served as a knowledge partner in setting up the "First 1000 Days of Life" nutrition park at Chengalpet Medical College and Hospital, Tamil Nadu to impart nutrition literacy and awareness to young mothers and accompanying family members and local communities. The garden is designed in the shape of a fully developed human foetus with path and adequate resting places.

Sub Programme Area 306

Every Child A Scientist Programme

'Every Child A Scientist' (ECAS) programme aims to kindle scientific temper among middle-school students studying in corporation schools. The ECAS programme has been revived after the Covid-19 pandemic with the support provided by Larsen and Toubro Ltd. to set up a smart classroom with personal desktops and access to modern digital learning tools to bridge the digital and knowledge divide among students. Incorporation of digital tools (interactive smart boards, personal computers and the internet) in the teaching/learning process reinforces and provides deeper understanding of STEM (Science, Technology, Engineering and Mathematics) concepts. This method of learning through smart devices also encourages students to study independently and is designed to encourage creative thinking and instil self-confidence in students by adopting appropriate educational teaching tools. Accordingly, innovative learning modules in Biology, Chemistry and Physics have been developed. These modules have been custom designed in alignment with the syllabi followed by middle-school students (sixth, seventh, eighth and ninth grades) in the corporation schools of Chennai, Tamil Nadu. Modules on the following topics were developed: (i) health and hygiene; (ii) prokaryotic and eukaryotic cells; (iii) plants and pigments: separating chlorophyll pigments using paper chromatography; (iii) microscopy in relation to plants and microbes; (iv) nutrition in relation to plant and human health and nutritional needs of plants; (v) soil complexity, soil as a living system, biodiversity, microbes and isolation, role of soil biodiversity in maintaining soil health; (vi) trophic responses in plants; (vii) application of machine learning and artificial

intelligence in agriculture; and (viii) Google Earth, global positioning system (GPS) mapping, geographical information systems (GIS) application in agriculture and day-to-day life. A laboratory space for the children to conduct basic experiments is also available under the programme. During 2021–2022, 90 students from the corporation schools at Taramani and Thiruvanmiyur have participated in this programme.

Programme Area 400

ECOTECHNOLOGY

The Programme Area 400 aims to enhance rural livelihoods by harnessing advancements in Science and Technology to strengthen science–society linkages. The programme activities reached out to 1.75 lakh farmers directly through farmer collectives and modern information and communication tools. The team extended technical support to undertake more than 25 different types of climate-resilience measures under the MGNREGS in two districts of Tamil Nadu – Ramanathapuram and Tiruvannamalai. The adoption of ecological intensification for augmenting pollinator communities was carried out for Moringa and mango in Kannivadi, Tamil Nadu, and lady's finger in Puducherry. The Programme Area also initiated new activities in Andhra Pradesh, Jharkhand, Odisha and Rajasthan and started to scale-up use of Climate-Smart Technologies (CSA) in vulnerable areas of Assam and Odisha, in partnership with eight KVKs.








Sub Programme Area 401

Sustainable Livelihoods and Grassroot Institutions

Livelihood-promotion activities have been facilitated through Producer Collectives (PCs), among smallholders as well as landless agricultural labour households. These important services facilitated access to technology, new knowledge and skills, backward and forward linkages with institutions, and finance, including insurance and input as well as output marketing.

401.1 Coastal Agroecosystems: Mannadipet Region, Puducherry

The 'Nutrition Secure Puducherry' programme continued during 2021–2022 and has led to the creation of 63 nutrition gardens at individual households in 10 villages of Mannadipet commune as model gardens. The Innuyir Grama Sangam (IGS), a women's collective, has maintained its membership with 277 self-help groups (SHGs) and promoted women's entrepreneurship amidst the Covid-19 pandemic. The IGS has facilitated the formation of 101 enterprise groups (55 per cent on-farm, 28 per cent off-farm and 17 per cent non-farm) and access to credit to the tune of Rs 2.94 crores through banks. The IGS Farmer Producer Organization (FPO), a women's PC, is functioning with 611 shareholders, largely landless farmers dealing with small-scale diary and value-added foods, with a turnover of Rs 28.12 lakhs for 2021–2022. The Pasumai Farmer Producer Company Limited (PFPCL), with a mix of 550 men and women landed farmers are involved in producing pulses, paddy, groundnut and oilseeds.

MSSRF has been nominated as a representative for FPOs to conduct state-level stakeholder meetings under the 'Pradhan Mantri Formalisation of Micro Food Processing Enterprises Scheme' to help farmers, pastoralists and entrepreneurs.

In the context of declining insect pollinator population in vegetable cultivation, the main cash crop of smallholder farmers, a participatory on-farm experiment was conducted to augment pollinators through ecological interventions in lady's finger with marigold as intercrop and sunflower as border crop. The results revealed that the number and diversity of insect pollinators in low-inputs fields was about 28 per cent and 56 per cent, while it was 18 per cent and 26 per cent, respectively in high-input intervention fields when compared with control. To promote learning, an online course on apiculture was developed through WhatsApp. 35 farmers (including 17 women) participated, with 70 per cent course completion rate.

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

The Kulumai Producer Federation (KPF) facilitated access to credit support to a tune of Rs. 4.15 crores through nationalized banks for livelihood-enhancement activities such

as milch animal rearing, goatry, agriculture, country-chick rearing, petty business and tailoring activities. It also introduced an asset creation scheme in collaboration with Life Insurance Corporation of India, Dindigul, and 1,950 members have been enrolled in this scheme. Kulumai Milk Producer Company Limited, a subsidiary of KPF, has an annual turnover of Rs 48.35 lakhs. The shareholders received a higher procurement price of Rs 8/litre of milk more than non-shareholders. The Reddiarchatram Sustainable Agriculture Producer Company Limited (RESAPCOL), a collective of small and marginal farmers, is in the process of establishing a seed processing unit for pulses as there is a huge demand for quality seeds. Output marketing is a key service facilitated by RESAPCOL and an e-commerce portal was developed to promote marketing of bio-inputs, processed edible oils, oil cake and seeds of cotton, maize and vegetables.

To strengthen the knowledge of farmers, two MobiMOOC (Mobile based Massive Open Online Course) courses were facilitated on organic input use and water-saving technologies. A total of 1,500 learners were enrolled in each course and the completion rates were 48.2 per cent and 64.8 per cent respectively.

Field experiments were conducted with *Moringa* and mango to evaluate the impact of intercrop (marigold) and border crop (red gram) on pollinator abundance and diversity and impact of pollination. Due to increased insect pollinator visits, yield was enhanced by 20 per cent in *Moringa* and 30 per cent in mango. The pollinator abundance (numbers) and morpho-species richness (diversity) were significantly greater in the intervention fields than in the control fields. A handbook on the important pollinators, their ecological benefits as well as safety measures to conserve native pollinators was prepared in Tamil.

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

The Nallavur Farmer Producer Company Limited (NAFPCL), a farmers' collective working on pulse-based farming system, facilitated access to credit to the tune of Rs 1.29 crores to cultivate pulses, oilseed and paddy and to integrate dairy enterprises during both Kharif and Rabi seasons. As seed production is one of the key business activities in the region, in 2021–2022, certified seed production of paddy and black gram was initiated and a full-fledged seed processing unit has been established by the company.

401.4 Transforming India's Green Revolution by Research and Empowerment for Sustainable Food Supply, Sirkali block in Myladuthurai District, Tamil Nadu

A shelf of projects for a period of 5–7 years was developed for salinity management using GIS platform and implemented through MGNREGS in collaboration with the Department of Rural Development, Government of Tamil Nadu. A total of 3,967 potential work areas have been identified in the following categories

for managing salinity: (1) degraded public and common lands, (2) agriculture and allied sectors, and (3) rural infrastructure.

401.5 Capacity Building of Producer Collectives

MSSRF is one of the technical support agencies for the Tamil Nadu Rural Transformation Project (TNRTP), recently renamed *Vaazhndhu Kaattuvom*, and is being implemented in six districts of Tamil Nadu. Based on the mapping of local production systems, the focus crops identified for value chain development were groundnut, coconut, sesame, black gram, green gram, sorghum, small millets, banana, pepper and cardamom. Simultaneously, training manuals and tools for grading were developed and field tested, and state and district project team members were trained.

401.6 Study on Agriculture in the Cauvery Delta Region, Tamil Nadu

The study mapped the enabling factors for sustainable agriculture in the Cauvery Delta region of Tamil Nadu (Thanjavur, Thiruvarur, Nagapattinam and Myladuthurai districts). The primary study was conducted in seven blocks (covering head reach, middle and tail-end of Cauvery, Vennaru and Grand Anicut Canal) by adopting the mixed-methods approach. The key factors identified for ensuring sustainable agricultural practices were access to knowledge on scientific farming methods, ensuring supply of inputs at nominal costs and competitive market price of the harvested produce.

401.7 Study on Scope of Promoting Nutrition-Sensitive Agriculture

MSSRF is a technical support agency for the Japanese International Cooperation Agency (JICA), to assess the scope and importance of Nutrition Sensitive Agriculture (NSA) in JICA-assisted projects. We examined JICA funded projects operational in Andhra Pradesh (AP Irrigation and Livelihood Improvement Project), Jharkhand (Jharkhand Horticulture Intensification by Micro Drip Irrigation Project), Odisha (Rengali Irrigation Project), and Rajasthan (Rajasthan Water Sector Livelihood Improvement Project). The study used a mixed-methods approach with both qualitative and quantitative tools to identify state-specific strategies such as crop diversification with pulses, cultivation of biofortified crop varieties, and vegetables, conversion of backyard kitchen gardens into nutri-gardens. The recommendations were mapped to link agriculture with nutrition *via* production, income, price and women's empowerment pathways.

Sub Programme Area 402

Climate Change and Agriculture

402.1 Climate Information Services

During 2021–2022, the Agro Meteorological Field Unit, Kannivadi, developed 416 district-level bilingual weather forecast–based Agro-Advisory Service bulletins and five special advisories on extreme weather events through the Agromet Decision Support System portal. These climate agro-advisories reached a

minimum of 1.29 lakh farmers directly in six districts of the south zone of Tamil Nadu. Through the Government of India's 'mKisan' portal, 544 Agromet advisory messages were disseminated to farmers.

402.2 Enhancing Adaptive Capacity of Farmers

Building capacity on climate-resilient technologies and practices among farmers, through information and communication technology (ICT), and peer-learning methods are crucial strategies in enhancing farmer resilience. A total of 17,286 farmers (around one-third are women farmers) were trained in different CSA technologies in Odisha and Assam. The identified CSA technologies were promoted through 200 champions farmers, who not only practiced the CSA technologies in their fields but also transferred the knowledge and technologies to 7,600 fellow farmers during the reporting period. In all, 43 training programmes on CSA were conducted through champion farmers and experts from the Department of Agriculture and KVKs in Assam and Odisha. Moreover, as part of the upscaling efforts, eight virtual VKCs (E-VKCs) were established in eight KVKs each in Odisha and Assam. The outcome study among these farmers showed that 58 per cent of the farmers adopted alternate wetting and drying as an important water management technology in water-scarce regions, 56 per cent followed green manure/cover crop and 56 per cent adopted integrated pest management practices. The different CSA technologies introduced at the study sites in Odisha and Assam had improved crop yields of rice by about 25 per cent and farm income by 33 per cent.

402.3 Climate Change and Water Resource Management

As the lead technical partner in the WASCA[1] project, implemented in Ramanathapuram and Tiruvannamalai districts in Tamil Nadu during 2021–2022, MSSRF focused primarily on translating the identified Composite Water Resource Management (CWRM) works to action by building the capacity of the district team, field testing climate-resilient measures (CRM), updating the CWRM planning tool and developing the resources and tools for upscaling the planning process. Tiruvannamalai is ranked first in GIS planning, while Ramanathapuram is at the eleventh place at the national level.

Some of the new activities initiated include developing 429 village nurseries to promote nutrition-rich crops and trees, restoring waste and fallow lands with plantation models of 1,000 mini-forests, 11 mega-forests, 1 bamboo park, and 11 horticulture parks; promoting avenue plantation with flowering trees for a distance of 240 km and mass planting of 17.74 lakh palmyrah trees. Planning was carried out for 18 cascades of tanks and hands-on guidance provided to pilot one cascade to

1. Water Security and Climate Adaptation (WASCA), a bilateral project of the Ministry of Rural Development (MGNREGS), Ministry of Jalsakthi (National Water Mission) and GIZ (German Corporation for International Cooperation GmbH).

restore a chain of water bodies in Rajasinga Mangalam block of Ramanathapuram district. *Moringa* was planted in common and public lands in Ramanathapuram block with a processing facility to generate value added products. In Tiruvannamalai district, 12 CRM activities were piloted: greening of hillocks to develop the denuded ones in 14 Gram Panchayats (GP), 1,118 farm ponds for on-farm rain water harvesting, silvi-pasture in 28 GPs, nurseries for quality seedlings in 39 GPs, medicinal plant garden in 2 GPs, fallow land development for crop cultivation in 122 GPs, micro-irrigation in 2 GPs, horticulture park in 18 GPs, massive tree plantation and floriculture in 7 GPs, bamboo plantation in 9 GPs, inland fish culture in 258 farms and a honey park in 1 GP. All plans and reports are available in a web portal platform (http://tnwasca-mgnrega.org/). For upscaling the model to other districts of the state, a web application was developed and integrated with a mobile application for field verification and tested in three GPs and fine-tuned.

Sub Programme Area 403

Jamsetji Tata National Virtual Academy for Rural Prosperity

During the pandemic we used ICT tools to reach out to the rural communities.

403.1 Transforming Public Libraries to Lifelong Learning Centres

The International Network of Emerging Library Innovators initiatives were consolidated in two books and policy briefs. The two books *A Nation Reads for Change - "Nurturing and Accelerating Everyone to Read - No one is left behind"* and "*Trailblazing Indian Librarians Transforming Communities".* Learning modules were shared with the Asia Network of Library Innovators' Foundation.

403.2 Village Resource Centres and Village Knowledge Centres

The knowledge platform consisting of VRCs and VKCs have continued innovations to provide technological solutions to help farmers to access information. At present, 3 VRCs and 14 VKCs are functioning and extending services in virtual mode to 425 villages. Apart from providing needs-based, locale-specific, demand-driven information and knowledge, the centres have become hubs for training and awareness programmes and facilitated preparation of Grama Panchayat Development Plans. Multi-media (including video and audio conferences, phone-in programmes, video-based learning, farmers' helpline services, mobile-based audio advisories, WhatsApp and digital plant clinics) were used to disseminate information and knowledge to individuals. MSSRF reached out to 21,151 farmers (including 7,209 women) during the reporting period.

A study conducted revealed that 79 per cent of the farmers preferred helpline and social media (WhatsApp), 71 per cent liked phone-in programmes, 68.4 per cent used audio advisories and 48 per cent opted for both audio-video conferences and webinars. Farmers who received timely and integrated management

advisories prevented crop loss by up to 65 per cent and reduced input costs by 28 per cent. Farmers adopted recommendations received through WhatsApp that reduced input cost by Rs 25,000–3,750/ha.

Information on soil health and water quality was provided through mobile testing vans. 520 farmers from 90 villages in Tamil Nadu and Puducherry participated in awareness programmes on soil testing and nutrient management. High salinity was found in many areas especially in the Cauvery Delta for which suitable advisories were provided.

***Farm School*:** The farm school located at Pasupathikovil village, attached with the VRC at Thiruvaiyaru in Thanjavur district of Tamil Nadu, continues to help in capacity building of farmers through peer learning approach. A short feedback study found that about 62 per cent of the farmers who regularly attend the farm school harvested 6–6.8 metric tons/ha of paddy when compared with agronomic practices adopted earlier (5–6 metric tons/ha).

***Video-Based Learning*:** Work on two new video-based learning modules on organic plant growth promoters for crops and managing rice leaf folder pest infestations were completed. A total of 128 video-based learning programmes were conducted in 48 villages. Of the farmer participants, 83 per cent found the information in the videos useful and 51 per cent adopted new technologies.

***Plant Clinics*:** During 2021–2022, 268 plant clinic sessions were conducted in 75 villages, of which 74 were online sessions. A total of 3,872 farmers (2,876 men and 996 women) received plant health advisories for 3,884 affected crop samples. Twenty Pest Decision Management Guides were developed. A post-evaluation study of 200 farmers, found that 83 per cent of farmers adopted the recommendations given by the plant doctors and 62 per cent realized an increase in income of between Rs 12,500 to Rs 20,000/ha. About 58 per cent of the farmers who utilized the information provided by the plant clinics now prefer to opt for bio-inputs, have reduced the usage of red-labelled chemicals and increased the usage of green and yellow chemicals.

A study jointly conducted with the Centre for Agriculture and Bioscience International reiterated the role of women in production of bio-inputs. Almost all women managed the business and decision-making on production and marketing of bio-inputs. The study suggested that supporting bio-input-based cottage industries can transform the status of women in crop production.

Programme Area 500

Agriculture Health and Nutrition

In Odisha, a farming systems model approach has been taken up extensively to improve livelihood and nutrition through crop intervention, nutrition gardens, and use of fish production technology and increased nutrition awareness. In Kerala, participatory research trials on yield enhancement in traditional paddy landraces under organic conditions, nutrition gardens, promotion of medicinal plants, soil microbial research studies, plant clinic sessions were taken up. Also, capacity building efforts were taken up for stakeholders on human–wildlife conflict, post-harvest technology, marketing of value-added products of medicinal plants, mushroom production, fish processing, spice cultivation and bio-input production.


NATIONAL NUTRITION MONTH 2021


NUTRITION GARDEN
Implemented By
Supported by


DEMONSTRATION

Sub Programme Area 501

Farming System Model in Koraput, Odisha

501.1 Farming System Model for Strengthening Livelihoods and Enhancing Food and Nutrition Security, Koraput District, Odisha

Farming system model to improve the livelihood and nutrition status of small farm households is being implemented in 47 villages under two gram panchayats of Boipariguda block covering 1,575 households. The FSN interventions promoted were upscaled during this year.

***Crop Interventions*:** The area under nutri-dense crops, namely finger millet, pigeon pea, horse gram, green gram, black gram, biofortified rice, maize and orange flesh sweet potato (OFSP) has been increased. The area under finger millet cultivation has been increased by 16 per cent (from 174 ha to 202.4 ha). Two improved varieties, namely KMR-204 and Chilika, were promoted and their average productivity was 21.27 q/ha and 22.64 q/ha respectively. It is observed that about 70 per cent of the produce was retained for self-consumption, 5 per cent kept for raising seeds and the rest (25 per cent) sold in the local market. Intercropping of pigeon pea with maize in the ratio of 1:1 was continued to increase the availability of pulses. Biofortified paddy (cv. CR Dhan-310) cultivated was increased to 116 ha from 22 ha and number of farmers were also increased to 580 farmers from 215. The average productivity was 54.25 q/ha. 480 farmers were involved in OFSP cultivation, largely for self-consumption. The area under horse gram cultivation, was promoted as a pre-rabi crop in fallow land to an extent of 134 ha with an average yield of 13.56 q/ha. Green gram (cv. Nayagarh local) and Black gram (cv. PU-10-23) were cultivated in rice fallow covering areas of 44.8 ha and 10 ha respectively with an average productivity of 9.6 q/ha and 6.0 q/ha respectively.

One of the core interventions in the project is the cultivation of naturally fortified fruits and vegetables in a nutrition garden for household consumption. A total of 1,433 household nutrition gardens established in the previous year were regularly monitored, and seeds of seasonal vegetables were provided to the farmers for continuation of the activities. Yield and utilization data from nutrition gardens has been collected from a sample set of 80 households. A number of fish ponds were involved in freshwater pisciculture that harvested 46.67 q of fish used for home consumption and also generated additional income. Nutrition awareness and building community capacity are two of the core components of the project. Several cluster-level awareness programmes were organized. To spread awareness on nutrition literacy, 108 CHFs (59 men and 49 women) were trained. One hundred and forty-four fish farmers participated in a farmer-scientist interaction

on fish production technology organized at Musapadar and also discussed on various aspects of fish production technologies and sustainability of fish farming. At the end of the programme, 17 fishing nets and 136 multipurpose crafts were distributed to the farmers.

Four farmers' field days were organized and 173 farmers participated. 130 farmers were trained on vermicompost production technology and 45 on seed treatment of pulses; 38 landless households were acquainted with methods of backyard poultry rearing and 10 CHFs and five staff members were educated on drinking water and sanitation. Over 2000 farmers, researchers from other institutes and community-based organizations visited the FSN model hosted at the MSSRF Jeypore site.

***Nutrition Awareness*:** A nutrition awareness calendar was developed to create awareness among community members. Twelve cluster-level nutrition awareness programmes were organized. In addition, six training programmes (duration of six days each) on management of nutrition gardens were conducted for 252 farmers (149 men and 103 women). A community-level nursery was developed and managed by a women's SHG in a project village to supply fruit-bearing planting material to the community. Twenty model community level nutrition gardens were established with papaya, drumstick, guava, banana, lemon, custard apple and pomegranate along with seasonal vegetables. Besides, 432 individual household gardens were also supported with nutri-rich planting period.

Sub Programme Area 502

Agriculture, Nutrition and Health in Wayanad, Kerala

502.1 Food, Nutrition and Livelihood Interventions

***Enhancing the productivity of traditional land races of paddy under organic cultivation*:** To improve the productivity of traditional paddy landraces under organic cultivation, field experiments were conducted over three consecutive years in partnership with farmers. Farmer cultivation practices were compared with four different organic amendments under the system of rice intensification method and revealed higher productivity in all the ten traditional land races under the treatment farm yard manure and Jeevamrutham treatments compared to farmers practice.

***Nutrition gardens*:** Augmentation of 427 home nutrition gardens in Wayanad was carried out with the addition of five more nutri-rich plants such as papaya, cowpea, banana, *Moringa* and lemon.

Cultivation of medicinal plants as intercrops in coffee: As a pilot effort to promote the cultivation of medicinal plants as intercrops in coffee grown under homestead, 150 farms (tribal homesteads) in Meenangady panchayat of Wayanad district were selected. Among the five species promoted, better performance was recorded for *Maranta arundinacea* (arrowroot),

followed by *Curcuma aromatica* (kasthoori manjal) and *Justicia beddomei* (adathoda), and moderate performance was observed in *Kaempferea galanga* (galangal) and *Piper longum* (long pepper). The overall survival rate of the five species in coffee plantations was 72 per cent.

Integrated Watershed Management: Under the watershed programme a set of soil and water conservation measures have been implemented in Noolpuzha, Wayanad district. The activities enhanced *in-situ* water harvesting and storage in 500 ha that helped to increase the farm income by 20 per cent.

Promoting bioinputs use: Microbial inputs, such as *Pseudomonas fluorescence*, *Trichoderma harzianum* and *T. viride*, were produced and distributed to more than 1,000 farmers. Four PGPR bacterial strains were isolated and a Gene Bank accession number was received for one strain of *Bacillus subtilis*.

***Livelihood Enhancement*:** During the reporting period, 91 plant clinic sessions were conducted in the programme villages. The trained plant doctors diagnosed 1,201 pest and disease samples from 1,358 farmers. Thirty-four training sessions for 920 farmers on different climate-smart agriculture technologies were organised. The Community Resource Centre (CRC) at Ernakulam formally launched its initiatives for natural resources management and disaster risk reduction. The volunteers of CRC supported by marking the sea/tidal/flood levels and also by quantifying rainfall regularly to provide alerts to the nearby villages Ernakulam. Women-led enterprise units, one each at Puthenvelikkara, Kottuvally, Kunnukara and Chendamangalam villages in Ernakulam district were initiated. A total of 48 women stakeholders in Ernakulam district were trained in vocational trades. 12 primary fish processing units were established in 12 villages of Ernakulam district with the technical support of ICAR-Central Institute of Fish Technology.

***Training and capacity building*:** Training programmes were conducted on human–wildlife conflict, value-added products and market support for cultivating medicinal plants, mushroom production, fish processing, bio-input production, promoting improved varieties of ginger, turmeric and pepper, nursery management of coffee, soil health, bio-control agents and integrated farming practices for 300 farmers (150 tribal farmers: 60 men + 90 women) in selected five villages. Linkages were established with a soil testing facility to analyse 100 soil samples and soil health cards with necessary recommendations issued to the farmers across five selected villages in Wayanad.

Support services: As part of promoting education, five smart classrooms and language labs were set up in five villages of Ernakulam district. Twenty-eight schools in 14 villages of Ernakulam district were provided with library support; 28 Anganwadis were also upgraded with learning resources and toys and 14 villages of Ernakulam district beautified with wall paintings. The hamlet-level education programme was continued in five villages of Wayanad district, covering 113 Adivasi children.

Programme Area 600

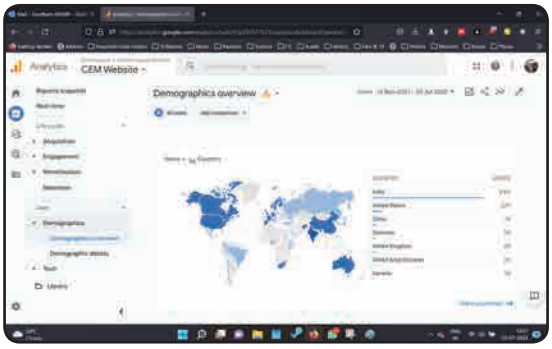
Climate Change

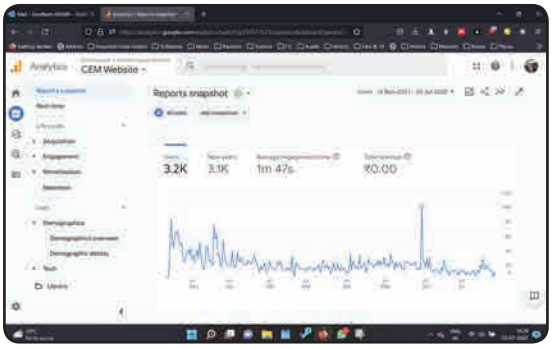
The Climate Change Programme at MSSRF undertakes independent work on various aspects of climate change and also envisages its inclusion as a cross-cutting theme across programme areas. With a strong interdisciplinary focus, guided by a commitment to equity and climate justice, the programme generates knowledge and policy outputs with regard to climate change to target policy influencers and policymakers at the state and central government levels. The programme also suggests interventions to address the needs of the poor and marginalized communities in the agriculture sector by leveraging existing capacities at MSSRF. The members of the Climate Change Group were part of the Government of India delegation to Conference of Parties (COP 26) as well as negotiating teams.

Climate Equity Monitor

The global carbon budget for a given temperature limit is a global resource, common to the entire world. It is also exhaustible and limited. As a common resource of humanity this global carbon budget should be equitably and fairly shared by all nations. The appropriation of a massively disproportionate share of this budget by developed countries, through their excessive historical, contemporary and even future cumulative emissions, is the source of the climate crisis which threatens humanity today. All consideration of climate equity must begin with this perspective.

Carbon Credit / Debt Map and Historical Emissions





Sub Programme Area 601

Policy Interventions

In a key policy intervention, MSSRF in collaboration with the energy and climate group at the National Institute of Advanced Studies, Bengaluru, launched the Climate Equity Monitor (www.climateequitymonitor.in), a research and information portal. This portal, with graphical search tools and text information, provides information and analysis for assessing equity in climate action related to climate mitigation, energy and resource consumption, and climate policy, covering all countries. This portal is the first such initiative from the Global South providing relevant information to compare climate policies and actions of developed and developing countries from the perspectives of equity, climate justice and the principle of common but differentiated responsibilities. This is part of `the project 'Equity and Common but Differentiated Responsibilities and Respective Capabilities in the Context of 2°C Warming – Implications for India'.

MSSRF has prepared a detailed policy briefs, along with research analysis and notes, for the negotiation at the COP26 of the United Nations Framework Convention on Climate Change (UNFCCC) held at Glasgow in November 2021. The briefs covered areas such as global mitigation and adaptation policies, policy aspects of climate science, technical dialogues and interventions focused on issues related to equity and differentiation. This is part of the GEF-GOI-UNDP NATCOM project 'Global Contextualisation and Inter-Country Comparisons in the Third National Communication'.

Research support was provided by the Climate Change Group at MSSRF to the Ministry of Environment, Forest, and Climate Change (MoEFCC) to review the Final Government Draft of the Summary for Policymakers as well as the full Reports of Working Groups I, II and III of the Intergovernmental Panel on Climate Change (IPCC) for the Sixth Assessment Report (AR6). Further, detailed policy and research briefs were prepared for the Government of India delegation to the approval sessions of Working Group Reports I, II and III of the IPCC AR6 in July 2021, February 2022 and March 2022, respectively.

Policy briefs were submitted to the MoEFCC, on the subjects of carbon budgets and operationalization of international equity in climate change based on the principle of access to an equitable and fair share of the global carbon budgets. This principle has now been incorporated as part of the Government of India's Climate Policy, an outcome to which the Climate Change Group at MSSRF has contributed significantly. In support of India's policy viewpoint, two brochures, titled "*Developed Countries Change Goalposts Every Time – Their Inaction Is the Only Unchanging Story"* and "*Developing Countries – Climate Strategy and the Global Carbon Budget"* were prepared and disseminated widely at COP26.

The MSSRF Climate Change Group also participated as an observer organization in

the research NGOs (RINGO) constituency of the UNFCCC for consultations on the Global Stocktake of the Paris Agreement, which is now under way. We provided intensive support to the MoEFCC in the preparation and submission of the Third Biennial Update Report of India to the UNFCCC and assisted in the technical review process, including the final presentation at COP26.

The team provided interalia, critical analysis of the global context to key elements of India's Third Biennial Update Report. Global warming being a collective action problem implies that climate action, including both adaptation and mitigation, has to be formulated and designed as well as monitored and assessed within the global context. However, very few countries in reality carry out such a contextualization, especially in their reporting requirements to the UNFCCC, highlighting the importance of India's initiative.

601.1 Climate Change and Cotton: Impact, Adaptation and Estimating Greenhouse Gas Emissions from Cotton Cultivation

The project was commissioned by Fairtrade UK to study the impact of climate change and mitigation and adaptation measures for Fairtrade (FT) cotton producers in India. Greenhouse gas (GHG) emissions from organically and conventionally cultivated cotton during the growing cycle in four different agro-climatic locations in India were compared.

The study was undertaken in four districts, namely Khargone (Madhya Pradesh), Kutch (Gujarat), Balangir (Odisha) and Salem (Tamil Nadu). Farm-level data was collected from both FT and non-FT (NFT) farmers in each district. From the analysis, a wide variation was found in both yield and emissions in the four study areas depending on the agro-climatic and socio-economic conditions and access to irrigation and inputs. Irrigation was found to play a significant role in improving productivity and was also the most important factor affecting emissions. However, it was also a very important measure for adaptation to climate change, especially with the changing precipitation patterns during sowing periods and in the late cotton season. The other major challenges to the cultivation of cotton across the four project sites included erratic monsoon patterns and pest attacks. For FT organic farmers, depending on the location, the major sources of emission were fertilizer application, energy usage for irrigation, crop residue management and, lastly, emissions arising from the use of farm machinery and implements that use fuel in the form of diesel. In all the locations (except Kutch), the dominant source of emissions for FT farms was fertilizer/manure use and their application. In Kutch, major emissions were associated with irrigation due to the use of high-powered water pumps for irrigating the fields followed by manure application. It was also observed that FT interventions in areas marked by low-input use provided useful gains in productivity. However, such gains from FT intervention diminished and eventually turned into deficits in regions where cotton cultivation

as a whole was carried out with progressively higher input use and better farm management practices. There is also a need to carry out a more in-depth investigation to identify ways of increasing productivity while managing emissions.

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

The on-going project, supported by the Google Artificial Intelligence (AI) for Social Good Programme carried out in collaboration with the Indraprastha Institute of Information Technology, Delhi, studies the scope for development and implementation of high-resolution satellite imagery to model the impact of aridification on paddy yields in the Cauvery Delta, Tamil Nadu, using remote sensing data and AI and machine learning (ML) techniques. Initiated by Google Research India Lab, in partnership with Google.org and Google's University Relations programme, the 'AI for Social Good Program' is aimed at bringing together non-profit institutions and academics to collaborate on projects that tackle social, humanitarian and environmental challenges.

The study is aimed at the application of state-of-the-art deep neural network models for the classification of satellite imageries to predict crop-type identification, estimate values of relevant biophysical and climatic parameters and determine crop production at higher spatio-temporal resolutions than is possible from usual ground-based administrative surveys. The project scope includes generating quantitatively verifiable predictions of crop cover map, sowing and harvesting date prediction, yield estimation and measurement of evapotranspiration. The predicted outcomes of these variables will be used for understanding any potential impact of aridification on paddy yields.

The study has been successful in the application of deep learning neural network model to predict paddy crop types using time series from the cross-fusion of Sentinel 2, Landsat 8 and Scope Planet image datasets. The results from the model experiments show prediction accuracies of 92 per cent and 93 per cent, respectively, with Landsat 8 and Sentinel 2 satellite images for paddy crop type with the test datasets. The preliminary results show that the application of remote sensing and AI can overcome limitations of data requirements to provide high-resolution validated information.

601.3 Vulnerability Assessments for Development of Adaptation Fund Proposal

The World Food Programme (WFP) Country Office in India, in association with the Government of India and State Governments of Odisha, Andhra Pradesh and Tamil Nadu, is in the process of developing a proposal for a climate change adaptation project focusing on the drought-prone dry zones in these states.

The project aims to strengthen access to reliable, timely and targeted last-mile climate services and to develop a system to co-produce, disseminate and scale up tailored agrometeorological and hydrometeorological

advisories. Further, it aims to enhance the adaptive capacity of poor farming households, with a focus on women and vulnerable groups, to develop and implement local adaptation plans informed by climate advisories, resulting in improved practices and diversified climate-resilient livelihoods.

MSSRF carried out a 'Climate Vulnerability and Capacity Assessment' for the proposal with suggested priority activities for the three target states in India. The assessment was undertaken along four axes, namely crop production by small and marginal farmers; climate information services and agrometeorological advisories; inclusion in financial services; and insurance and gender. This was a cross-cutting project across several programme areas and field stations of MSSRF. It also provided a detailed list of priority adaptation actions for the states.

MSSRF participated in state and national consultations and provided guidance for district selection and technical inputs in specific aspects of the assessment. It also undertook consultations with selected communities of the target districts in the three states, through the use of participatory techniques. Some of the key findings from the assessments undertaken by MSSRF are:

- Overall, crop production faces considerable risks from extreme events, climate variability and sensitivity to climatic variations but is also seriously affected by the current poor levels of agricultural productivity and the extent of social welfare in rural regions.
- Though agriculture remains the primary source of income and livelihood across all the three states, the focus group discussions (FGDs) carried out across the states confirm that the MGNREGS is the most prominent alternative source of livelihood providing income security. It is also a lifeline in case of reduced crop production or crop failures due to extreme climatic conditions such as drought or heat-waves. MGNREGS also offers considerable potential in addressing the underlying risk factors through designing disaster prevention projects and thus can extend dual benefits to the people in terms of income enhancement and risk reduction.
- In water-stressed regions where there have been adverse impacts on agricultural ecosystems, drought-resistant crops such as millets could be an alternative viable option as seen in the case of the Odisha Millets Mission. Moreover, crop diversification, multiple cropping, mulching, reducing post-harvest water usage and so on could be other options for future adaptation as well.
- One of the biggest challenges in the provision of climate information services is to develop locally relevant information that can inform farmer decision-making. The contents of advisories need to be location-specific, targeting specific crops, local soil conditions, livestock and market facilities since these vary within a district, block and even a village.
- Another critical challenge, which has a direct bearing on the entire value chain

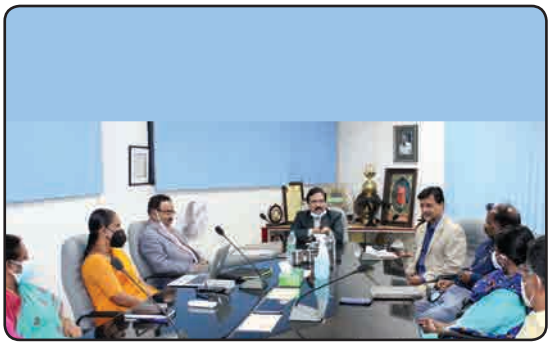
of climate information services, is related to the data currently available to generate advisories.

- Last-mile delivery of climate services is also a critical barrier to successful diffusion and adoption of even existing advisories. Although advisories are at present delivered through multiple channels, including village extension officers, television, newspapers and mobile phone messaging services, their reach among small and marginal farmers continues to be low. There was a general perception among most respondents and discussion participants that climate information and advisories currently available are inadequate in terms of access and crop coverage.
- Irrespective of the study sites, both women and men have limitations in accessing and using climate information services. The agro-advisories and forecast information substantially fail to cover women's specific needs. Women also have lesser access to agricultural extension services, skills training, information, institutional linkages, land, water resources, financial resources and services, entitlement schemes and market access. In addition, they have additional responsibilities of social reproduction and care work and are bound by social and cultural norms with reduced mobility.
- In case studies from two highly vulnerable districts in one state, the participants reported significant lack of understanding of crop insurance and claim settlement. It was reported that not all farmers who had applied for crop insurance could avail compensation for crop damage. Overall, they found the process too complex and wanted a greater outreach programme to improve the understanding of farmers regarding crop insurance and for the process of applying and receiving pay-outs to be simplified.


NATURAL


Judith Ravin
Ronald Vercoink
Madhura Swaminathan


THE M. S. SWAMINATHAN ROSE
JEWEL OF MONKOMBU




ஒவ்வொரு குழந்தையும் ஒரு விஞ்ஞானி
EVERY CHILD A SCIENTIST


MSSRF
FESTIVAL CUM
SEMINAR ON MILLETS
BIO-DIVERSITY
FESTIVAL-CUM
SEMINAR ON
MILLETS

Communications and Outreach

The Covid-19 pandemic transformed the approach of communicating information about the work done by MSSRF to stakeholders. The communication team promptly adapted a hybrid (online and offline) mode for advocacy and outreach activities. During 2021–2022, MSSRF continued to reach out to policy-makers, research and academia, press/media and grassroots communities (men and women farmers) regarding evidence-based science. Some of the efforts are detailed below:

The Mina Swaminathan Media Fellowship for Gender and Development

The Mina Swaminathan Media Fellowship was instituted in 2020 by Prof. M. S. Swaminathan in recognition of Ms Mina Swaminathan's work on gender and development, child care and women's work. The three media fellows of the first year (2020–2021) shared key learnings from field stories in the annual consultation organized by MSSRF from 7 to 9 August 2021. Based on the field stories, three policy briefs were prepared and disseminated widely to stakeholders in the respective states.

The theme of the second year (2021–2022) is 'Gender Transformative Approaches for Sustainable Food Systems'. The media fellows are Ms Dharini Balasubramanian from Tamil Nadu, associated with Puthuiya Thalaimurai television network; Ms Neenu Mohan from Kerala, working with Malayalam Manorama; and Mr Gyananchand Jagannath from Sambad News, Odisha. Currently, they are in the process of curating and publishing their stories.

Bhoothalingam Library

The Bhoothalingam Library was inaugurated on 6 January 1994 by Mrs Mathuram Bhoothalingam, mother of late Ms Mina Swaminathan. The primary mission of the library is to provide physical and intellectual access to information, consistent with the present and the anticipated educational and research functions. There is a large print collection of over 19,500 books, journals, theses and reports. Over 4,500 back issues of periodicals and a collection of technical and annual reports from various organizations can also be found in the library. A separate webpage (https://www.mssrf.org/bhoothalingam-library/) on the MSSRF website links to research publications by MSSRF staff. The library provides many services to its users, including Current Awareness Services, Selective Dissemination of Information, and Online Public Access and Catalogue (OPAC).

The MSSRF library's OPAC website now includes links to open access books and journals in agriculture and related fields. Besides, to provide quality services to its users, the library has subscriptions with several renowned journals such as Nature, Sage journals and New Scientist, Down to Earth and Economic and Political Weekly and more.

MSSRF e-newsletter

The MSSRF e-newsletter reaches over 2,000 subscribers, well-wishers and journalists as

a direct mailer with updates covering major news and events from MSSRF with links to research papers and media coverage. This communication tool gives us the opportunity to keep our stakeholders, members and friends across the country up to date on MSSRF research and development work.

Social Media

MSSRF uses a diverse set of social media platforms such as Twitter, Facebook, LinkedIn, Flickr, Instagram and YouTube to disseminate information about research, events and news at MSSRF to its stakeholders. We receive encouraging responses to our regular posts – messages, photos and videos. The following are links to our social media pages:

Twitter: https://twitter.com/mssrf

Facebook: https://www.facebook.com/mssrf.org

LinkedIn: https://www.linkedin.com/company/ms- swaminathan-research-foundation

Flickr: https://flickr.com/photos/mssrf/

Instagram: https://www.instagram.com/mssrf_official/

YouTube: https://www.youtube.com/channel/UCqPZ7OKG9vfLJgQFRlQv9sA

Key Events

The virtual consultation 'Ensuring Food and Nutrition Security in the Context of Climate Change and the Covid-19 Pandemic' was inaugurated by the Chief Minister of Tamil Nadu, Thiru M. K. Stalin, on 7 August 2021. This was followed by intellectual deliberations by global experts, national policy-makers and scientists on climate change, agriculture, food and nutrition to find practical solutions with evidence-based science. Speakers included Dr Shakuntala Haraksingh Thilsted (World Food Prize laureate, 2021), Prof. M. S. Swaminathan (Founder, MSSRF), Mr Gernot Legenda (Chief of Climate Disaster Risk Reduction Program, United Nations World Food Programme, Bangkok), Dr Jacqueline d'Arros Hughes (Director General, ICRISAT, Hyderabad), Mr N. Ram (Chairman, The Hindu Group), Dr Maximo Torero Cullen (Chief Economist, FAO), Dr Revati Phalkey (Health and Climate Change Unit, Public Health, England), Dr Maria Isabel Andrade (World Food laureate, International Potato Center, Peru), Prof. Donald Bundy (London School of Hygiene and Tropical Medicine), Dr Reetika Khera (Associate Professor, IIT, Delhi), Dr Soumya Swaminathan (Chief Scientist, WHO), Dr Vinod L. Paul (member, NITI Aayog), Ms Supriya Sahu (IAS, Principal Secretary to Government of Tamil Nadu, Department of Environment, Climate Change and Forests) and Mr C. Samayamoorthy (IAS, Agriculture Production Commissioner and Secretary to Government of Tamil Nadu, Department of Agriculture and Farmer's Welfare).

MSSRF revived the 'Every Child A Scientist' initiative that inculcates scientific curiosity among Greater Chennai Corporation school students, with support from Larsen and Toubro Ltd., as part of the company's corporate social responsibility effort. The Tamil Nadu Education Minister, Mr Anbil Mahesh Poyyamozhi,

inaugurated the programme on 26 September 2021. Other dignitaries present were Dr Soumya Swaminathan (Chief Scientist, WHO), Mr Vinod Jacob Chacko (Head – Corp. Comm. & CSR, L&T Chennai), Mr R. Bharthidasan (Education Officer, Greater Chennai Corporation, Government of Tamil Nadu), Dr Madhura Swaminathan (Chairperson, MSSRF) and Dr K. S. Murali (Executive Director, MSSRF).

Mr Ron Verdonk, Career Minister-Counsellor for Agricultural Affairs, US Embassy, New Delhi, visited the MSSRF Chennai office on November 9, 2021

Dr Sudhanshu Singh, Director IRRI South Asia Regional Centre (ISARC) interacted with staff at MSSRF on November 19, 2021

In collaboration with the Rotary Club of Madras East, MSSRF established a nutrition garden behind Thiruvanmiyur Railway Station, Chennai, to demonstrate the importance of nutrition and enhance nutrition literacy among visitors. Dr J. Radhakrishnan (Principal Secretary, Department of Health and Family Welfare, Tamil Nadu) inaugurated the 'Nutri-rich Plants/Awareness Garden' on 8 January 2022, in the presence of Dr Soumya Swaminathan (Chief Scientist, WHO), Mr Gagandeep Singh Bedi (Principal Secretary/Commissioner Greater Chennai Corporation) and Rtn. M. Nachiappan (Director, Environment Rotary Club of Madras East).

Rose varieties named in honour of Prof. M S Swaminathan: Kodaikanal based M. S. Viraraghavan, a leading horticulturist and rose breeder from India, bred a magenta-purple, aromatic, highly disease-resistant rose variety named the 'M.S. Swaminathan Rose'. Another rose variety – the 'Jewel of Monkombu' – bred by K. Sriram of Kasturirangan and Sriram, Bengaluru, was presented to Prof. Swaminathan by Dr Narendra Dadlani (Floriculture Scientist and former Director (Horticulture), Government of India, New Delhi).

MSSRF entered into an agreement to institute the Hema Ramachandran Fellowship for Women Scientists to improve female equity in research. Mr G. P. Ramachandran, spouse of the late Dr Hema Ramachandran, instituted an endowment at MSSRF to commemorate her significant scientific contributions and pave the way for women scientists to return to research careers. The MoU was signed by Dr Madhura Swaminathan (Chairperson, MSSRF) and Mr G.P. Ramachandran.

The United Nations World Food Programme and MSSRF entered into a strategic partnership on research and programmes focused on agriculture and food security, nutrition, climate change adaptation, community resilience building, and sustainable livelihoods in India. The MoU was signed by Mr Bishow Parajuli (WFP India Representative and Country Director) and Dr Madhura Swaminathan (Chairperson, MSSRF).

MSSRF organized a panel discussion to commemorate World Soil Day on 5 December 2021, as part of the Global Soil Partnership of the Food and Agriculture Organisation.

The discussion was on the global theme 'Soil Salinization and Sustainable Food Systems' and focused specifically on halting soil salinization to boost productivity. It was organized by MSSRF-TIGR2ESS and DBT KISAN Hub (MSSRF), and Dr D. Jawahar (Former Director – Natural Resource Management, Tamil Nadu Agricultural University, Coimbatore) delivered a keynote on 'Sustainable Approaches for Soil Salinity Management'.

A new version of the Fisher Friend Mobile Application (version 5.1) was launched with the support of Qualcomm and the INCOIS on 27 January 2022 to mark the twelfth anniversary of the Fish for All Research and Training Centre, Poompuhar. Over 100 fisher folk, government officials and members from different NGOs participated. The new version enables availability of instantaneous ocean status information to fishermen at 1026 fish landings across India.

The Royal Thai Consul-General, HE Mr Nitirooge Phoneprasert, visited MSSRF on 15 February 2022 to discuss and explore areas of mutually beneficial collaborations. He was accompanied by Ms Lalana Jitsattanane (Deputy Consul-General), Mr Mongkol Siwaluk (Consul) and Ms Lavanya C (Consular Officer, Thailand).

Dr Ajay Kohli (Global Director – Research) and Dr Uma Shankar Singh (South Asia Advisor for Research & Partnership), from the International Rice Research Institute, Philippines, visited MSSRF on 3 February 2022 for discussions on possible strategic partnerships.

In collaboration with Pragati, Indian Institute of Millet Research, Odisha Millets Mission, WASSAN and EdelGive Foundation, together with several civil society organizations from Chhattisgarh, Odisha and Jharkhand, MSSRF organized a 'Biodiversity Festival-cum-Seminar on Millets' in March 2022 at Koraput, Odisha. More than 750 tribal farmers participated in the event. The chief guest was Dr R. K. Samant (Ex-VC, Bidhan Chandra Krishi Viswavidyalaya (BCKV), Mohanpur, West Bengal). Dr G. N. Hariharan (Executive Director, MSSRF), Shri Iswar Chandra Panigrahi (Chairperson, Seed Corporation of Odisha), Dr Varaprasad (RRA Network), Dr Anupam Paul, and Mr Narayan Sethy (Chief District Agriculture Officer, Koraput) were also present on the occasion.

Celebration of International Women's Day: Every year, 8 March was celebrated as International Women's Day, a global celebration of the economic, political and social achievements of women. The theme for International Women's Day, 2022, was 'Gender equality today for a sustainable tomorrow'. Biju Patnaik Tribal Agro-biodiversity Centre (BPTAbC) of M. S. Swaminathan Research Foundation, Jeypore, celebrated the programme on 8 March at their premises. A total of 65 women from the field of agriculture, nutrition, health and education, Covid-warriors, SHG leaders and CHFs participated in the programme.

The Honourable Ms Anisa Kapufi Mbega, High Commissioner of the United Republic of Tanzania, Mr Krishna N Pimple, Honorary Council of the United Republic of Tanzania, and Prof Ranganathan J, Honorary Council of Myanmar, along with other delegates, visited the Foundation on Wednesday April 13, 2022, to explore collaborations to further agricultural development in Tanzania.

The Consul General of Israel to South India - Ms Tammy Ben-Haim visited MSSRF on May 26, 2022, to explore collaborative innovative solutions for agricultural and fishery development in Israel.

MSSRF entered into an agreement with the Central University of Odisha (CUO), Koraput, to undertake collaborative research on biodiversity, sociology, anthropology, journalism and mass communication and so on. The MoA between the institutions was signed on 27 January 2022 and launched on 3 February 2022 at the chamber of the Vice Chancellor, CUO, Koraput. It was agreed upon that the institutes will have collaborative research, which can be translated to the field. Both 'Land to Lab' and 'Lab to Land' aspects of research shall be in focus.

To commemorate the silver jubilee year of the Community Agrobiodiversity Centre, MSSRF organized an International Consultation on 'Biodiversity, Climate Change and Adaptation' between 5-6 June 2022. The Consultation was organized to deliberate global, national and regional issues pertaining to biodiversity conservation and impacts of climate change on livelihoods, food and nutrition security of smallholders. The deliberations were also aimed to set the future directions of the Centre by evaluating its ongoing activities and their impacts.

Publications

Books / Monographs / Manuals / Electronic Material

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Vedavalli, L. and R. Rengalakshmi. 2021. *Crop Diversity in Peril, a case of Kolli Hills in India*. New Delhi: Academic Publishers.

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Awards and Honours

Institutional

M.S. Swaminathan Research Foundation. 2021. Apollo Krishi Alert Award – 2021 for promoting digital technology under Resilience project, The Smart Tech Farmers Producers Company Ltd., Ganjam, Odisha.

M.S. Swaminathan Research Foundation. 2021. Tech for Good Award 2021 for the Fisher Friend Mobile Application under the category of disaster management, NASSCOM Foundation and CGI.

M.S. Swaminathan Research Foundation. 2022. Biodiversity Conservers Award 2022, Andhra Pradesh State Biodiversity Board, Govt of Andhra Pradesh.

M.S. Swaminathan Research Foundation. 2022. Best Performing Project Award 2022, Project titled “Integerated Tribal Development Project for Malayali tribes in Kolli Hills”, NABARD, Chennai.

M.S. Swaminathan Research Foundation. 2022. Best Performing Project Award 2022, Project titled “Integrated Mangrove Fishery Farming System to Enhance Adaptive Capacity of Fishing Community to Sea Level Rise in Cuddalore District”, NABARD, Chennai.

Individual

Jaiswal, Sreeja. 2022. Alexander von Humboldt Foundation’s International Climate Protection Post-Doctoral Fellowship, University of Heidelberg, Germany.

Swaminathan, M.S. 2022. Honorary Doctorate, Jai Narain Vyas University.

Swaminathan, M.S. 2021. Kerala Sasthra Puraskaram 2021. Kerala State Council for Science, Technology and Environment, Govt of Kerala.

Velvizhi S. 2021. K. Chidambaram Memorial Annual Award. Fisheries Technocrafts Forum, Chennai.

About the Foundation

The M.S. Swaminathan Research Foundation (MSSRF) was registered in 1988 as a non-profit Trust. MSSRF is recognized by the Department of Scientific and Industrial Research, Government of India, New Delhi as a Scientific and Industrial Research Organisation and by the Director General of Income Tax Exemptions, for the purpose of exemption of contributions from Income Tax under Section 80G and sections 35(1)(ii) of Income Tax Act, 1961, read with Rule 6 of Income Tax Rules, 1962. The Ministry of Home Affairs, Government of India, has recognized MSSRF for receiving funds from sources abroad under the provisions of Foreign Contribution (Regulation) Act, 1976.

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Thiruvanmiyur, Chennai 600 041

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Treasurer - CRSARD
Technical Director
M/s. Sundar Chemicals (P) Ltd
6-G, Century Plaza,
No. 560-562, Anna Salai
Teynampet, Chennai 600018

Ms. Mina Swaminathan**
Distinguished Chair - Gender and Development, MSSRF
No.21, Ratna Nagar
Teynampet, Chennai 600018

*** expired during the year*

Dr. Madhura Swaminathan
Chairperson
M S Swaminathan Research Foundation
3rd Cross Street, Taramani
Chennai – 600 113

Dr. K.S. Murali*
Executive Director
M.S. Swaminathan Research Foundation
3rd Cross Road, Taramani
Chennai 600 113

Mr. B.S. Raghavan, IAS (Retd.)
Ex-Policy Adviser to UN(FAO)
No. 4, Second Street, Nehru Nagar
Adyar, Chennai 600 020

Dr. K.V. Raman
 # 3-A, 'Shrayas'
36, Fourth Seaward Road, Valmiki Nagar
Thiruvanmiyur, Chennai 600041

Mr. A.M. Mahmood Hussain, IFS (Retd.)
29, 1st North Cross Street
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Neelankarai, Chennai 600 115

Rtn. Mr. S.S. Rajasekhar
No.2, River View Road
Kotturpuram, Chennai 600 085

Dr. V. Geethalakshmi
Vice Chancellor
Tamil Nadu Agricultural University
Coimbatore 641 003

Dr. K. N. Selva Kumar
Vice-chancellor
Tamil Nadu Veterinary &
Animal Sciences University (TANUVAS)
Madhavaram Milk Colony, Chennai 600051

Shri. N. Gopalaswami, IAS (Retd.)
Chairperson
Madras Institute of Development Studies
79 Second Main Road, Gandhi Nagar
Adyar, Chennai 600020

Dr. R. Velraj
Vice Chancellor
Anna University, Chennai 600 025

Prof. S. Gowri
Vice-Chancellor
University of Madras
Chepauk, Chennai 600005

Dr. A.A. Nambi
Director (Climate Resilience Practice)
World Resources Institute
4, Warden Quarters, IIT Madras Campus
Chennai 600036

Mr. K.M. Sethu
Kalyanasundaram & Associates
No.6, Jaganathapuram 1st Cross Street,
Velacherry, Chennai 600042

Auditor

M/s. Brahmayya & Co,
Chartered Accountants
48, Masilamani Road, Balaji Nagar
Royapettah, Chennai

**left during the year*

Steering Committee, Community Agro-biodiversity Centre, Kalpetta, Wayanad District, Kerala

Dr. K. K. Narayanan
CEO, Agrigenome Labs Private Limited
5th Floor, SCK 01 Building,
"SmartCity Kochi", Infopark Road
Kakkanad - 682 042, Kerala

Dr. Sarada Krishnan
Executive Director
International Women's Coffee Alliance

Prof. Sabu Abdulhameed
Pro-Vice Chancellor
Kannur University, Kannur, Kerala

Dr. S. Pradeep Kumar
Member Secretary
Kerala State Council for Science Technology And Environment
Thiruvananthapuram

Dr. B. Sesikeran MD
Former Director
National Institute of Nutrition (ICMR)
Hyderabad

Dr. C. George Thomas
Chairman
Kerala State Biodiversity Board
Thiruvananthapuram

Dr. Harisankar Sreedharan Nair
Former MD and CEO,
Punjab and Sind Bank
Independent Professional Director
on the Board of Directors of KSCB
Kerala State Cooperative Bank
(Kerala Bank), Thiruvananthapuram

Dr. D. Girija
Former Registrar &
ICAR Emeritus Professor
Kerala Agricultural University
College of Agriculture, KAU, Thrissur

Dr. C.L. Laxmipathi Gowda
Former Deputy Director General- ICRISAT
Co-Founder, GRSV Consulting Services
Karnataka

Dr. G. N. Hariharan
(Member Secretary)
Executive Director, MSSRF, Chennai

Dr. V. Shakeela
(Ex-officio Member)
Director
MSSRF CAbC, Wayanad, Kerala

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Dr. G.N. Hariharan, *Executive Director*

Dr. K. S. Murali, *Executive Director**

COASTAL SYSTEMS RESEARCH

Dr. R. Ramasubramanian, *Senior Fellow*

Chennai

Mr. R. Nagarajan,
Head-GIS & Remote Sensing
Ms. S. Punitha, *Scientist*
Dr. N. Sithranga Boopathy, *Scientist*
Dr. R. Murugan, *Scientist*
Ms. S. Tulasi Priya, *JRF**
Mr. S. Mahendiran, *GIS Analyst*

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Mr. G. Rajavelan, *Project Associate*
Mr. M. Arulselvam, *Devp. Assistant**

Machilipatnam

Mr. K. Gopalakrishnan, *Project Fellow*
Mr. N. Babji, *Devp. Assistant*
Mr. V. Titus Vijayendra, *Devp. Assistant**
Mr. Srinivasarao Divisam, *Devp. Assistant*

FISH FOR ALL RESEARCH AND TRAINING CENTRE, Poompuhar

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Dr. S.J. Priyangha, *Scientist*
Mr. Deepak Ramaiyan, *Devp. Coordinator**
Mr. M. Saravana Kumar,
*Associate Devp. Coordinator**
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Mr. E. Thamizhazhagan, *Devp. Associate*
Mr. E. Selvaganapathy, *Devp. Associate**
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Chennai

Ms. N.A. Anbuvahini, *Scientist*

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Mr. Kumar Sahayaraju, *Devp. Associate*

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Kollam

Mr. E. Edison, *Devp. Assistant**

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Ms. M. Pallavi, *Devp Associate**

Nagercoil

Mr. A. Mubarak Ali, *Devp. Associate*

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Mr. C. Lourdessamy Maleappane, *Devp.* Assistant
Mr. U.K. Saravanan, *Devp. Assistant**

Thangachimadam

Mr. J. Arockia Kevikumar, *Devp. Assistant*
Mr. K. Abdul Salam, *Devp. Assistant*

BIODIVERSITY

Dr. E.D. Israel Oliver King, *Director*

Community Agrobiodiversity Centre, Kalpetta, Kerala

Dr. N. Anil Kumar, *Sr. Director*
Dr. V. Shakeela, *Director*

Mr. G. Girigan, *Sr. Devp. Coordinator*
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Mr. Joseph John, *Scientist*
Ms. Archana Bhatt, *Scientist*
Dr. Merlin Lopus, *Scientist*
Ms. C.S. Dhanya, *Scientist*
Ms. P. Asiya, *Project Fellow*
Ms. Telna Sebastian, *Devp. Assistant**
Mr. K.T. Satheesh, *Devp. Assistant**
Ms. Elsy Mathew, *Assistant Manager – Admin**
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Community Biodiversity Programme, Kolli Hills, Namakkal

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Prof Hema Ramachandran Fellow
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Mr. S. Gurusarithan, *JRF*
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Mr. M. Kannan, *Lab Assistant*
Ms. N. Nagalakshmi, *Assistant*

Kalpakkam

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Karnataka

Ms. Manjula Dharwadkar, *JRF*
Mr. Manikantha V. Gunaga, *Field Assistant*

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Ms. Gargee Baruah, *Devp. Associate*
Mr. Madhuryya Mohan Khanikar,
Devp. Associate

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Research Associate
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Dr. S. Priyanka, *SRF*

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Mr. N. Arunkumar, *District Coordinator*

Ganjam

Mr. Omkar Vinay Kumar*, Devp. Coordinator**
Mr. Rabindra Behera, *Devp. Associate*

Jeypore

Mr. Vivek Babu, Research Fellow*

Kannivadi

Mr. M. Devaraj, *Devp. Coordinator*
Mr. R. Seenivasan, *Devp. Coordinator*
Mr. R. Ranjith, *Scientist*
Mr. P. Manikandan, *SRF*
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Mr. J. Sesurayappan, *Devp. Assistant*
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Ms. P. Muthulakshmi*, Field Assistant*
Ms. A. Arockia Mary, *Field Assistant*
Mr. V. Sathivel, *Office Assistant*

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Madurai

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Namakkal

Mr. S. Gnanavel, *District Coordinator*

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Mr. R. Vinoth Kanna, *Devp. Assistant*
Ms. T. Vimala, *Devp. Assistant*
Mr. M. Veeramuthu, *Research Associate**

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Mr. J. Mohankumar, *SRF**
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*Sr. Technical Assistant**

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Theni

Mr. M. Kalimuthu, *District Coordinator*

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Mr. G. Sudhakar, *Devp.* Associate
Mr. G. Murugan, *Devp. Assistant*
Mr. P. Silambarasan, *Devp. Assistant*
Ms. S. Sujitha, *Devp. Assistant*
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Mr. S. Sivakumar, *Associate Devp. Coordinator**
Mr. V. Samu Jebaraj, *GIS Analyst*

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Mr. K. Rubesh, *GIS Analyst – Junior**
Mr. M. Karunamoorthi, *Associate Scientist*
Mr. R. Kumaragurubaran, *Associate Scientist*
Mr. R. Arun Siddharth, *Watershed Expert*
Mr. M. Balasubramanian, *Watershed Expert**

Poompuhar

Mr. K.R. Sandeep Kumar, *Devp. Assistant**
Mr. V. Kumaresan, *Devp. Assistant**

Ramanathapuram

Dr. B. Selvamukilan, *Sr. Scientist*
Mr. P. Gopalakrishnan, *Associate Scientist*
Ms. S. Bhavani, *Associate Scientist*
Mr. C. Kamaludeen, *Technical Assistant*
Mr. B. Dharma Muneeswaran, *Watershed Expert**
Mr. E. Thiruvengadam, *GIS Analyst**

Villupuram

Mr. P. Nandeesa, *Devp. Coordinator*
Ms. G. Viji, *Technical Assistant*

AGRICULTURE, NUTRITION AND HEALTH

Chennai

Dr. D.J. Nithya, *Scientist*

Alappuzha

Mr. Majith M. Varghese, *Devp. Assistant**

Ernakulam

Ms. P.R. Chaithara, *Devp. Associate*
Ms. Anju Biju, *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*

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

Idukki

Mr. R. Sanjeev, *Scientist*
Mr. Sijo Thomas, *Devp. Coordinator*
Ms. Jisna Michael, *Devp. Assistant*

Kottayam

Ms. A.S. Jimmol, *Devp. Assistant**

Kuttanad

Mr. P. Prajeesh, *Sr. Scientist*
Mr. Jibin Thomas, *Devp. Associate*
Ms. Parvathy Radhakrishnan, *Project Fellow*
Mr. Milan Jose, *Project Fellow**
Mr. P.K. Raveendran, *Project Accounts Officer**
Ms. Sibi Kuncharia, *Devp. Assistant**
Ms. Nisha M. Nair, *Office Assistant**

**left during the year*

Thiruvananthapuram

Mr. K.D. Pradeep, *Devp. Coordinator*
Ms. E.K. Shyama, *Devp. Assistant**

Wayanad

Mr. N. Gopalakrishnan, *Devp. Coordinator*
Mr. V. Abid, *Devp. Coordinator**
Mr. Robin Varghese, *Devp. Coordinator**
Mr. Vipindas, *Devp. Associate*
Mr. V.A. Abdulla Habeeb, *Devp. Associate*
Ms. Gayathri Kalathil Sajeev, *Devp. Associate*
Mr. M.V. Rahul, *Devp. Associate**
Ms. S. Anu, *Devp. Associate**
Mr. P.M. Noushique, *Devp. Assistant*
Ms. E. Radha, *Devp. Assistant*
Mr. A. Anoop, *Devp. Assistant*
Mr. Sujith Marath, *Devp. Assistant*
Ms. Bindu Joseph, *Devp. Assistant*
Mr. T. Ravindran, *Devp. Assistant**
Mr. P.C. Sanil, *Young Professionals II*
Mr. P.K. Namsheed, *Young Professionals II*
Ms. Aparna Joseph, *Young Professionals II**
Mr. M.K. Bineesh, *Junior Manager*
Ms. M.A. Shyamili, *Assistant – Accounts*

CLIMATE CHANGE

Dr. T. Jayaraman, *Senior Fellow*

Dr. Kaushik Bora, *Project Manager**
Mr. R. Goutham, *Project Associate*
Mr. Sandeep Mahato, *Project Associate*
Mr. L. Isaac, *Research Associate*
Mr. Charu Chandra Devshali,
Research Associate
Mr. Peeyush Priya, *Research Associate*
Ms. Shubhangi, *Research Assistant*
Mr. Manjeet Kumar Patel, *MMSS Fellow**

COMMUNICATION & LIBRARY AND INFORMATION SERVICES

Ms. Sangeetha Rajeesh, *Director*

Dr. N. Parasuraman,
Principal Archivist and
Knowledge Manager
Mr. Jitendra Choubey, *Head**
Mr. Subhranshu Bhusan Sahoo, *Librarian*
Mr. G. Suresh Kumar, *Library Assistant*

PERSONNEL AND ADMINISTRATION

Mr. Govindarajan Dhandapani, *Head HR*

Mr. C.V. Parthasarathy, *Manager-Admin*
Ms. A. Uma, *Sr. Executive-HR*
Ms. R. Malathy, *Executive Secretary*
Ms. Y. Dilhara Begam, *Sr. Secretary*
Mr. A. Sakthivelan, *Sr. Secretary**
Mr. K. Suresh, *Office Assistant*

ACCOUNTS

CA. Rajalekshmy S. Balasubramanian,
Deputy Head

Mr. Kumaran Varadharajan,
Chief Financial Officer*

Ms. K. Selvi, *Associate Manager*
Mr. K. Saravanan, *Associate Manager*
Ms. Nalina Muthukumaran, *Accountant*
Ms. R. Jayashree, *Accountant*
Mr. M. Aravindha Mohan, *Accountant*

**left during the year*

Mr. R. Suban, *Accountant*
Ms. R. Selvarani, *Accountant*

INFORMATION TECHNOLOGY SERVICES

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

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

DISTINGUISHED CHAIR & FELLOW

Ms. Mina Swaminathan
*Distinguished Chair - Gender and Development***

CONSULTANT

Dr. Sreeja Jaiswal
Ms. Noopur Varma
Mr. P. Senthilkumar
Mr. P. Sasikumar
Mr. R. Srinivasan
Mr. Dildarkhan Pathan*
Ms. D. Suvitha*

**left during the year*
*** expired during the year*

List of Donors 2021-2022

Individual Donors - National

Prof. P.C. Kesavan, Chennai

Mr. G.P. Ramachandran, Bangalore

Sources of Project Support

Programme Area 100: Coastal Systems Research

National	*International*
National Fisheries Development Board, Hyderabad	ICEM Asia Consulting Pvt. Ltd, Vietnam
Centre for Sustainable Conservation Action and Protection of Ecosystems of the Seas (C-SCAPES), Gujarat	Qualcomm, USA
Indian Council of Agricultural Research (ICAR) – National Bureau of Fish Genetic Resources, Lucknow	Bluesensus, Germany
Indian National Centre for Ocean Information Services (INCOIS), Ministry of Earth Sciences, Govt. of India, Hyderabad	Mitsubishi Corporation, Japan
National Bank for Agriculture and Rural Development (NABARD), Mumbai, Hyderabad and Chennai	ORACLE, USA
Department of Science & Technology, Ministry of Science & Technology, Govt. of India, New Delhi	
HCL Foundation, New Delhi	
National Centre for Coastal Research, Chennai	
Andhra Pradesh Forest Department, Wildlife Division, Eluru	
Space Application Centre, ISRO, Ahmedabad	

Programme Area 200: Biodiversity

National	*International*
National Bank for Agriculture and Rural Development (NABARD), Mumbai & Chennai	The Global Forum on Agricultural Research and Innovation (GFAR), FAO, Rome
Indian Council of Agricultural Research (ICAR) – National Agricultural Science Fund (NASF), New Delhi	Asia Pacific Network, Japan
Indian Council of Agricultural Research (ICAR) – Indian Institute of Millets Research, Hyderabad	
Indian Council of Agricultural Research (ICAR) – Indian Institute of Rice Research, Hyderabad	
Directorate of Agriculture and Food Production, Govt. of Odisha, Bhubaneswar	
Dept. of Science & Technology, Ministry of Science & Technology, Govt. of India, New Delhi	
Dr. Moopan's Wayanad Institute of Medical Sciences, Meppadi, Wayanad, Kerala	

Programme Area 300: Biotechnology

National	*International*
Biotechnology Industrial Research Assistance Council (BIRAC), Govt. of India, New Delhi	
Larsen & Toubro Ltd, Chennai	
Department of Biotechnology, Ministry of Science & Technology, Govt. of India, New Delhi	
Department of Science & Technology, Ministry of Science & Technology, Govt. of India, New Delhi	
Rotary Club of Madras East, Chennai	
Swayam Charitable Trust, New Delhi	

Programme Area 400: Ecotechnology

National	*International*
CABI, New Delhi	Asia-Pacific Network for Global Change Research, Japan
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Indian Meteorological Department, Ministry of Earth Sciences, Govt. of India, New Delhi	Global Challenges Research Fund, University of Reading, UK
Japan International Cooperation Agency – India, New Delhi	Commonwealth of Learning, Canada
Vaazhndhu Kaattuvom Project (formerly Tamil Nadu Rural Transformation Project - TNRTP), Govt. of Tamil Nadu, Chennai	Norwegian Institute of Bioeconomy Research, Norway
GIZ, New Delhi	SAARC Development Fund (SDF), Bhutan
State Development Policy Council, Govt. of Tamil Nadu, Chennai	Global Challenges Research Fund, University of Cambridge, UK
VA Tech Wabag Ltd., Chennai	WorldFish, Penang, Malaysia
The Nature Conservancy Centre, India	Global Child Nutrition Foundation, USA
Dept. of Biotechnology, Ministry of Science & Technology, Govt. of India, New Delhi	

Programme Area 500: Agriculture, Nutrition and Health

National	*International*
Agricultural Technology Management Agency, Department of Agriculture, Koraput	
Directorate of Agriculture and Food Production, Govt. of Odisha, Bhubaneswar	
National Bank for Agriculture and Rural Development (NABARD), Thiruvananthapuram, Kerala	
Kerala Council for Science, Technology and Environment, Govt. of Kerala, Thiruvananthapuram	
HDFC Bank Parivartan	
Cochin Shipyard Ltd, Kochi, Kerala	
Shashawath Foundation, Ahmedabad, Gujarat	

Programme Area 600: Climate Change

National	*International*
National Innovations in Climate Resilient Agriculture, ICAR-CRIDA, Hyderabad	The Fairtrade Foundation, London
United Nations Development Programme, India	
United Nations World Food Program, New Delhi	
Google India Pvt. Ltd., Bengaluru	
Ministry of Environment, Forest and Climate Change, Govt. of India, New Delhi	

Others

World Resources Institute India Pvt. Ltd., New Delhi	The World Food Prize Foundation, USA

FINANCIAL STATEMENT 2021-2022

M.S.SWAMINATHAN RESEARCH FOUNDATION

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

BALANCE SHEET AS AT 31st MARCH 2022

FOUNDATION — **Figs in Rs. Lakhs**

LIABILITIES	Sch. No.	2021-2022 Rs.	2020-2021 Rs.	ASSETS	Sch. No.	2021-2022 Rs.	2020-2021 Rs.
OWN FUNDS				**OWN ASSETS**			
CORPUS FUNDS	1	167.26	166.96	FIXED ASSETS	5	396.81	422.1
ENDOWMENT FUNDS	2	4972.54	4902.81	INVESTMENTS	6	6754.15	6729.05
GENERAL FUND & OTHER FUNDS	3	3593.58	3473.31	CURRENT ASSETS			
CURRENT LIABILITIES	10	413.48	504.51	CASH & BANK BALANCES	7	1409.87	1421.72
				ADVANCES	8	586.03	474.72
TOTAL [A]		**9146.86**	**9047.59**	**TOTAL [A]**		**9146.86**	**9047.59**

PROJECTS

LIABILITIES	Sch. No.	2021-2022 Rs.	2020-2021 Rs.	ASSETS	Sch. No.	2021-2022 Rs.	2020-2021 Rs.
PROJECT FUNDS & OBLIGATIONS	4	1323.62	1471.92	PROJECTS RECEIVABLES	9	150.47	123.84
CURRENT LIABILITIES	10	219.95	184.02	ADVANCES	8	306.23	487.16
				BANK BALANCES	7	1086.87	1044.94
TOTAL [B]		**1543.57**	**1655.94**	**TOTAL [B]**		**1543.57**	**1655.94**
GRAND TOTAL [A]+[B]		**10690.43**	**10703.53**	**GRAND TOTAL [A]+[B]**		**10690.43**	**10703.53**

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 2022

FOUNDATION **Figs in Rs. Lakhs**

EXPENDITURE	Sch. No.	2021-2022 Rs.	2020-2021 Rs.	INCOME	Sch. No.	2021-2022 Rs.	2020-2021 Rs.
SALARIES	15	428.13	506.22	INTEREST INCOME	11	545.33	587.60
ENDOWMENT EXPENSES	16	36.98	41.04	DONATION	12	221.14	181.84
MEETINGS & OTHER RELATED EXPENSES	17	76.16	6.25	RENTAL RECEIPTS		2.18	0.92
DEPRECIATION ON FIXED ASSETS	5	24.71	27.49	MISCELLANEOUS		68.46	61.31
OTHER ADMINISTRATIVE EXPENSES	18	101.55	129.75				
10% OF ENDOWMENT INTEREST INCOME TRANSFERRED TO ENDOWMENT FUNDS		44.73	48.20				
EXCESS OF INCOME OVER EXPENDITURE FOR THE YEAR TRANSFERRED TO THE GENERAL FUND		124.85	72.73				
TOTAL		**837**	**832**	**TOTAL**		**837**	**832**

Provisional (Unaudited)

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