MSSRF

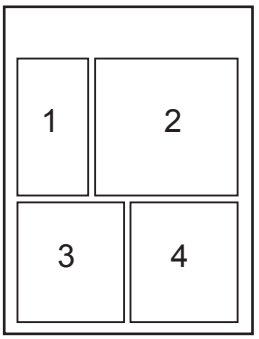
Science for Sustainable Development

M. S. SWAMINATHAN RESEARCH FOUNDATION

2018–2019

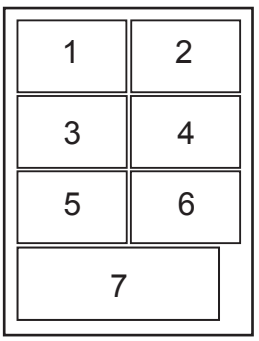
TWENTY–NINTH ANNUAL REPORT

CENTRE FOR RESEARCH ON SUSTAINABLE AGRICULTURAL AND RURAL DEVELOPMENT



Front Cover

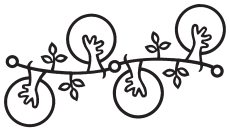
1. Hon'ble Sri Ram Nath Kovind, President of India, inaugurating the Rice Biopark in Myanmar,12th December 2018.
2. Prof. M. S. Swaminathan receiving the 1st World Agriculture Prize, 26th October 2018.
3. Tribal woman involved in production of finger millet seeds, Khilaput, Koraput.
4. Audio conference on livestock management among women producers in Thiruvaiyaru.



Back Cover

1. Harvesting of fish from community pond, Murjiaguda, Koraput.
2. A tribal woman engaged in mushroom cultivation, K. Pakhnaguda, Koraput.
3. Monsoon bash to explore the floral and faunal diversity of M S Swaminathan Botanical Garden, Wayanad.
4. Dehusking of blackgram at pulse processing unit, Villupuram.
5. Biofertilizer produced by self-help group being mixed with farmyard manure, Kolli hills.
6. Hon'ble Shri. Nitin Gadkari, Minister of road transport and highways inaugurating the "International consultation on water" at MSSRF 7th August 2018.
7. LANSA symposium at golden jubilee conference of Nutrition Society of India, Hyderabad, 16th Nov. 2018.

Twenty–Ninth Annual Report
2018 – 2019



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Contents

Chairperson's Introduction

This Annual Report marks the thirtieth year of MSSRF's existence. It gives a glimpse of the activities that were carried out and the outputs that were obtained over the past year. A reorganization of programme areas led to the consolidation of activities. The Report presents work done under five thematic areas: coastal systems; biodiversity; biotechnology; ecotechnology or sustainable livelihoods; and agriculture, nutrition and health (earlier named food security).

Climate change is one of the most challenging crises of our times, one with local, national and global implications. This year, as earlier, several programmes at MSSRF addressed issues related to climate change. Two significant studies were carried out on carbon-stock assessment and soil CO_2 efflux in the Pichavaram mangroves of Tamil Nadu, revealing that mangrove wetlands are potential carbon sequesters. In the laboratory, salinity tolerance mechanisms in the wild rice *O. coarctata* were examined using molecular, electro-physiological and cell biological approaches. Purified Kagga paddy varieties were assessed for performance in salinity-affected districts of Kumta taluk, Karnataka. In Wayanad, MSSRF is playing a crucial role in promoting agro-forestry as part of a carbon-neutral initiative in Meenangadi panchayat. After the flood of 2018 in Kerala, a climate change related disaster, MSSRF conducted a study to assess the loss of biodiversity and developed a comprehensive project to support the livelihoods of flood victims.

Achieving zero hunger is our mandate, and MSSRF continued to work on models of farming systems for nutrition, and dissemination of these models, especially in the states of Andhra Pradesh, Odisha and Maharashtra. One of our approaches involves improving access to nutri-cereals and nutrient-dense crops. In Koraput, Odisha, 2000 tribal farming households participated in millet cultivation, and a women-managed millet processing unit was established, in collaboration with the government of Odisha. In Tamil Nadu, the Kolli Hills Agrobiodiversity Conservers' Federation (KHABCOFED) marketed 11.5 tonnes of millet value-added products under the Kolli Hills Natural Foods brand. A special issue of the journal *Food Policy* was devoted to research from LANSA (Leveraging Agriculture for Nutrition in South Asia), a research programme consortium led by MSSRF.

An important international initiative was the establishment of a Rice Biopark in Myanmar, a facility to improve the livelihoods of paddy growers, inaugurated by Mr. Ram Nath Kovind, the honourable president of India, in December 2018. MSSRF grew within India too, and extended its operation to the northeastern region as part of a project to promote climate smart agriculture technology.

Our work in the area of small-scale sustainable fishery received recognition. S. Velvizhi, head of the Fish for All Research and Training Centre, received the 'SPARK – Pancharatna Women Achiever Award' instituted by Junior Chamber

International (JCI-India Zone XXIII), INSPIRE and SPARK Chennai. The Fisher Friend Programme of the Centre was selected as one of the winners of Global Resilience Partnership (GRP) – Mini Innovation Challenge Award.

This is only a glimpse of the many achievements of our staff and scholars. I thank them for their hard work and commitment. I am very grateful to our Trustees for their oversight of these endeavours and to our many well-wishers and donors for their continued support.

Anil Kumar, R. V. Bhavani and V. R. Prabavathy coordinated the preparation of this annual report. Suni Ann Sebastian edited the content and the printing was done by AMM Prints, Chennai. I record my appreciation to all of them.

Programme Area 100

COASTAL SYSTEMS RESEARCH

During the year, about 133 ha of degraded mangroves were restored in the three coastal states of Tamil Nadu, Andhra Pradesh and Maharashtra. A mangrove nursery having 40000 mangrove saplings has been developed at the Coringa Wildlife Sanctuary, Andhra Pradesh. The Society for Integrated Coastal Management of the Ministry of Environment, Forests and Climate Change (MoEF&CC) carried out the final evaluation of the Integrated Coastal Zone Management (ICZM) project in Vedaranyam, Tamil Nadu. Three wave rider buoys (WRBs) were deployed in Puducherry, Colachel and Tuticorin to receive real-time data on waves and transmit it to the Indian National Centre for Ocean Information Services (INCOIS), to forecast wave heights. More than 55000 fisherfolk receive the INCOIS information daily as SMS on their mobile phones. The fisher friend mobile application (FFMA) has been updated with 10 major changes based on the feedback received from fisherfolk. An MoU was signed with the Department of Fisheries, government of Kerala, for the upscaling of FFMA along the coastal districts of the state. More than 10000 new users have downloaded the FFMA app and are now using it. A study on the impact of cyclone Gaja with the involvement of multiple stakeholders was carried out in the Vedaranyam region and short-, medium - and long-term rehabilitation plans prepared and submitted to the government. A major flood rehabilitation initiative supported by HDFC Bank was undertaken in Kuttanad, Kerala.


INCOIS-INSSIF
REVERSE OSMOSIS WATER PLANT
OPENED BY
Shri. MANDALI BUDDHA PRASAD
DEPUTY SPEAKER, AP LEGISLATIVE ASSEMBLY
IMPLEMENTED BY
M S SWAMINATHAN RESEARCH FOUNDATION &
PRAJA PRAGATHI SEVA SANGAM
SUPPORTED BY
MITSUBISHI CORPORATION INDIA PVT. LTD
ON 26th JUNE, 2018

Sub Programme Area 101

Mangrove and Non-Mangrove Coastal Bioshields

Work on mangrove forest restoration was undertaken in Andhra Pradesh, Maharashtra and Tamil Nadu. Integrated mangrove fishery farming system is being established over an additional 10 ha in Krishna district of Andhra Pradesh. The Vedaranyam project site was severely affected by cyclone Gaja.

101.1 Mangrove Restoration

***Tamil Nadu – Tiruvallur district*:** Mangrove restoration was completed by MSSRF on 15 ha near the NTPC Tamil Nadu Energy Company Limited (NTECL) power plant along the northern bank of the Koratallaiyar river estuary in the Ennore region, as part of the company's compensatory plantation efforts. The degraded area was covered with dense trees of *Prosopis juliflora*, an exotic invasive species uprooted along with 1 m topsoil to reduce land elevation, and prepared for mangrove restoration. Main canals (3 m x 1.5 m x 1.0 m) and side canals (2.0 m x 1.0 m x 0.75 m) of predefined dimensions were dug in June–July 2018 to link the area with the Koratallaiyar estuary and enable tidal flushing. About 30000 matured propagules of *Avicennia marina* and 5000 of *Rhizophora apiculate* were planted in October 2018 along the canals with a spacing of 50 cm. The rate of survival of *R. apiculata* was about 80 per cent while that of *A. marina* was about 60 per cent.

***Andhra Pradesh – Krishna district*:** Mangrove restoration was completed in an area of 110 ha near the Sorlagondi Extension Reserve Forest with the participation of the people of Basavanipalem village. Canals measuring a length of 93264 m were dug during April–May 2018 and mature mangrove propagules of five species – *A. marina* (371960), *Rhizophora* sp. (143250), *Ceriops decandra* (46800), *Bruguiera* sp. (40320) and *Xylocarpus moluccensis* (2600) were planted at a distance of about 50 cm between September and December 2018. Survival rate of *Rhizophora* sp. was more than 80 per cent. Dead saplings were replaced in November and December 2018.

***Godavari district*:** A Mangrove Genetic Resource Conservation Centre (MGRCC) and a mangrove nursery are being established in the Coringa Wildlife Sanctuary with the participation of the Andhra Pradesh Forest Department and Eco-Development Committee of Chollangipeta village. A total of 22 sunken beds with defined dimensions (10–12 m x 1 m x 0.2 m) were prepared to raise 40000 mangrove saplings (Table 1.1). In addition, propagules of 16 mangrove species collected from the wetlands along the east coast are also being raised in the nursery. These saplings will be planted in the MGRCC in the coming years.

***Maharashtra (Navi Mumbai)*:** The mangrove restoration method developed by MSSRF was demonstrated over 8 ha of land near Kanjurmarg (East), Mumbai, to the Maharashtra Forest Department and a partnering local NGO, Vanashakti. About 600 m of main canal and 6650 m of side canals were dug and 5000

Table 1.1 ***Number of saplings in the mangrove nursery at the Coringa Wildlife Sanctuary***

S. No.	Species	No. of Seedlings	Place of Collection
1	*Avicennia officinalis*	14000	Godavari
2	*Avicennia marina*	14500	Godavari
3	*Ceriops decandra*	4000	Krishna
4	*Excoecaria agallocha*	3000	Godavari
5	*Xylocarpus granatum*	2100	Krishna
6	*Bruguiera cylindrical*	2000	Krishna
7	*Rhizophora apiculata*	200	Godavari
8	*Bruguiera gymnorrhiza*	200	Krishna
Total number of seedlings		**40000**	

nursery raised saplings of *A. marina* and 5500 matured propagules of *Ceriops tagal* planted in October 2018.

101.2 Integrated Mangrove Fishery Farming System

As a part of the project on enhancing the adaptive capacity of the local community to sea-level rise, an integrated mangrove fishery farming system (IMFFS) has been established in an area of about 15 ha near Sorlagondi in Krishna district of Andhra Pradesh. This year, aqua-farmers shifted to sea bass and shrimp culture in IMFFS farms due to a viral disease outbreak in crabs across the Andhra Pradesh coast. The farmers earned an average profit of about Rs 25000 per ha. An additional 10 ha of IMFFS is being established near Basavanipalem in the same district.

101.3 Integrated Coastal Zone Management of the Vedaranyam Coast

The project is being implemented in 49 coastal villages of Nagapattinam district in Tamil Nadu. It has five components, namely, community mobilization and organization, natural resource management, village and community development, development of Salt Satyagraha Memorial site, and training and capacity building.

Cyclone Gaja and its impact

On 16 November 2018, a severe cyclonic storm, Gaja, with wind speed of 100–120 km per hour, crossed the coast between Nagapattinam and Vedaranyam causing heavy damage at the project intervention sites. An assessment of the damage caused by the cyclone to project interventions was carried out with the support of the Ecotechnology and Agriculture, Nutrition and Health Programme teams. Based on interviews and interactive meetings with family members of affected households and the community, a report containing details of short-term (less than 5 months), medium-term (3 years) and long-term rehabilitation measures, such as agriculture, fisheries and other livelihood interventions, was prepared and submitted to the district administration. MSSRF also undertook immediate relief work in 10 villages. Village-level institutions in the project villages played a key role in relief and rehabilitation work as their members were trained in leadership skills. Tropical dry evergreen plantations and mangrove restoration work affected by Gaja are being revived with the support of the community in the project villages. The interpretation centre, constructed near the Salt Satyagraha Memorial Pillar, was partially affected and was reconstructed. In addition,

the genetic garden of halophytes is also being renovated.

The final evaluation of the Integrated Coastal Zone Management (ICZM) Vedaranyam project was conducted by the Agriculture Finance Corporation (AFC) on behalf of the Society for Integrated Coastal Management (SICOM) of the Ministry of Environment, Forests and Climate Change (MoEF&CC), government of India, from 5 to 7 February 2019, using a combination of field visits, group discussions and interviews with individual participants. The report is awaited.

101.4 Integrated Rural Development Programme

An Integrated Rural Development Programme for improved water, sanitation and livelihood in Andhra Pradesh is being implemented in three villages, namely, Sorlagondi, Nali and Mangalapuram in Krishna district, in partnership with the respective village panchayat, district administration and a local NGO, Praja Pragathi Seva Sangam (PPSS). A reverse osmosis (RO) plant with a capacity of about 1000 litres per hour was installed in Nali to increase the supply of drinking water to 424 families. A nominal cost of Rs 5 for 20 litres is collected by the village development and management committee (VDMC) formed in the village. A deep borewell (560 feet) was dug with contribution from the community, and it is being used by the water plant. An overhead water tank with a storage capacity of 800 litres was constructed in the schools in Nali and Sorlagondi to supply water to the 132 students studying there.

As part of training and capacity building, 85 people received training on oyster mushroom cultivation, including spawn procurement and culture maintenance, processing paddy straw, mushroom bed preparation, maintenance of beds for mycelium and mushroom development, maintenance of optimum environmental conditions and hygiene, harvesting, packing, selling and storage of mushroom. Livelihood support training programmes on candle-making and phenol preparation were also organized in Mangalapuram and Sorlagondi villages.

Sub Programme Area 102

Fish for All Research and Training Centre

The MSSRF Fish for All Research and Training Centre (FRTC) continued its focus on building the resilience of small-scale fishing communities in the coastal regions by demonstrating various technologies, training for disaster preparedness and promoting and diversifying sustainable livelihoods among the fishing communities.

102.1 Capture Fisheries Resource Enhancement and Management

Co-management of fisheries

The government of Puducherry invited FRTC to partner with it in implementing the Fisheries Management for Sustainable Livelihoods (FIMSUL) project that aims to reduce the vulnerability of coastal fishing communities by involving them in the decision-making

process for the participatory management (co-management) of fishery resources. Capacity-building activities include awareness building among fishing communities along with continuous engagement during the process of developing co-management principles and strategies with key stakeholders. During the reporting period, 1527 fisherfolk from 27 fishing villages were sensitized regarding co-management concepts using structured training programmes. Co-management committee members have been identified and trained in all the project villages. In order to strengthen livelihood options for fisherfolk, a village specific livelihood assessment study was conducted in all 27 fishing villages of Karaikal and Puducherry districts using the five capital (natural, human, social, financial and infrastructure) sustainable livelihood approach. Based on the report submitted by MSSRF, a livelihood plan for the FIMSUL II project has been developed for implementation by the Fisheries Department.

Wave rider buoys

Sixteen wave rider buoys (WRBs) have been deployed by Indian National Centre for Ocean Information Services (INCOIS) across the Indian coast to forecast surface and subsurface ocean parameters for the Indian Ocean rim countries. FRTC became part of this national network in 2018 to deploy and monitor WRBs in Puducherry, Colachel and Tuticorin along the Tamil Nadu coast. Three receiver shore stations equipped with necessary data transmitters have been established in Panithittu, Tharuvaikulam and Colachel fishing villages to receive real-time data on ocean waves from WRBs. This in turn is sent to INCOIS and is crucial for generating ocean state advisories for coastal communities. Data from the shore station also helps INCOIS/MSSRF to monitor and measure real-time waves to improve the national ocean forecast system as well as to validate wave model outputs for the region. During 2018–19, Puducherry shore station received data for 315 days, Colachel for 291 days and Tharuvaikulam for 14 days from their respective WRBs.

A community based monitoring mechanism has been evolved to safeguard and monitor the WRBs by engaging the local fisher community and key stakeholders (such as fishermen associations, Fisheries Department, Indian Coast Guard, Coastal Security Police and Port Trust). A total of 55615 fisherfolk from 632 villages have registered with MSSRF across the states of Tamil Nadu, Puducherry and Andhra Pradesh and receive information (ocean state forecasts, high wave alerts and potential fishing zones) daily through mobile based information communication technology (ICT) applications. Moreover, 4758 fisherfolk accessed the INCOIS/MSSRF 24/7 helpline facility, available in both Tamil and Telugu, for relevant information. Traditional knowledge and practices followed by 87 fisherfolk have been documented with regard to oceanographic parameters (weather, wind, rainfall, cyclone, water current and identification of fish shoal) through interactions, discussions and informal interviews. This data will be used to strengthen marine fishery advisories issued through this system.

Fisher Friend Mobile Application

Five new versions of the Android Fisher Friend Mobile Application (FFMA), with upgraded features incorporating 10 major changes based on feedback received from fisherfolk, were released. FFMA has also been developed for the KaiOS platform. The KaiOS based application was successfully launched on the Reliance Jio play store for upscaling. MSSRF entered into an MoU with the Department of Fisheries, government of Kerala, on 30 November 2018, for upscaling of FFMA across the northern coastal districts of the state. District Level Advisory Committees (DLACs) were constituted in seven coastal districts of Tamil Nadu, Puducherry and Andhra Pradesh to draw a roadmap for upscaling FFMA through governmental and nongovernmental platforms. In the process, MSSRF strengthened its network of partners in all the project sites and gained extensive support from the Fisheries Department. In addition to this, proactive community members identified as master trainers were engaged to promote FFMA. Currently, there are 192 master trainers.

The FFMA is now being used by 49328 members from 65 districts spread across nine coastal states, namely, Kerala, Tamil Nadu, Puducherry, Karnataka, Andhra Pradesh, Maharashtra, Gujarat, West Bengal and Odisha; during 2018–19, 10690 users were added, with an average of 4800 views per day. A total of 805 awareness meetings were organized in the states of Tamil Nadu, Puducherry, Kerala, Andhra Pradesh, Karnataka, West Bengal and Odisha in which 23053 fisherfolk (M: 21085; F: 1968) participated. Moreover, 99 case studies involving FFMA users were recorded. The cases reflect economic benefits gained through various features of the FFMA as well as time saved by wise decision-making. The FFMA application helped save the lives of 22 per cent of the respondents during disasters and also in safeguarding assets (boats/nets/equipment) worth Rs 1.71 crores. The case studies also highlight the impact of this advanced information system on the alleviation of/reduction in mental and physical strain among the fisherfolk.

Community based artificial reef programme

Following detailed research, a site for deployment of a fabricated reef (concrete fabrication, weighing 52 tonnes) was identified 23 km offshore. The programme was launched on 23 August 2018 by Mr. Kamala Kannan (minister of education and agriculture, government of Puducherry), among other dignitaries. It has been designed to accommodate three different marine species: lobsters, grouper fish and small fishes. The reef was deployed on 30 September 2018 with the support and active participation of the local fishing community and the district administration of Karaikal. The reef coordinates were communicated to the villagers for monitoring and protection.

102.2 Culture Fisheries Resource Management and Enhancement

***Integrated fish farming system*:** As part of the integrated fish farming system (IFFS), the

FRTC developed a prototype for integrated fish culture technology with active participation of local fisherwomen from Poompuhar. Initially, two ponds – a nursery pond (36 m x 30 m) and a main pond (12 m x 10 m) – were designed for culturing inland fish species, namely, Catla, Rohu (*Labeo rohita*), Mirgal (*Cirrhinus mrigala*) and Botala. Fisherwomen were trained on various aspects of fish culture (monitoring water quality, pond cleanliness and maintenance of ambient water level, feeding application) and maintenance. Three types of fish feed were experimented with and floating feed was found to give best results for fish growth. With the technical know-how provided by the FRTC, fisherwomen were able to overcome many issues related to fish culture (fish mortality, microbial infections, fluctuations in oxygen due to algal blooms etc.). The first harvest of fish in November 2018 gave a yield of 312 kg and an income of Rs 40500. Of the one acre of land allocated for promoting diversified cropping systems under IFFS, 20 cents were used for vegetable cultivation and 12 cents for planting jasmine saplings as bund crops. The women's group earned a seasonal income of Rs 6254 over a period of three months from the sale of vegetables and flowers.

***Ornamental fish culture*:** Fresh water ornamental fish culture technology was promoted as one of the diversified livelihood strategies for fisherwomen along with demonstration of culture practices by the FRTC. A 12-member women's group was selected for training on various aspects of ornamental fish tank development (water quality, managing disease outbreaks if any and feed formulation) as an additional source of income. Seasonal variations in microbial infection and parasitic infestation were recorded over a period of one year for further pathological studies and analysis. The women's group earned an additional income of Rs 27800 over a period of six months.

***Water testing laboratory*:** The water testing laboratory set up during 2017 at FRTC was upgraded with additional facilities to measure various water quality parameters, such as salinity, pH, alkalinity, hardness, dissolved oxygen and ammonia. The facility was used by 80 fish farmers from seven villages and 158 water samples were analyzed. Recommendations were provided based on the results obtained. The FRTC also created awareness on different aspects of collection of water samples and transportation to the laboratory. In addition, by using ICT platforms farmers are being linked with the Central Institute of Brackish Water Aquaculture (CIBA) and Fisheries Institute of Technology (FIT), Rajiv Gandhi Centre for Aquaculture, Tamil Nadu Fisheries University (Nagapattinam), to obtain updated information regarding fish and shrimp culture practices and disease management.

102.3 Post-Harvest Management

***Fish processing unit*:** The fish processing unit at FRTC is equipped with low-cost packing machinery and processing equipment that are regularly used by the Winmeen Women Federation members from Poompuhar for the production of hygienic fish produce (fresh/dry

fish: value-added fish products). A total of 185 fisherfolk were trained on various aspects of hygiene in relation to fish handling, dry fish production and fish processing technologies. Fifty-three fisherwomen from five villages were mobilized for 261 working days, and they processed nearly 7 tonnes of fishes. The processed fish was marketed through Fish Chain, a Bengaluru based marketing company, providing an additional income of Rs 1.9 lakhs.

102.4 Training and Capacity Building

***Training centre*:** To utilize FRTC resources adequately, continuous needs assessment was done for different target groups, and their needs were prioritized. A training calendar was prepared and circulated among various stakeholders at both the block and the district level. Many agencies have come forward to utilize the facilities and expertise available with the FRTC (e.g. Indian Overseas Bank, Network of Fish Quality Management [NETFISH], Marine Product Export Development Agency [MPEDA], Nehru Yuva Kendra and Fisheries Department at the district). During 2018–19, 63 training programmes on quality dry fish production, processing technology, fish culture and marine biodiversity conservation were conducted in which 2078 marine fisherfolk and aqua farmers participated. Details are given in Table1.2.

***Literacy on sustainable fisheries and fish quality management*:** A series of awareness programmes was conducted through the village resource centres (VRCs) at Poompuhar and Thangachimadam and a virtual VRC in Kanyakumari, in collaboration with NETFISH, to address issues such as over-exploitation of fish resources and poor fish quality management. The awareness campaign focused on various aspects such as coastal regulations, regulation of mesh size, promotion of square meshes, hygienic handling of fish resources and sustainable management of fisheries. In all, 79 training programmes involving 4116 fisherfolk (M: 2712; F: 1404) were organized.

***Village resource centre*:** Two VRCs and four village knowledge centres (VKCs) are operational in the coastal districts of Ramanathapuram, Nagapattinam and

Table 1.2 ***Training programmes organized under FRTC (2018–19)***

S.No.	Training Topics	No. of Training Programmes	Participants		Total
			Male	Female	
1	Co-management of fishery resources	37	911	315	1226
2	Sea safety techniques	4	153	0	157
3	Fish value-added products	14	0	420	420
4	Square mesh for responsiblefishing	3	90	0	90
5	GPS troubleshooting techniques	2	63	0	63
6	Ornamental fish culture	1	0	10	10
7	Integrated fish farming	2	30	82	112
	Total	**63**	**1247**	**827**	**2078**

Puducherry. During 2018–19, an integrated plan was developed to use VRCs for disseminating knowledge on disaster preparedness, fisheries resources management, sustainable fisheries and government schemes and policies, using ICT tools. Tools utilized for information dissemination include public address systems, notice boards and ICT tools such as text and voice SMS, phone-in programmes, audio/ video conferences, WhatsApp and Facebook. Table 1.3 lists user information and knowledge services accessed through the VRCs and VKCs during the year.

Table 1.3 ***User details of VRCs and VKCs (2018–19)***

Name of the VRC/VKC	Total Users	Male	Female
Poompuhar VRC	320	180	240
Thangachimadam VRC	488	253	235
Olaikuda VKC	664	346	318
Keezhapoothanur VKC	1169	640	529
Prathabaramapuram VKC	590	244	346
Panithittu VKC	1019	296	723
Total	**4350**	**1959**	**2391**

VKC: village knowledge centre;
VRC: village resource centre.

Sub Programme Area 103

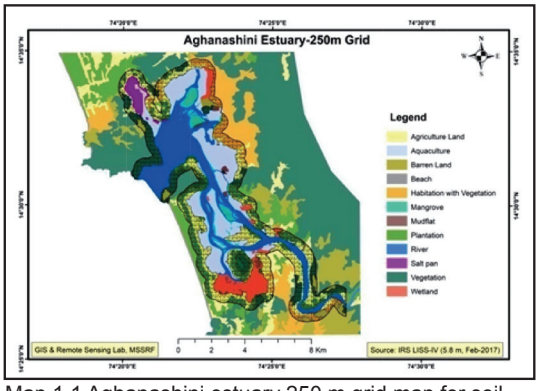
Remote Sensing and Geographical Information Systems (GIS)

The WebGIS based pest management system was pilot tested and is being finalized for release. Soil salinity and vulnerability mapping was undertaken along the Karnataka coast. Mapping of nutrition status and Gaja-affected areas was done in Tamil Nadu.

103.1 GIS Based Forewarning Model for Pest Management (GFPM)

A centralized pest and disease forewarning system based on real-time, past and forecasted weather variables was initiated in Vedaranyam in 2017. Building on this, a WebGIS based pest management system was developed and pilot tested among farmers in Vedaranyam block. This is being finalized and will be released to the farmers by August 2019. During 2018–19, the farmer database was updated to include voice SMS advisory services. Agro advisories were disseminated to 2000 farmers through voice SMS service on a pilot basis. Near infrared (NIR) drone survey was carried out in Kathripulam village to update the cadastral boundaries and study the health of the crops. The drone image has been updated in the Android app for better visualization of the farm lands.

Soil analysis was carried out by the MSSRF mobile soil testing laboratory for 400 farmers in Kathripulam, Vanduvanchery and Thennadar. Based on testing results, soil maps were



Map 1.1 Aghanashini estuary 250 m grid map for soil sampling.

prepared by interpolation using ArcGIS, and soil health cards were issued to farmers with suitable recommendations by experts with regard to crop (species) suitability and fertilizer application regimes. Around 50 progressive farmers were trained at the Centre of Excellence for Vegetables, Horticulture Department, government of Tamil Nadu, in Dindigul, to better manage pest and disease incidence in their lands. Moreover, 38 farmers were trained on various aspects of paddy management for higher yield, lower water usage and lower pest and disease incidence at the Tamil Nadu Rice Research Institute, Aduthurai.

In addition, about 400 farmers from the three project villages of Kathripulam, Vanduvanchery and Thennadar were trained on pest and disease management practices for paddy, brinjal and jasmine with support from experts from the Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal.

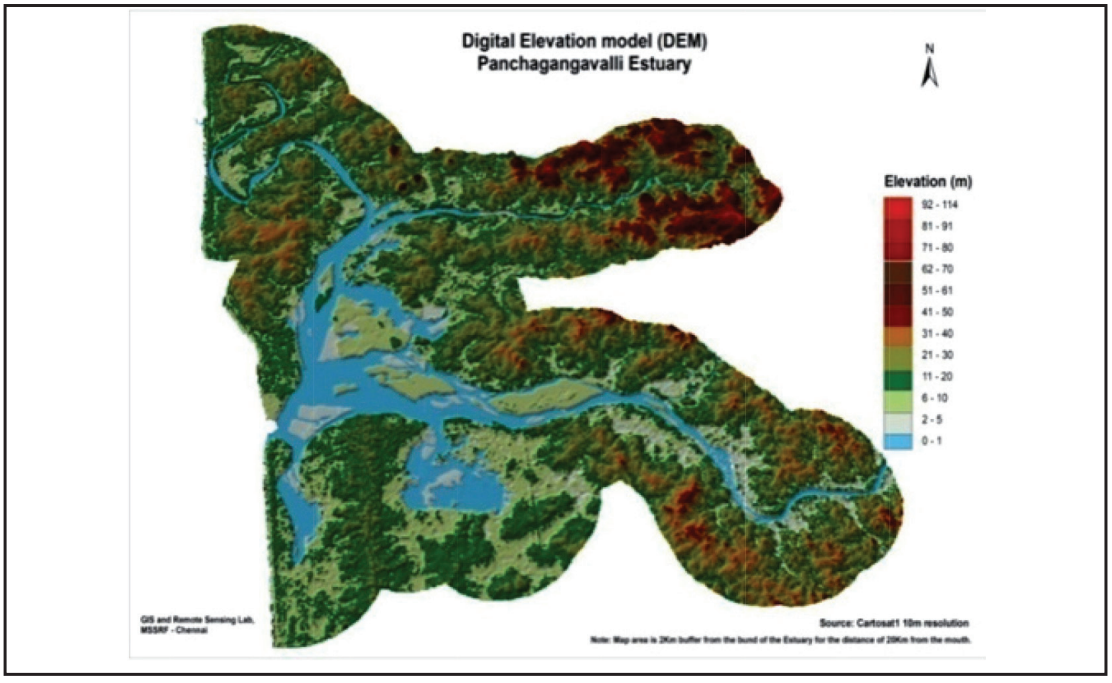
103.2 Reclamation of Coastal Saline Soils of Karnataka: An Integrated Approach towards Biosaline Agriculture

***Soil salinity mapping*:** Soil salinity was estimated in the 500 m buffer zone along Panchagangavalli and Aghanashini estuaries with the support of Zonal Agricultural and Horticultural Research Station (ZAHRS) and University of Agricultural Sciences (UAS), Dharwad, in a 250 m grid (Map 1.1). The EM 38 instrument was used for *in situ* soil salinity measurement. Using this data, a web-based GIS integrated innovative decision support system for promoting soil health will be prepared.

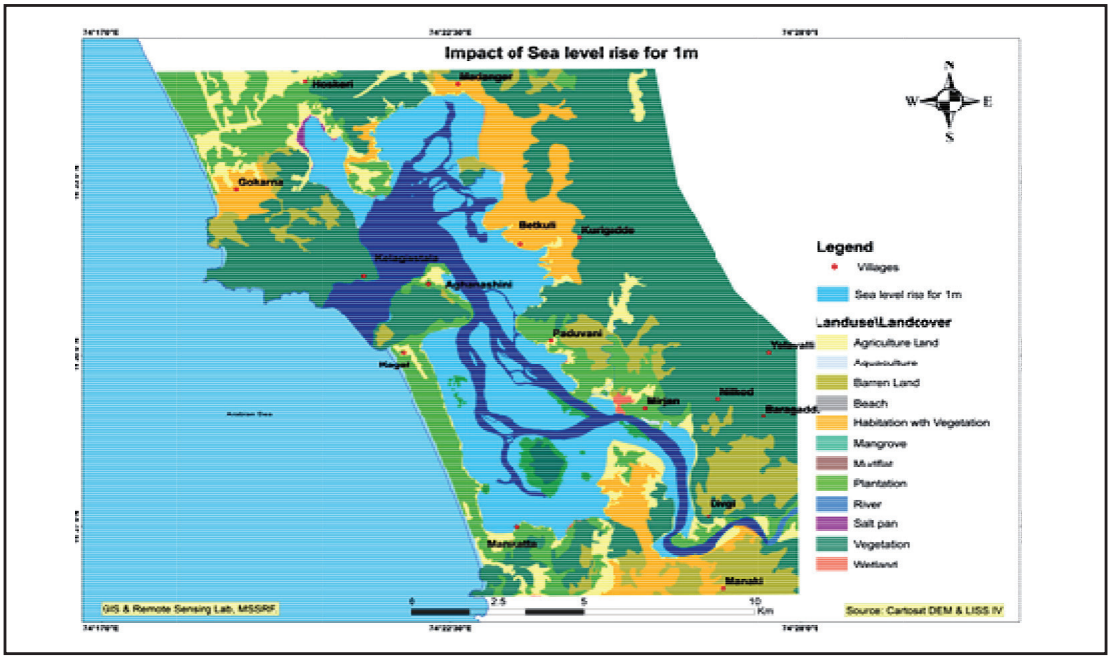
***Vulnerability of the Karnataka coast*:** Land use/land cover maps for the entire Karnataka coast (380 km length and 15 km landward region) were prepared on a 1:10000 scale using Linear Imaging Self-Scanner (LISS IV) satellite images at 5.5 m resolution. A hybrid classification technique was adopted to categorize satellite images using ERDAS software. Data on different land use patterns were extracted from satellite images. Cartosat satellite images and digital elevation model (DEM) data were procured from the National Remote Sensing Center (NRSC), Indian Space Research Organization, to generate DEM for entire Karnataka, including Panchagangavalli and Aghanashini estuaries (Maps 1.2 and 1.3). The bath tub model was used to study the physical vulnerability of the Panchagangavalli and Aghanashini estuaries region to sea-level rise using different Intergovernmental Panel on Climate Change (IPCC) scenarios with the help of ERDAS and ArcGIS 3D software.

103.3 Mapping of Nutrition Status in Tamil Nadu

Nutrition status maps were prepared for the 33 districts of Tamil Nadu. Thematic maps were generated using the natural break classification method. Eight thematic maps were prepared from secondary data on underweight children and stunting and wasting among children below 5 years, anemia among



Map 1.2 Digital elevation model of Panchagangavalli estuary



Map 1.3 Impact of 1m sea-level rise for Aghanashini estuary.

children in the age group of 6 months to 5 years, '15 to 49-year-old' women with chronic energy deficiency (CED), and access to safe drinking water and sanitation facility from the National Family Health Survey (NFHS-4) at the request of the Agriculture Nutrition Health programme team at MSSRF.

103.4 Assessment of Damage Caused by Cyclone Gaja

***Damage assessment at Vedaranyam*:** The damage caused by cyclone Gaja to vegetation in Vedaranyam was documented using satellite images obtained from the European Space Agency Sentinel 2B. False colour composite (FCC) images at a 10 m resolution were used for the analysis. The epicentre of damage caused by the cyclone was clearly identified from pre- and post-Gaja images. A detailed analysis is being carried out to assess damage to plantation crops using the village-wise normalized difference vegetation index (NDVI) method and the results will be published soon.

***Field survey in Muthupet mangrove region*:** A detailed field survey was carried out in the Gaja-affected Muthupet mangrove region. The reserve forest boundary has been surveyed and mapped. Transect surveys were carried out to assess the damage to the mangroves in 10 m x 10 m quadrats. The data is being analyzed and results will be shared shortly with the Department of Environment and Forests, government of Tamil Nadu, to plan mangrove restoration strategies.

Sub Programme Area 104

Below Sea Level Farming Research and Development Centre at Kuttanad

The scope of work in the Kuttanad region was expanded from being a community water knowledge centre and given broader focus as a below sea level farming research and development centre. The region was badly affected by floods in 2018. A major project for flood rehabilitation and livelihood enhancement in 30 villages, supported by HDFC Bank, is underway.

104.1 Water Literacy Campaign and Training on Pollution

A key focus area of the programme has been conducting water literacy campaigns and training on pollution, biodiversity conservation, sustainable agriculture and livelihoods. The centre organized various trainings programmes, such as advanced design of rainwater harvesting (RWH) structures, capacity building of local self-government on water conservation, water literacy and water management. About 450 people participated in these programmes. Five poster presentations on water knowledge centres were conducted at various locations in Kerala in which more than 5000 people participated.

A study on point and non-point sources of soil and water pollution in Kainakary panchayat of Kuttanad in Kerala was conducted by

postgraduate students of MG University, Kottayam. The study revealed that the major point sources of soil pollution are improper waste disposal, animal and human waste, slaughterhouses and plastic waste, and the major non-point sources are fertilizer (nitrate, phosphate) residues, pesticides and chemical residues, heavy metals and sediments. The major point sources of water pollution in the study area were listed as sewage, household waste, greywater discharge, washing, slaughterhouse waste, sanitary waste and pesticides used in fishing. Agricultural field run-off, a by-product of pesticides and fertilizers used by farmers, was the major non-point source of water pollution. Another study on water- and soil-related diseases in Kainakary showed that the major water-related diseases in the study area are cancer, itching, diarrhea, vomiting, skin problems, ulcers, polio, jaundice, swelling, fever, cough and sneezing. Soil-related diseases include skin allergy, pulmonary diseases, asphyxia, headache, suffocation, nausea, kidney failure and eosinophilia.

A student from Wisconsin-Madison University, USA, conducted a comparative study on water pollution in Kainakary and Kumarankary panchayats in Alappuzha district. The main finding was that the water in Kainakary was suitable only for agricultural purposes whereas in Kumarankary it was suitable for both drinking and agricultural purposes. An SBI Youth for India Fellow is currently working on affordable and environment-friendly solutions to address day-to-day problems in the Kuttanad region. Two postgraduate students from the School of Environment Science and Disaster Management of MG University, who worked as interns for a month in March 2019, studied rainfall data on the Kuttanad region and drought in the upper Kuttanad region.

The June 2018 floods, which became very severe in August, badly affected the entire Kuttanad region. The water testing laboratory was completely damaged and the office had to be shifted from Ramankary to Perunna in Changanacherry town. A water sample survey was conducted in the flood-affected regions of Kuttanad in September 2018. The survey revealed that ferrocement RWH systems established by MSSRF in Kainakary and Ramankary panchayats of Alappuzha district and Vechoor panchayat of Kottayam district in 2012 were safe sources of drinking water. The RWH system had the capacity to cope with flood waters upto 5 feet from the ground level without any water contamination.

104.2 HDFC Parivarthan Project Initiatives

Initially, 10 villages were identified in the Kuttanad region for implementation of the HDFC Parivarthan programme, which mainly focuses on natural resource management and livelihood enhancement by addressing health, education, extension and financial inclusion. After the recent floods in Kerala, MSSRF and HDFC jointly decided to add another 20 villages (Kuttanad, 5; Ernakulam, 5; Idukki, 5; and Wayanad, 5) to the programme. Rapid rural appraisal (RRA) was conducted in the project villages and the report compiled. Entry-point flood rehabilitation activities will commence shortly.

Programme Area 200

BIODIVERSITY

In Tamil Nadu, Kolli Hills Agri-Bioresource Producer Company Ltd., consisting primarily of small and marginal farmers, procured and marketed about 33.70 tonnes of primary produce such as coffee, pepper, cashew, pineapple, tamarind, millets and bio-fertilizer and earned a net income of Rs 2.92 lakhs. Kolli Hills Agrobiodiversity Conservers' Federation (KHABCOFED) marketed 11.50 tonnes of millet value-added products under the Kolli Hills Natural Foods brand and generated a gross income of around Rs 9.5 lakhs. In Odisha, finger millet and green gram varieties were identified for production of certified seeds. KMR-204 variety in finger millet recorded a yield of 2055 kg per acre in a farmer's field, which is considered to be the highest finger millet yield in the state. Demonstration of integrated aqua and non-aqua farming systems models for sustainable livelihoods is underway. In Kerala, M.S. Swaminathan Botanical Garden in Community Agrobiodiversity Centre (CAbC), Wayanad, attracted 10000 visitors during the year through diverse activities. Field operations were expanded to Thiruvananthapuram; a new Farmer Producer Organization (FPO) for organic products was promoted in Wayanad. Herbal gardens of medicinal plants were set up in 13 schools in Wayanad and Malappuram districts and 24500 seedlings of 35 species of prioritized medicinal plants were propagated and distributed to 410 farm households covering 30 acres.


MEDICINAL & AROMATIC RICE INITIATIVE
RICE DIVERSITY PLOT
Workshop on Value Addition & Quality Control in Millets
KOLLI HILLS NATURAL FOODS
MILLET VALUE ADDITION CENTRE

Sub Programme Area 201

Community Conservation Programme in Kolli Hills

Promotion of millet cultivation and its processing continued to be the focus of work in Kolli Hills in Namakkal district of Tamil Nadu. The project team provided technical support for the initiation of similar activity in Madhya Pradesh. Horticulture produce was promoted under an integrated tribal development project.

201.1 Millet Promotion and Value Chain Development

Millet promotion, value chain development and linking with mainstream market are among the major activities in Kolli Hills since the past two decades. Promotion of participatory varietal selection, quality seed production, improved agronomic practices, community seed banks, customized farm implements, value addition, branding and linking with urban markets are key activities under this programme.

***Distribution of millet seeds through community seed banks*:** Tribal farmers from 14 panchayats of Kolli Hills were mobilized for millet promotion activities through village-level meetings and programmes, including millet seed fairs. A total of 225 millet growing farmers were identified to take up activities covering an area of 93.29 acres. About 995 kg of quality seeds of finger millet, little millet and foxtail millet were distributed through community seed banks.

***Yield enhancement trial and cost-benefit analysis*:** Yield enhancement trial was taken up to help farmers get higher yield from small millet cultivation by promoting farmer-friendly and improved agronomic practices. Two methods of cultivation of mono-crop of millet or intercrop with pulses were followed in the same field for comparative study: one was row planting or line sowing using a furrow maker and recommended packages of practices; and another was the broadcasting method or farmers' practice of mono-crop or mixed crop. During kharif 2018, a demonstration of these comparative methods was successfully done in 225 farmers' fields.

Cost and return assessment was done for both line sowing and broadcast method in the trial fields. Cost of cultivation includes seed cost, manure cost, labour cost for ploughing, bush cleaning, seed sowing, weeding, thinning, harvesting and post-harvest processing. Seed cost was found to be higher under farmers' practice due to the requirement of greater quantity under broadcasting. The yield from grain and straw was monetized based on the current market value to calculate the return. Average grain yield was 9.94 qtl/ha under farmers' practice and 12.30 qtl/ha under improved agronomic practices. Although cost was higher using improved practices, by following these methods, farmers got 23.84 per cent higher yield and higher net return than using traditional farmers' practices.

***Vermicompost production*:** In Kolli Hills, the project monitored 87 tribal farmers who have been trained and have vermicompost production units. Total production during the

year was about 13 metric tonnes, which was totally used for their fields. There was no sale.

***Finger millet processing*:** The performance of pulverizers established earlier at Padasolai, Puliyampatti, Thiruppuli, Orpuram, Sundakkadu, Semputuvalvu, Navakkadu, Periyakovilur, Thuvarappallam, Vendalappadi and Kuchakiraipatti villages in Kolli Hills was monitored. The first four are managed by farmers' clubs and the rest by self-help groups (SHGs); processing is done both for individual households and for supplying to Kolli Hills Agrobiodiversity Conservers' Federation (KHABCOFED). The mills have helped reduce the drudgery involved in millet processing as well as created opportunities for additional income. Rice and wheat are also processed into flour in the mills. The processing cost ranges from Rs 6 to Rs 8 per kg. During the year, about 8.6 tonnes of millets and cereals were processed and a net monthly income of Rs 600–700 was shared by members of the group.

***Production and marketing of Kolli Hills Natural Foods*:** Since 2001, members of KHABCOFED are producing and marketing products under the brand name 'Kolli Hills Natural Foods'. During the reporting year, 11.50 tonnes of millet value-added products were sold and an overall gross income of around Rs 9.5 lakhs earned.

201.2 Integrated Tribal Development Programme

The Integrated Tribal Development Programme is being implemented in four panchayats in Kolli Hills since July 2010. The project has so far covered 1000 tribal farm families from 40 settlements across four panchayats.

***Supply of organic inputs and survival estimation of horticulture plants*:** All the 1000 farmers' fields are being cultivated under organic conditions and farmers have used only farmyard manure, bio-inputs and neem cake. About 117 metric tonnes of farmyard manure and 4.26 metric tonnes of bio-inputs were used over 195 acres in Thiruppuli and Gundur Nadu panchayats during the reporting period. Mortality and survival assessment was carried out every month for major horticulture crops, namely, jackfruit, mango, lime and cashew, in a participatory mode. The current survival rate is 91.82 per cent.

***Soil conservation and water resource development*:** Water resource development is a critical component of the wadi or valley; so far, 215 percolation ponds and 17 common wells have been established in the project locations. These mini percolation ponds and common wells are used for irrigation of wadi farms and also as a source of drinking water for villagers. In addition, renovation of compartmental bunds or V bunds and trenches constructed for soil conservation was undertaken as required across all 1000 wadi farms.

***Intercropping in wadi farms*:** Every year, wadi farmers are encouraged to cultivate millets, such as little millet, finger millet, foxtail millet and sorghum, as intercrop in and around

wadi fields. During kharif 2018, 113 farmers adopted millet intercropping and 18294 kg of millets were harvested from around 45 acres of land. About 85 per cent of the output (15564 kg) was consumed by the cultivator families and the balance converted to value-added products and sold as Kolli Hills Natural Foods.

***Promotion of kitchen garden*:** During the reporting period, several village-level awareness camps were organized to create awareness on nutrition-related issues. In addition, high-yielding varieties of vegetable seeds, including tomato, brinjal, chilli, green leafy vegetables, lady's finger, ribbed gourd, bitter gourd, cucumber, bottle gourd and pumpkin, were sourced and distributed to all 1000 farmer households to raise kitchen gardens on available backyard land. The area of such plots ranges from 1 cent (equivalent to 0.02 acre) to 5 cents; 500 households harvested about 22011 kg of vegetables. The remaining 500 were unable to maintain the kitchen garden due to inadequate availability of water. This is a major challenge in the region.

***Yield of major horticulture crops*:** The majority of mango saplings planted earlier in Alathur and Gundani Nadu panchayats started to yield fruit; few jackfruit and lime trees also yielded fruit. During 2018–19, 70.85 tonnes of mango, 10.71 tonnes of lime, 7.79 tonnes of jackfruit and 1.7 tonnes of cashew were harvested by the farmers in Thiruppuli, Gundur Nadu, Alathur and Gundani Nadu panchayats. The produce is primarily marketed through Kolli Hills Agri-Bioresource Producer Company Limited (KHABPCOL), established with the 1000 farmers in the project villages.

201.3 Kolli Hills Agri-Bioresource Producer Company Limited

KHABPCOL is an FPO being nurtured since January 2016. Its major objective is to build capacity of the farmers' collectives to access financial and nonfinancial support such as bank linkages, manufacture value-added products and market primary products.

The major target crops are millets, fruits (jack, mango, pineapple, orange, lime), cashew, pepper, coffee and pulses. The board of directors (BoD) and chief executive officer (CEO) of the FPO have prepared business and strategy plans for the next five years. During the reporting year, about 33.70 tonnes of primary produce were procured from member farmers and marketed with a total turnover of Rs 33.36 lakhs. The net return of Rs 2.92 lakhs was ploughed back into the company.

***Training and capacity building*:** During the year, 57 orientation training programmes were conducted across 39 settlements covering 583 member farmers. The training sessions included formation of farmers' interest groups and FPOs and linking with banks and building share capital for new members. Fifteen training-cum-exposure visits were organized for BoD members and the CEO on formation of FPOs, roles and responsibilities of the CEO, farmers' mobilization, database management, raising share capital, equity grants and credit guaranty fund.

201.4 Technical Support for Developing Millet Value Chain

Technical support was extended by the MSSRF team to the NGO Action for Social Advancement (ASA) for establishment of a millet value chain for tribal farm families in Mandla and Dindori districts of Madhya Pradesh, with financial support from Bioversity International and the European Union.

***Establishment of millet processing units*:** As part of the activities, MSSRF and ASA teams conducted orientation meetings with the CEO and members of Mandla Tribal FPO, Maheshmati Tribal FPO and Vindhavasini Kisan FPO in Mandla and Dindori regions. Following the meetings, suitable locations were identified in Bhodi, Sahar and Kachari village panchayats for the establishment of millet processing units, each comprising a millet de-stoner, grader and de-husker.

***Baseline survey*:** Based on selection of FPOs and locations for establishment of millet processing units, secondary data was collected on list of villages, households and millet farmers associated with the three FPOs. As per this data, about 3389 tribal households are associated directly and indirectly with these FPOs. Of these households, around 1905 are presently cultivating millets in the aforementioned regions. Baseline survey was undertaken of 15 per cent or 285 households selected using proportionate random sampling method to understand the existing practice of production, processing and marketing of millets in the area. The survey has just been completed and data analysis is in progress.

Sub Programme Area 202

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

Promotion of millet cultivation under the Odisha Millet Mission, production of millet seeds and value-added products, biodiversity conservation on campus and preparation of People's Biodiversity Register were among the activities undertaken during the year.

202.1 Socioeconomic Upliftment of the Tribal Community through Cultivation of Small Millets

Support was received from the Indian Institute of Millet Research under their Tribal Sub Plan for promotion of improved sorghum and small millet cultivation.

***Identification of millet farmers and sources of seeds*:** The tribal farmers of Umuri gram panchayat (GP) of Koraput block were mobilized for promotion of millet cultivation. The project team conducted mobilization programmes such as millet seed fairs and village-level meetings. Improved seeds of finger millet varieties such as GPU-28, GPU-66 and KMR-204 were procured from the University of Agricultural Sciences, Bengaluru, and Chilika and Arjun varieties were procured from Centre for Pulses Research, Berhampur.

***Yield enhancement trial*:** Improved methods of cultivation, such as the system of millet intensification (SMI), line transplanting (LT)

along with application of both chemical and bio-fertilizers and bio-pesticides, were promoted. A total of 91 farmers cultivated 100 acres out of which 56 cultivated GPU-28, 11 GPU-66, 8 KMR-204, 10 Arjun and 6 Chilika. It was observed that average grain yield using farmers' practice of seed broadcasting was 15.7 qtl/ha whereas it was higher under all improved varieties with better agronomic practices, ranging from 26.4 qtl/ha in the case of GPU-66 to 33.8 qtl/ha with KMR-204. The net return per hectare was also higher, ranging from Rs 34682 per ha with the GPU-66 variety to Rs 52409 per ha with the KMR-204 variety as against Rs 16598 per ha following traditional farmers' practice.

***Training on integrated nutrient and pest management*:** Three village-level training programmes on integrated nutrient and pest management, in which 117 farmers participated, were organized. Preparation of bio-pesticides such as Handikhata, Jibamruta and Amrutajala was demonstrated. Pest cycle, nature of pests, time of pest attack, symptoms and integrated ways of pest management were explained to the participating farmers.

202.2 Odisha Millet Mission

A special programme for promotion of millets for addressing crop failure and nutritional deficiencies: 'Reviving Millets in Farms and on Plates-' was launched in tribal areas by the government of Odisha in 2017–18. It is being implemented in partnership with a network of civil society organizations. MSSRF is a facilitating agency under the programme for Kundra block of Koraput district.

During the year, 636 farmers covering 62 villages under 10 GPs were mobilized to cultivate finger millet in 279.6 ha by adopting improved agronomic practices and modern technologies such as SMI and LT while maintaining spacing of 25 cm x 25 cm, through a series of capacity-building training programmes and exposure visits. The farmers received incentives from the government as prescribed for adoption of different practices, such as Rs 5000 per ha land under SMI and Rs 2500 per ha land under LT in the first year and Rs 3000 per ha and Rs 1500 per ha respectively in the second year for following such practices. A total amount of Rs 12.08 lakhs was received by farmers under this programme.

***Crop-cutting experiment*:** A total of 23 samples were randomly selected from the 636 farmers for testing dry gain weight. The highest dry grain weight among all the samples was recorded in the SMI field of Mrs. Bhanumati Santa of Ghandiguda village at 7.22 kg/25 sq. m. This works out to an estimated yield of 29.2 qtl/ha, which is considered a very good yield in case of finger millet experience in Odisha given the average yield of 7.56 qtl/ha.

Ten awareness campaigns were organized on production, consumption and marketing of millets and 14 training programmes conducted on SMI, LT, good agronomic practices, preparation and application of organic inputs and seed centre management, covering 409 farmers (F: 192; M: 217) under the programme. Twenty progressive farmers were taken on an exposure visit to Agricultural Research Station,

Vizianagaram, to learn millet seed production technology and seed storage.

***Finger millet seed production in rabi 2018*:** Steps towards quality finger millet seed production were initiated in 12 villages under five GPs involving 55 farmers and covering 50 acres under improved agronomic practices and crop technologies such as SMI and LT. Local millet varieties such as bada mandia, sana mandia and dashara mandia and improved varieties such as KMR-204 and GPU-67 were cultivated. Eight random samples were taken for crop-cutting experiment in 25 sq. m, and the highest fresh weight recorded was 11.25 kg. Dry weight is yet to be measured.

202.3 Alternative Seed System Model for Production and Supply of Improved Seed Varieties of Millets and Pulses

The project initiated in April 2018 has training farmers on improved seed production technologies and sustainable livelihood security through economic empowerment as its objectives. Koraput district is the site for finger millet seed production and Ganjam district for green gram seed production.

Ten villages of four GPs in Koraput block of Koraput district are being covered under the project. During kharif 2018, a total of 86 farmers were involved covering 67.5 acres. Breeder seeds of ML-365 and KMR-204 along with five check varieties, namely, Kalua, Arjun, Chilika, Bhairabi and Jam, were provided to the farmers. The KMR-204 variety recorded yield of 2055 kg per acre in a farmer's field, which is considered as the highest finger millet yield in the state. The average yield of KMR-204 was 1254 kg per acre; the lowest yield of 450 kg per acre was recorded in the case of Bhairabi, and the average yield per acre of other varieties was as follows: Arjun, 1094 kg; ML-365, 1030 kg; Chilika, 932 kg; and Kalua, 528 kg. Figure 2.1 gives the yield comparison. Based on the performance, KMR-204 and Arjun were identified by the farmers for certified seed production in 2019.

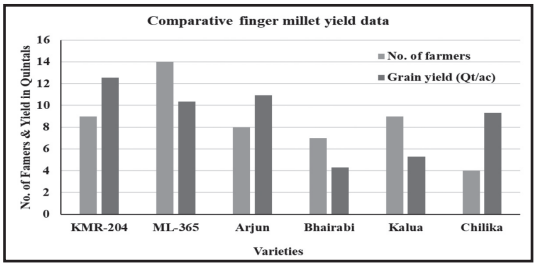


Figure 2.1 Yield comparison of improved varieties.

In the case of green gram, seed production was focused in five villages of two GPs in the Chikiti block of Ganjam district. Following training on improved package of practices for seed production, 300 kg of breeder seeds of IPM 02-03 and IPM 2-14 were provided to 22 farmers for seed production. The highest yield of 5.4 qtl/acre of IPM 02-03 was recorded in a farmer's field; the average seed yield was 4.37 qtl/acre. In the case of IPM 2-14, an average yield of 4.1 qtl/acre was recorded. Based on this performance, it has been decided in consultation with farmers to undertake certified seed production of both varieties.

***Capacity-building programme*:** Four training programmes were organized on integrated pest and disease management in both districts, covering 135 farmers in Koraput and

80 farmers in Ganjam. A total of 75 progressive farmers participated in two post-harvest seed technology training programmes. Ten best practices starting from field preparation to post-harvest technologies were demonstrated to farmers at the field level in Koraput and seven in Ganjam. Four farmers' field days were organized in finger millet fields and two in green gram fields involving 152 and 74 farmers respectively. Training on improved cultivation practices such as SMI, LT and seed treatment covered 125 farmers in Koraput and 161 in Ganjam.

202.4 Integrated Farming Systems Model for Income Enhancement of Small and Marginal Farmers

The overall objective of the project is to design and develop land based and aquaculture based integrated farming system models comprising both crop and non-crop components suitable to the location. This project is being implemented in Boipariguda and Kundra blocks of Koraput district covering around 2000 households.

***Aqua-based interventions*:** Under this model, fish culture is the major component and agriculture, horticulture, duck farming and fodder units are integrated as subsidiary components. Five aquaculture models were developed during the year. In five fish ponds covering an area of 0.9 ha, 7000 yearlings of Catla, Rohu and Mirgal fish were stocked in the month of August 2018. A total of 538 kg of fish were harvested in three complete harvest and two partial harvest ponds. Under the other components, 48 qtl of paddy were harvested from 4 acres, and 3.8 qtl of green gram and 4.1 qtl of black gram from 2 acres; vegetables were also harvested in good quantities and fruit trees are in the growing stage. Ten ducks were provided to four households in Kundra block and 15 ducks to four households in Boipariguda in late 2018. The 10 ducks in the Kundra cluster started laying eggs from April 2019 onwards and till date around 90 eggs have been collected; around 50 eggs were consumed and the remaining 25 sold in the village itself. Another 15 eggs were hatched by local country birds, for furthering the duckery activity.

***Non-aqua agriculture based interventions*:** Paddy cultivation involving 34 farmers covered 34.5 acres of land and recorded an average production of 20.6 qtl/acre. Maize cultivation covered 4.3 acres with an average production of 7.76 qtl/acre; finger millet covered 24 acres with an average production of 7.29 qtl/acre; and pigeon pea 4 acres with an average production of 7.8 qtl/acre. Backyard kitchen garden activity was undertaken by 33 households. Brinjal, broad bean, runner bean, cowpea, annual moringa, orange flesh sweet potato and okra were some of the vegetables cultivated. In the rabi season, 34 farmers cultivated green gram and black gram. Average production of green gram from the 16.5 acres cultivated was 3.75 qtl/acre; in the case of black gram cultivated over 14.5 acres, the average yield was 4.1 qtl/acre.

***Landless families and group activities*:** Under this component, 32 farmer groups were engaged in mushroom cultivation activities. Nearly 32000 beds were formed and approximately 9600 kg of mushroom

were harvested by the end of March 2019. In addition, 900 poultry chicks of Khadaknath variety were distributed to 32 identified groups comprising of 10–12 members each. Farmer groups were also identified for 'value-addition' activities. Under vermicompost promotion, 21 pits were prepared with active participation of farmers.

***Trainings and exposure visits on good agricultural practices*:** Five training cum field demonstration programmes on aquaculture were conducted involving 110 farmers. Four training programmes were organized on seed treatment on pigeon pea (local variety), vegetables and finger millet at field level involving 87 farmers. In addition, four training programmes on package of practices and integrated pest management (various traps and other biological methods) were conducted at the centre in which 93 farmers participated. Under the project, an intra-block exposure visit was conducted to Bhejaguda village in Boipariguda block. Another exposure visit to a finger millet field in Dumuriguda village was organized; 45 farmers from different villages participated and observed the best practices. One interstate exposure visit of Boipariguda and Kundra poultry farmers was organized to the government poultry farm in Jagadalapur, Chhattisgarh.

202.5 Sustainable Livelihood Enhancement through Empowering Tribal Women

The project is being implemented in Machhara, Mendhaguda, Chapper, Padheiguda and Bogeipadar villages in Koraput block of Koraput district. Women from around 660 tribal households in these five villages are being covered under the project whose objective is to empower them through enhancement of sustainable livelihoods.

***Improved agronomic practices to enhance productivity in millets and paddy*:** SMI trials were conducted during kharif 2018 in all five villages. A total of 51 farmers were involved in cultivation of 33.75 acres using improved agronomy practices following training on SMI and LT. In addition, for comparison, 16 trials were conducted following farmers' practices of broadcasting using the same landraces. Significant yield difference was observed between the practices. The SMI method yielded 1.58 tonnes/ha, followed by1.46 tonnes/ha under LT and 0.90 tonnes/ha under broadcasting.

Paddy trials using four improved varieties and one local variety were conducted in 12 different fields of 10 farmers covering an area of 10.30 acres through SRI and LT methods along with farmers' practice for comparison. The project team provided training and demonstrated how to operate the cono weedier and cycle weedier. Crop-cutting experiment was conducted by marking a plot of 25 sq. m. Biometric observations were recorded in 45 demo fields and 16 traditional practice fields. A total of 305 samples and 10 parameters were documented. Paddy cultivated using the SRI method showed slightly higher yield of 2.5 tonnes/ha compared to 2.04 tonnes/ha in the case of LT. The trials demonstrated that the

improved agronomy practice has the potential to enhance productivity of the crop and thereby provide additional income to farmers.

***Capacity building (training and exposure visits)*:** Four training programmes on integrated pest and disease management, such as preparation and application of Handikhata, Jeevamruta and Amrutajala, was conducted for 138 farmers (M: 99; F: 39). Exposure visits to various demonstration fields of finger millet were organized for 41 farmers (M: 21; F: 20).

***Millet value chain development*:** An exposure visit to Nuaguda village in Kundra block was arranged with 14 women SHG members for training in millet value addition through peer group learning process in preparation of ragi murukku, ragi laddu and ragi pakoda. The trained group demonstrated the process to 51 other members. After consumption at household level, these women are now also selling in local markets.

***Study of threatened varieties and culinary practices*:** A study was conducted on threatened varieties of millets and paddy. Five-cell analysis of farmer varieties and number of farmers cultivating and extinct varieties indicates that the most threatened varieties of finger millet are Janha mandia, Mardha mandia, Chili mandia and Kaluva. Many finger millet varieties have vanished due to unfavourable edaphic factors and less culinary importance. In case of little millet, Machli suan, San Machli suan, Kalia suan, Khara suan, Barang suan and Lelabaria suan are the threatened varieties. In case of paddy, Sundri dhan, Lachei dhan, Ranglachei dhan and san Sapur dhan are threatened varieties in these villages.

***Current culinary practices in millet*:** Households across all the villages were found to be preparing and consuming 12 traditional dishes. Out of these, 11 are frequently preferred, but 6 dishes, namely Peja (millet porridge), Mandiaanda (ragi upma), Mandru (sweet dumpling), Pitha (cake), Landa (liquor) and Mecha (ragi balls), have priority. Women spend 2 hr on average for processing 3 kg of finger millet grains. In a household of four members, on average 42 kg of finger millet flour is used per month for which a woman has to spend 28 hr in manual processing. Seven different types of little millet based traditional dishes, such as Bhata, Peja, Bedana, Khiri and Upma, are consumed. It is apparent that irrespective of the village, women spend time in the processing of millets, which is tedious and drudgery driven. The provision of processing equipment and establishing community based management systems especially by women will save time and stop the drudgery leaving them free to pursue other activities.

202.6 Conservation of Biodiversity

Ex situ *conservation of ethno-medicinal plants at Jeypore*: A centre with a botanical garden of medicinal plants used by different tribes is a special attraction for the local communities and students of this region. The garden on campus with nine tribe-wise medicinal plants is conserving 384 ethno-medicinal plants; in addition, there is a paddy conservation plot with 125 landraces, millet

conservation plot with 28 varieties and one wild food garden containing 62 species of wild fruits, leaf and tuber plants of this region. During this year, around 2000 plants of 20 species were propagated and supplied to schools, the Forest Department, NGOs, traditional healers and individual plant lovers. In addition, around 4000 saplings of different horticulture species like papaya and drumstick were also propagated and supplied to project operational villages for planting in household nutrition gardens. Under various projects, 250 bottles of the bio-fungicide '*Trichoderma viride'* were prepared and supplied to the farming communities.

***People's biodiversity register*:** Preparation of people's biodiversity registers (PBRs) was undertaken with support from Odisha Biodiversity Board (OBB) and Biodiversity Management Committees (BMCs) were formed in 32 GPs with 224 members covering 160 villages from Boipariguda, Jeypore and Kundra blocks of Koraput district. Moreover, 55 local rice varieties, 12 millet landraces, 16 tubers, 22 wild flowers, 32 wild fruits, 5 fumigating and chewing plants, 26 wild animals, 16 bird species, 19 fishes and 21 insects were documented. A one-day capacity-building training programme was organized at the TAbC for 77 members of 14 BMCs. To sensitize students of classes 9 and 10 on the importance of biodiversity, an essay competition on 'Contribution of Forest Food to the Health, Livelihood and Economy of the People of Odisha' was organized on 8 May 2019. A total of 17 children from five schools of Kundra and Boipariguda blocks participated.

202.7 Grassroots Institution

Panchabati Grama Unnayan Samiti (PGUS), a grassroots institution (GRI) formed in February 2003, is working in 16 villages covering 1086 households. During the year, 82 varieties of paddy landraces and 12 varieties of millets were conserved in 8 villages. Around 200 backyard gardens with minimum support of seeds were promoted among farm families in 12 villages. One training programme on vegetable cultivation and paddy cultivation was conducted. Mrs. Kamala Pujari, a key member of PGUS, was awarded the Padma Shri by the government of India for her outstanding contribution in the field of conservation of rice landraces.

Sub Programme Area 203

Community Agrobiodiversity Centre (CAbC), Wayanad

Activities at the centre can be categorized under three heads: (1) biodiversity conservation, (2) education and capacity building and (3) food and nutrition security.

203.1 Biodiversity Conservation

Conservation programmes give thrust to documentation and conservation of important plant genetic resources of food, medicinal and economic value. The CAbC continued its work on the conservation and sustainable use of medicinal plants, tubers, rice, vegetables and native spices such as pepper and ginger.

***Medicinal and aromatic rice initiative*:** Seed purification process for ensuring the quality

of seeds has been progressing by combining both traditional knowledge of farmers and scientific knowledge. In this process, the healthy panicles selected with the help of farmers were cultivated in Athikolli village (Thondi and Chenthadi varieties), Paramoola village (Gandakasala and Chenellu varieties) and Puthurvayal village (Adukkan and Veliyan varieties) for producing purified seeds. The floods in August 2018 severely affected paddy cultivation in all the villages. In Athikolli, the fields were completely flooded and the seed purification process badly affected. In Paramoola, only 2 kg of purified Gandakasala seeds were obtained, and in Puthurvayal, 5 kg each of purified Adukkan and Veliyan seeds were produced.

A participatory trial using SRI and farmers' practices was laid in the rice plot of Karani village to compare the yields of Adukkan and Chenellu varieties. This initial trial projected that SRI was found to be effective on Chenellu with over 10 per cent increase in yield compared to farmers' practice. The trial will be continued for the next two seasons. A total of 422.7 kg of seeds of eight traditional paddy varieties (Adukkan, Chenellu, Chenthadi, Gandhakasala, Jeerakasala, Kalladiaryan, Mullankaima and Thondi) were distributed to 86 farmers during the reporting period. In addition, the seed exchange register maintained in 10 seed villages showed that a total of 3623 kg of traditional rice variety were exchanged by farmers during the year. The seeds exchanged have to be returned by the farmers next year to continue the seed supply chain.

Training on 'System of Rice Intensification' was given to 13 farmers (M: 12; F: 1) from 13 seed villages during November 2018. There has been a huge decrease in the number of farmers involved in traditional paddy cultivation due to low productivity, attack from wild animals and birds as well as due to the unavailability of purified seeds. Unpredictable weather patterns are also posing a threat to the seed village initiative because paddy cultivation as a whole was badly affected by the floods of 2018.

***Community seed festival*:** A three-day Wayanad Community Seed Festival and 'National Seminar on Survived Seeds' was organized at CAbC from 7 to 9 March 2019 and it attracted 263 delegates; 159 farmers (M: 86; F: 73) from different districts in south India exhibited seed materials in 36 stalls. The seminar participants decided to strengthen custodian farmers' network in Wayanad and establish community seed banks across the state with the support of Kerala State Biodiversity Board.

***Promotion of medicinal plants and spices*:** A total of 24500 seedlings of 35 species of prioritized medicinal plants were propagated and distributed to 410 farm households in Wayanad and adjacent districts thereby extending the cultivation to approximately 30 acres as either mono-crop or intercrop. Herbal gardens of medicinal plants were also set up in 13 schools in Wayanad and Malappuram districts. The small-scale herbal production unit – Navachaithanya Herbal Initiative – set up at Pozhuthana panchayat

was sustained by providing necessary training and technical support, including three-phase power supply. The 10 women members were given two orientation sessions and two training sessions on production of herbal tooth powder and other semi-processed drugs such as the powdered form of asparagus and dried gooseberry. Validation of ethno-veterinary practices pertaining to mastitis was done in collaboration with the Department of Pharmacology, Kerala Veterinary and Animal Sciences University. Phytochemical profiling of *Cipadessa baccifera, Hopea parviflora, Celastrus paniculatus* and *Ampelocissus indica* has been taken up with the support of CSIR-NIIST, Thiruvananthapuram.

***Value addition of ginger*:** The ginger value addition unit – Ardrakam Organic Ginger Initiative – run by a women's group at Pulpally, was provided with modified technology for ginger processing. The 10 group members also underwent intensive training of 38 days on production of value-added products, namely, ginger tea cuts, ginger candy, ginger paste, ginger-garlic paste, dried ginger powder and dried ginger slice. The unit processed 200 kg of fresh ginger to produce the different value-added products during the reporting period.

***Ginger and pepper seeds*:** Production of seed material of ginger (9 varieties) and multiplication of mother material for bush pepper (1600 seedlings) were taken up at the centre along with maintaining the existing germplasm of 16 traditional and wild varieties of pepper and 11 varieties of ginger. Efforts were also made to promote production of organic ginger through homestead pot cultivation. During the reporting period, 1200 kg of fresh ginger were produced by two women's groups and four progressive farmers. From this, 350 kg of seed ginger were procured and distributed among the groups for further cultivation.

***M.S. Swaminathan Botanical Garden*:** M.S. Swaminathan Botanical Garden (MSSBG) focuses on conservation, scientific education and recreation to disseminate knowledge on environment and biodiversity to the general public. The garden supports biodiversity conservation of genetic wealth of selected crops through 20 different components such as wild food garden, climbing plants area, aquatic plants area, fernery and orchidarium. It attracted about 10000 visitors during the year through diverse activities such as birding to explore avian diversity and monsoon bash, a nocturnal tour to sight frogs and toads during the monsoon season along with a nature trek to know about the birds during the season. Students, researchers and nature enthusiasts from various parts of the country participated in the programme. Customized events on the biodiversity in the garden were also organized for 67 students from 13 different countries.

A strategic plan (2018–25) has been developed for the expansion of MSSBG first sequential phase, the Community Zone with children's garden, Sensory Garden, Butterfly Garden, Amphitheatre and Amenity Centre. A two-day workshop for fund-raising, facilitated by a consultant, Mr. Itty Varugis, was organized in May 2018 to brainstorm on achieving the strategic goals in the stipulated time. A web

page specifically for MSSBG (https://mssbg.mssrf.org/) has been created for knowledge dissemination and outreach and updates of activities. It has a secured donation link with details of the purpose of the project and activities. Major achievements during the year were one new taxa and one new record from India introduced to the scientific world. Our services as consultant have been requested for garden design and landscaping at Kannur University Campus, Mananthawadi, and Karlad Lake, Kalpetta. MSSRF played a vibrant role in 'Mission Clean Wayanad', a post-flood cleaning programme, and the effort has been certified by the government of Kerala.

***RET and conservation of medicinal plants*:** The garden has been equipped with software for updating the inventory of nursery plants and the propagation and distribution of saplings. CAbC has 20000 propagules of 62 species of RET/medicinal plants collected as part of forest exploration study and has distributed more than 15000 seedlings to different conservation sites such as Koottakkavu and Manikavu. MSSBG's conservatory maintains 150 species. A mass planting of RET plants and awareness action programme on annihilation of plastic was conducted as part of 'World Environment Day' celebrations in June 2018. A painting competition on innovative imprints to beat plastic pollution, which saw the participation of 100 students, was also organized.

***Panchayat-level conservation efforts*:** With the support of National Biodiversity Authority, a project for empowering Panchayati Raj Institutions (PRIs) in biodiversity governance was initiated. As part of this initiative, training programmes were conducted for panchayat authorities (78 panchayat members and 6 officials) and participatory resource mapping undertaken to develop strategies and action plans for the conservation of natural and bio-resources at the panchayat level. MSSRF facilitated the initiation of the process of declaring the Heronomy of Panamaram panchayat as Biodiversity Heritage Site (BHS) for encouraging the nesting of migratory birds. Thousands of migratory water birds of 12 species nest every year at this site.

203.2 Education, Communication and Training

Educational activities on biodiversity and climate change are primarily targeted at students. The Centre selected six secondary schools from three taluks of Wayanad district and initiated environmental educational activities with thrust on climate change and its impact.

***Weather portal*:** Three automated weather stations have been established with the support of Kerala State Council for Science, Technology and Environment (KSCSTE) in three different locations in Wayanad. Daily weather data is collected at the stations and is analyzed with the participation of students and teachers on a daily, weekly and monthly basis to discuss the changes in local weather and climate. A web portal has been developed in order to facilitate access to weather data of Wayanad, and data from the three automated

weather stations are uploaded to this portal on a daily basis. The weather portal was launched by Mr. C.K. Saseendran, honourable MLA, Kalpetta, on 22 June 2018.

***Vacation training programme, 2018*:** A state-level residential vacation training programme was organized on 'Biodiversity and Climate Change' from 2 to 11 May 2018 for students who had appeared for their class 10 examination. A total of 23 students from different parts of the state attended the camp. The objective of the programme was to inspire children to choose a science-led career, create awareness and engage them in finding solutions to the environmental problems being faced by our country.

***Child climate volunteer camps*:** A total of 337 students (199 girls and 138 boys) from the six selected schools were enrolled as child climate volunteers. They were given orientation on biodiversity and climate change related topics. Experts in the areas of climate change, biodiversity, environmental science and agriculture handled sessions for them. It is expected that they will disseminate the knowledge among peers.

To understand the cognition of child climate volunteers in aspects related to climate change, its mitigation and adaptation measures, an essay competition for high school students was conducted in two schools – Government Higher Secondary School (GHSS), Perikkalloor, and GHSS, Meppadi – in which 24 students participated. Students from two other schools GHSS, Vythiri, and Sarvajana GHSS, Sulthan Bathery, attended the District Level Biodiversity Congress held at Kalpetta on 5 January 2019 and got first and second prizes respectively. The two schools went on to attend the state-level Kerala Biodiversity Congress held at Brennan College, Thalassery, in the last week of the month. Students from another partner school S.K.M.J. HSS, Kalpetta, participated in project competitions at the state-level seminar on climate change organized by the Directorate of Environment and Climate Change (DoECC) in Meenangadi on 19 January 2019 and secured first prize.

***Carbon neutral Meenangadi*:** MSSRF is a knowledge partner in the Kerala government's initiative on Carbon Neutral Wayanad. With the support of Meenangadi GP, MSSRF formed a research consortium for undertaking research and field-level implementation of carbon neutral activities. The consortium consists of research organizations such as the Centre of Excellence in System Energy and Environment, Government College of Engineering, Kannur, IISc Bangalore, IIT New Delhi and TU-Delft, The Netherlands. The centre is also engaged in the promotion of agro-forestry activities and technical support was extended for nursery raising of native tree species; more than 40000 tree saplings of different species were distributed among farmers. A preliminary survey on energy use pattern and potential of biochar application was undertaken in partnership with Government Engineering College, Kannur. A 'Soil Organic Carbon' map of the GP was also prepared with the support of the students. The map showing soil organic carbon will be helpful to identify locations

where interventions are required. Survey was conducted across the GP to assess the biodiversity status conservation issues pertaining to sacred groves, natural resource management practices and so on. A strategy for conserving existing agrobiodiversity of Meenangadi GP was prepared based on the request of the panchayat BMC.

***Rural innovators meet, 2018*:** The centre in partnership with the KSCSTE organized a state-level rural innovators' meet in May 2018. The event was inaugurated by the honourable chief minister Mr. Pinarayi Vijayan, and more than 200 rural innovators attended the programme and exhibited their innovations. The meet discussed the scope of scaling up potential innovations that can bring positive changes in the quality of life in rural areas.

203.3 Food, Nutrition and Livelihood Interventions

Promotion of home nutrition gardens within an average area of 2 cents, with 29 different varieties of vegetables and fruits in a structured and unstructured manner, covered 420 tribal families. In order to address shortage of seeds of vegetables and tubers, a centralized nursery was established along with community conservation plots for pulses, plantains and tubers. For scaling up of nutrition garden interventions, an MoU was signed with the block-level programme head of Integrated Child Development Services (ICDS) of Kalpetta block to promote nutrition gardens in ICDS centres. The gardens are to be established in 50 selected centres in areas where vulnerability to malnutrition is high.

***Tribal livelihood development projects*:** Five joint liability groups of both men and women with 12–20 members each were formed in Cheeyambam tribal hamlet and linked with Kerala Gramin Bank, Irulam, for vegetable cultivation, collection of wild arrowroot, processing and value addition of wild honey, wild gooseberry, jackfruit and other fruits and vegetables. Processing and marketing of wild honey was started; 298 kg of processed wild honey priced at Rs 700/kg was sold by the Village Planning Committee, from which a return of Rs 48000 accrued to the honey processing group. Twelve tribal farmers from the hamlet were linked to the FPO Wayanad Agri Marketing Producer Company Limited (WAMPCo) promoted by MSSRF. Tribal women's groups participated with 12 value-added products in the exhibition cum sales stall of Wayanad Seed Fest 2019 and earned an income of Rs 30000 from the sale of wild gooseberry.

Forty-four training programmes were conducted with 507 participants (M: 120; F: 387) on value addition of jackfruit, bee keeping, group formation and leadership, as part of skill training and awareness programme. Another 53 training sessions on nutrition awareness, leadership building, livestock management, crop management, medical camp and exposure visits were conducted. A total of 675 participants (M: 258; F: 417) benefited from this training.

During the year, two ponds in Cheeyambam were renovated facilitating farmers to address water shortage in summer. Shallow stream renovation of 1.6 km with 70 m bunds, stream bank protection with reeds and

vetiver and water conservation activities with rain pits for 74 households was completed; compost-making units were constructed for 96 households.

***Sustainable watershed development programme*:** The project team facilitated 30 watershed villages in Wayanad district as Resource Support Organisation for developing Sustainable Development Plan (SDP). The total number of beneficiary families under the SDP was 6200 during the reporting period and the total land area under 30 watersheds was 6440 ha. Two meetings were conducted with the representatives of 30 village watershed committees (VWCs) to integrate nutrition and assess the impact of flood in the watershed intervention areas. Six bi-monthly VWC meetings were conducted for review of ongoing activities such as vegetable cultivation, food processing, crop management, skill development, and physical and financial achievement. Sixty field visits were undertaken for monitoring of sustainable agricultural practices, watershed management, auditing and training.

***Agriculture production enhancement through microbial inputs*:** Activities of the lab were confined to increased production of bio-inputs and tissue culture of banana for disease-free planting materials. Microbial bio-inputs such as *Pseudomonas fluorescence, Trichoderma harzianum, T. viride* and *Beauveria bassiana* were produced for the control of various pests and diseases affecting major crops in the district. Technology for the production of these bio-inputs was transferred to three women's groups each consisting of five members as a microenterprise activity. The women were trained in the production and application of bio-inputs. During the reporting period, 2.5 tonnes of *Trichoderma* spp. and 3 qtl of *Pseudomonas* spp. were produced by them and given to the farmers of the district at a rate of Rs 70/kg.

Two hundred and fifty saplings of three banana varieties (Attunendran, 75; Nadan nendran, 100; and Grand Nain, 75) were raised through micro-propagation in the laboratory and planted in trial plots in Wayanad and Calicut districts for yield trials. Another set of 500 planting materials is being maintained as stock culture and can generate quality planting materials at least numbering 3000. During the year, 2.4 tonnes of mushroom spawn were produced and given to farmers. The mushroom laboratory preserves eight species of the oyster mushroom (*Pleurotus* spp.) for spawn production and supplies to farmers on demand. The most common variety of oyster mushroom cultivated in the district is *Pleurotus florida*.

203.4 GRI Initiatives

The GRIs Seed Care and Wayanad District Tribal Development Action Council (WTDC) promoted by MSSRF focus on conservation of plant genetic resources and address poverty and malnutrition among tribal communities. There are 12 activity groups under WTDC across five different tribal communities in Wayanad working on cultivating diverse traditional food basket items. Thirty-three activity groups have been formed under Seed

Care across the Malabar region to encourage farmers to conserve valuable plant genetic resources. The activities of the GRIs are summarized below:

- Conserved 16 traditional rice varieties through the network of custodian farmers under Seed Care. These rice varieties exhibit multiple traits including tolerance to flood.
- Established a 'Seed Bank' with12 varieties of rice at Thavinjal panchayat in Wayanad district.
- Collected 4 qtl of Kalladiyarayan rice seeds and distributed them among farmers who lost their seeds in the flood.
- Three women groups initiated vegetable farming with native vegetables, such as varieties of cucumber, beans, pumpkin, ash guard, peas and so on. They are marketing vegetables through the outlet of WAMPCo.
- Trained 15 youth (M: 11; F: 4) to undertake flood impact studies and conducted a survey on agrobiodiversity and resilient practices in the post-flood scenario. With the active participation of local youth and PRI representatives, MSSRF conducted a three-month-long intense assessment study on loss of agrobiodiversity due to floods and varieties of crops that withstand floods. The study recorded 425 crop varieties under cultivation during the flood season. Among them, traditional rice varieties such as Veliyan, Adukkan, Kalladiyarayan were found to be the most resilient. Banana, arecanut and pepper in the lower elevation were found most vulnerable, while traditional varieties of pepper in the higher elevation showed resilience.

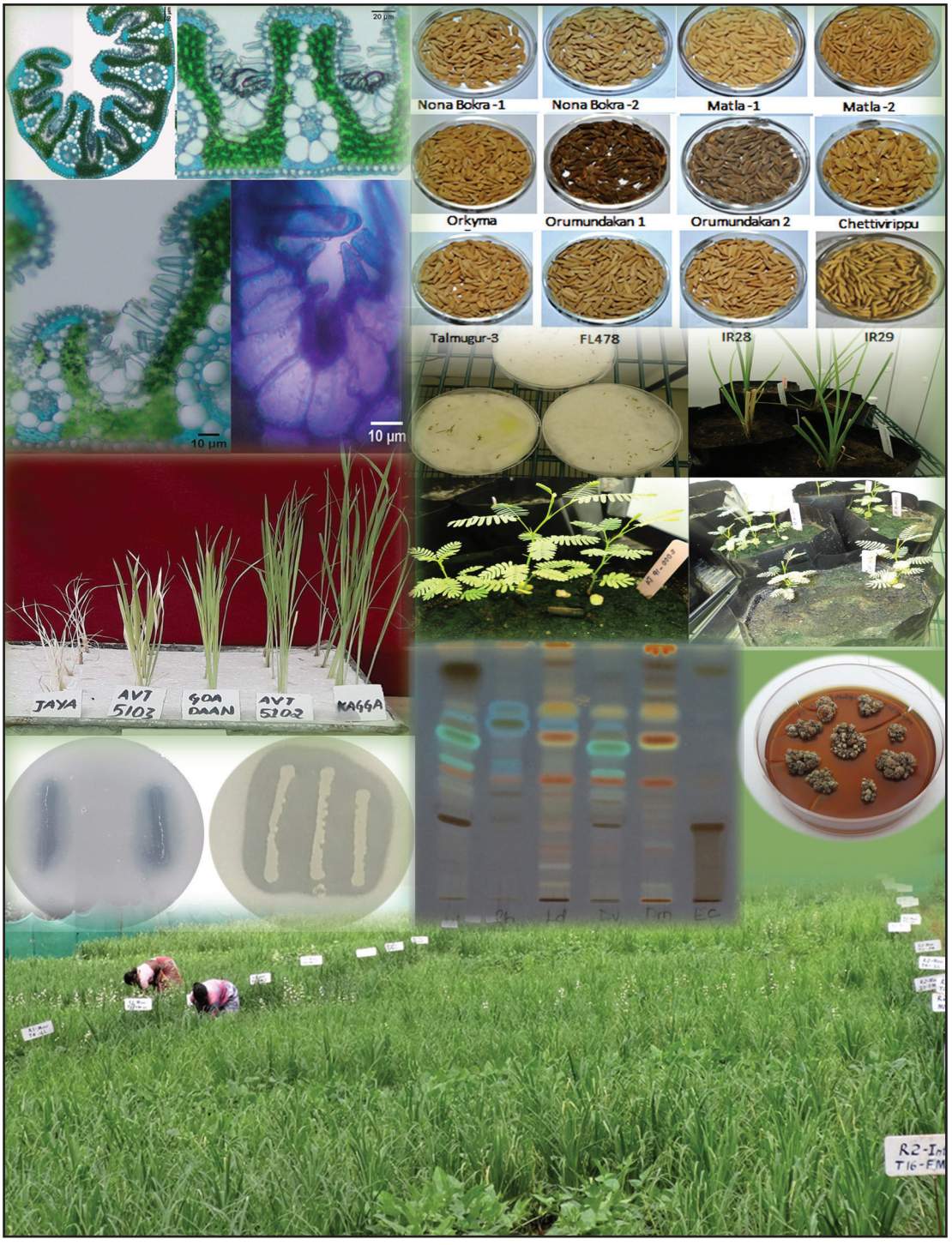
In addition, during the year, WAMPCo FPO was promoted by MSSRF and NABARD with 156 organic farmers as members. The FPO opened an outlet for 'Safe to Eat/Organic Produc' in Kalpetta on 16 July 2018 with support from the Department of Agriculture and Farmer Welfare, government of Kerala, under the scheme 'Safe to Eat Kerala Organic'. Organic products such as rice, coffee, spices, pulses, seasonal vegetables, fruits, honey and other value-added products are being sold. The outlet had an aggregated sales turnover of Rs 3.2 lakhs during the year.

***WADI – Vithura/Thiruvananthapuram*:** Thiruvananthapuram district is a new intervention site of CAbC. A wadi project was launched on 21 November 2018 by the honourable speaker of the government of Kerala in the presence of the chief general manager of NABARD, Kerala regional office, panchayat president and other stakeholders. Five hundred Kanikkar tribal families in Vithura panchayat are to be covered under the project. Seven major *oorukoottam*s or neighbourhood group meetings covering 19 hamlets were conducted for finalizing the beneficiaries and selecting hamlet-level representatives for a Village Planning Committee (VPC). The VPC was formed with 21 members (M: 13; F: 8) from the community for participatory planning and implementation. Fifteen family group meetings were conducted and 15 women's groups formed for micro-enterprise development activity. Seedlings of pepper (6000), clove (2400) and arecanut (2200) and agri-tool kits with five tools were distributed to 500 families as part of orchard development.

Programme Area 300

BIOTECHNOLOGY

The Biotechnology Programme uses modern biotechnology tools to develop salinity stress tolerant and nutritionally rich rice varieties and microbial products for promoting crop yield enhancement, and to isolate novel compounds from lichen species of pharmaceutical importance. Under the sub-theme Genetic Enhancement, special focus was given to elucidating the mechanisms governing salinity tolerance in halophytic wild rice Oryza coarctata *using transcriptomic, cell and molecular biological methods. The sub-theme Bioprospecting established lichen subcultures for the biosynthesis of secondary compounds. The group isolated a lead molecule against* Mycobacterium tuberculosis. *Under the sub-theme Microbial Diversity, the plant rhizospheres were screened for their plant growth promoting properties and potential strains were tested in experimental and on-farm trials to assess their impact on crops. A large number of dimethylsulfoniopropionate (DMSP) bacterial strains were isolated from the mangroves and characterized.*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Sub Programme Area 301

Genetic Enhancement

301.1 Studies Related to Salinity Tolerance in Halophytic Wild Rice *Oryza coarctata*

***Analysis of salt secretory microhairs of* O. coarctata**

Oryza coarctata leaves showed the presence of two types of microhairs in the adaxial leaf surface furrows that secrete salt under salinity: long microhairs (three morphotypes) line the epidermal furrow walls while shorter microhairs arise from bulliform cells and were reported for the first time. An efficient method for the isolation and enrichment of *O. coarctata viable* microhairs has been developed. The robustness of the microhair isolation procedure was confirmed by subsequent viability staining (PI), total RNA isolation and RT-PCR amplification of *O. coarctata* trichome specific *WUSCHEL*-related homeobox 3B (*OcWox3B*) and transporter gene specific cDNA sequences.

The present microhair isolation work from *O. coarctata* paves the way for examining genes involved in ion secretion in this halophytic wild rice model. In addition, an *in vitro* secretory system for *O. coarctata* leaf tissue under salinity was established. Using this, it was shown that increases in leaf secretory volume and Na^+ content in secretions from the adaxial *O. coarctata* leaf surface depend on the concentration of the salt in the medium.

Transcriptomics of* O. coarctata *leaf and root tissues

Oryza coarctata leaf and root tissue specific transcriptomes (RNA-seq) were generated under salinity to identify candidate genes functioning under these conditions. Transcription factors (TFs) in the ethylene biosynthesis pathway are upregulated in *O. coarctata* leaves while those involved in lignification are upregulated in root tissues under salinity. Real-time PCR data showed good correlation with RNA-seq data (correlation coefficient - 0.6991).

Examining suberization of the endodermal barrier in* O. coarctata *roots under salinity

Oryza coarctata root endodermal tissues showed significant suberization and lignification in soil with an electrical conductivity of 0.91 (~25 mM NaCl) in contrast to the saline tolerant landrace *O. sativa* (landrace Pokkali). Roots were examined across their entire cross-section for suberization (confocal/fluorescence microscopy) and lignification (light microscopy) using FluorolYellow088 and phloroglucinol staining respectively. The process of endodermal suberization/lignification is now being examined in hydroponics in freshly emerged *O. coarctata* roots, in the presence or absence of NaCl. In addition, qRT-PCR analysis of genes involved in suberization was completed for *O. coarctata* roots, and three genes showed upregulated profiles under salinity, correlating with root endodermal suberization.

Examining lignification and suberization in the apical nodes and internodes of* O. coarctata *rhizomes under salinity

A clear reversal of lignification and suberization was observed in the first three *O. coarctata* apical nodes/internodes (rhizome tissues) under salinity. This correlates also with downregulation of genes involved in suberization as determined by real-time PCR, suggesting movement of ions under salinity is through apoplastic spaces in rhizome tissues. The cell biological data also correlates with electrophysiological microelectrode ion flux (MIFE) data obtained for *O. coarctata* rhizome tissues by the University of Tasmania (UTAS), Australia, our collaborating partner in the DBT-IABF (Department of Biotechnology, Government of India, Indo-Australian Biotechnology Fund) project. Cellular Na^+ profiles using the sodium specific fluorescent dye CoroNa Green will now be generated for *O. coarctata* rhizomes under salinity.

***Analysis of transporter genes from wild rice* O. coarctata**

Transformation of *O. coarctata* sodium transporter gene *Oc*HKT1;5 in rice is underway (over-expression). Two CRISPR constructs to study the effect of knocking out sodium transporter *OsHKT1*;5 (*Os*HKT1;5-KO) and the outward potassium rectifier genes, *OsGORK* (*Os*GORK-KO), were prepared and transformation into *indica* variety is underway. Twenty-two putative CRISPR *Os*HKT1;5-KO (T_0 generation) derived *indica* transgenic lines have been obtained and are being analyzed by PCR.

301.2 Genetic Diversity of Rice Landraces from Saline Coastal Regions of India

In the previous year, we had genotyped a set of rice landraces from the saline coastal regions of India using simple sequence repeat (SSR) markers. This year, the landraces were assessed for relative tolerance to salinity at the seedling stage and various growth parameters, and shoot/root Na^+ and K^+ content was estimated. Analysis of the data showed (i) significant variations in shoot and root growth parameters, (ii) significant differences in root architecture and (iii) shoot/root Na^+ content that is genotype dependent. Select landraces were also examined for apoplastic barriers (lignification and suberization of exodermal and endodermal regions of the root that contribute to apoplastic bypass flow) through qRT-PCR and microscopic staining methods. The data suggests that differences in sodium uptake correlate with root anatomical plasticity and apoplastic barrier features that differ among genotypes.

301.3 Phenotypic and Molecular Characterization of Saline Tolerant Kagga Paddy

Purified seeds of Kari Kagga and Beli Kagga paddy were multiplied in fields at the Agricultural Research Station, Kumta, Karnataka. Distinctness, uniformity, stability (DUS) characterization was carried out in both the varieties during the kharif season. Varietal performance in saline-affected (12.00 dS/m) fields in Manikatta and Masoor villages of Kumta taluk was assessed. Both the varieties

showed uniformity in the DUS characterization. A cleaved amplified polymorphic sequence (CAPS) marker for the sodium transporter gene HKT1;5 was validated in the Kagga variety. Applications for submission of farmer varietal registration (for both varieties) are under preparation. These applications will be submitted to Protection of Plant Varieties & Farmers' Rights Authority (PPV&FRA), India, through their regional office at the University of Agricultural and Horticultural Sciences (UAHS), Shivamogga.

301.4 Functional Analysis of Five Drought/ Salt Responsive Transcription Factors from the Tree Species *Prosopis juliflora*

Prosopis juliflora, an extremely drought tolerant tree species from the family *Fabaceae*, is an ideal organism for studying plant abiotic stress tolerance. Previously, whole transcriptome profiling of *P. juliflora* leaf and root tissues under both drought and salinity stress had generated a large data set on genes responsive to these abiotic stress conditions (Figure 3.1). This data set was mined to obtain information on genes that are up or down regulated in a specific tissue or its responses to a specific abiotic stress. It will also aid in the identification of specific gene subsets that show changes in expression to either a combination of abiotic stress factors and/or tissues.

Functional validation of five TFs in *P. juliflora* that were found highly responsive to drought or salt stresses in either root or leaf tissues was initiated. Using bioinformatics tools, characterization of the selected TFs was carried out during this period (details shown in Table 3.1). Full-length cDNAs for three TFs were isolated and sequenced. Four reference housekeeping genes for real-time PCR analysis were identified from *P. juliflora*. Real-time PCR validation of selected TF and genes that are highly responsive to drought or salt

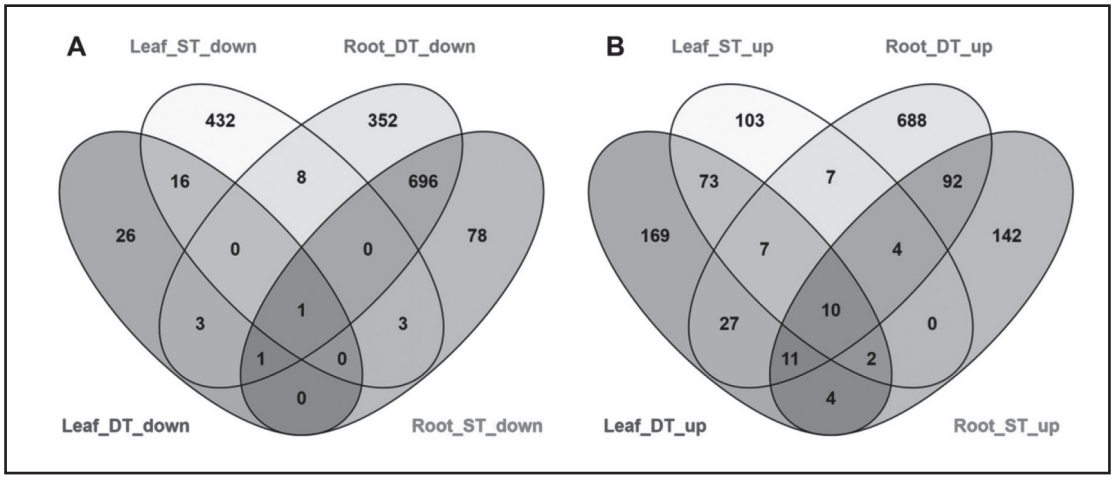


Figure 3.1 Differential gene expression under salt and drought stress in *P. juliflora*: Venn diagram showing the number of common and differentially expressed genes under salt and drought stress in leaf and root tissues. (A) Downregulated genes; (B) upregulated genes; ST: salt stress; DT: drought stress.

Table 3.1 ***List of transcription factors selected for functional validation from the transcriptome of*** *Prosopis juliflora*

S.No	Gene ID	Transcription Factor	Upregulation/Downregulation in *P. juliflora* (LogFC)	Function
1	PJ33881_c0	MYB TF	Highly upregulated (leaves; drought stress); (8.269463518)	Unknown
2	PJ43509_c1	HLH93-like TF	Highly upregulated (leaves;salinity); (8.230037957)	Possible role in differentiation of stomatal guard cells
3	PJ42575_c1	Ethylene-responsive TF 1b-like	Highly upregulated (leaves;salinity); (7.67973749)	Involved in the regulation of gene expression during plant development, and/or mediated by stress factors and by components of stress signal transduction pathways
4	PJ51038_c0	–	Highly upregulated (roots;drought); (11.08538706)	Unknown
5	PJ38658_c0	Ethylene-responsive TF win1-like	Highly upregulated (roots;salinity); (8.044638131)	Promotes cuticle formation, confers drought resistance, transcriptional activation

(Log FC): logarithm fold change in expression.

stress in either root or leaf tissues is underway. Attempts to isolate and characterize promoters of these genes have also been initiated.

The results from this work will further contribute towards understanding molecular mechanisms of abiotic stress tolerance in plants and to identify and recommend candidate genes and promoters for engineering abiotic stress tolerance in crop plants like rice.

Sub Programme Area 302

Bioprospecting

MSSRF, in collaboration with the National Institute for Research in Tuberculosis (NIRT), Chennai, screened lichen compounds with anti-tuberculosis (TB) activity against the TB causing *M. tuberculosis*.

302.1 Bioprospecting of Secondary Compounds

Lichen culture repositories and secondary compound biosynthesis

MSSRF has established mycobiont cultures of *Diorygma junghuhnii*, *Glyphis cicatricosa*, *Graphis caesiella*, *G. lineola*, *G. cf. gracilescens* and *Platygramme caesiopruinosa* for the biosynthesis of secondary compounds. These cultures were grown with different concentrations of sucrose (in modified malt extract [MME] mediums) for the biosynthesis of secondary compounds. The molecular identity of these cultures was confirmed by PCR amplification and sequencing of conserved regions of the mitochondrial small subunit (mtSSU) and nuclear small subunit (nrSSU) rDNA fragments, including the fungal-specific

internally transcribed spacer (ITS) sequences. The molecular identities of these fungi were confirmed by comparing the sequences amplified with available sequence data at the National Centre for Biotechnology Information (NCBI).

Isolation and characterization of secondary compounds from lichen species

Compound MSSRF/UA/01, isolated from *Usnea* spp., was characterized using NMR (nuclear magnetic resonance) experiments (^{13}C, ^{1}H with distortionless enhancement by polarization transfer (DEPT) Imat and IR analysis, in collaboration with IIT, Madras, this year.

Screening of lichen derived compounds against tuberculosis causing bacteria

Twelve lichen compounds (MSSRF/BS/F0, MSSRF/BS/F1, MSSRF/BS/F2, MSSRF/BS/F3, MSSRF/BS/F4, MSSRF/BS/F5, MSSRF/BS/F6, MSSRF/N1, MSSRF/N2, MSSRF/C1, MSSRF/C6 and MSSRF/C7) were screened against *M. tuberculosis* (strain H37Rv) at NIRT this year. Compounds MSSRF/N2 and MSSRF/C6 showed significant minimum inhibitory concentration (MIC) against *M. tuberculosis*.

Meta-barcoding of lichen inhabiting fungal communities: Insights into host selectivity and documentation of seasonal (temporal) changes

Lichens are fungi (mycobiont) that form symbiotic associations either with green algae or with cyanobacteria (photobiont). The resulting thallus lacks protective, assimilative and conductive tissues. The lichen thalli fulfil their water and nutrients requirements by direct absorption from the environment rather than the substrate. During this passive absorption, microbes also enter the lichen thalli, which thus serve as a substrate for other microbes constituting the lichen microbiome. Globally, the lichen microbiome is a current research thrust area since it plays a key role in maintaining the stability of the lichen thallus, is responsible for the persistence and longevity of the lichen symbiosis, and provides protection from biotic and abiotic stress factors (pest, pathogen attack, desiccation and metabolism). The lichen microbiome also contributes to the biosynthesis of both known and novel compounds that have potential pharmaceutical, cosmetic and agrochemical applications.

The microbiome of lichen species *Dermatocarpon miniatum*, *Umbilicaria hirsuta* and *U. pustulata* were analyzed for species diversity and variation in relation to seasons by amplification of inter-transcribed spacer sequences (ITSs) ITS1 and ITS2 (fungal ribosomal DNA) from the collected samples using Illumina paired-end sequencing. This study identified 192 taxon-level operational taxonomic units (OTUs) that showed seasonal variation. In meta-barcoding analysis (study of genetic material recovered directly from environmental samples), an OTU is used to classify groups of closely related individuals. In the above data sets, community composition was similar, with Ascomycota and Basidiomycota representing the most abundant phyla. The data set revealed a

significant shift in OTU composition across four seasons and also a significant degree of host selectivity.

Sub Programme Area 303

Microbial Diversity

In continuation with the previous year's focus on understanding microbe-mediated bio-fertilization and bio-irrigation in a mixed cropping system, three pulse species in combination with finger millet were grown in semiarid regions and tested for overall performance with reduced use of mineral fertilizers. Research on diversity of the dimethylsulfoniopropionate (DMSP) bacterial community of the mangrove ecosystem contributing to the sulfur cycle is continuing. Further, microbe-mediated bio-fortification of iron (Fe) and zinc (Zn) in rice has been initiated.

303.1 Microbial Community Profiling of the Mangrove Ecosystem

The dimethylsulfoniopropionate bacterial community in the mangrove rhizosphere

Marine microbes (including phytoplankton, macroalgae, corals and bacteria) and a few angiosperms produce the anti-stress molecule DMSP. Catabolism of DMSP by marine algae and bacteria generates the climate-active gas dimethylsulfide (DMS), a major source of global organic sulfur. Oxidative products of DMS act as nuclei that promote atmospheric cloud condensation, affecting local and global climate. This study aims to explore DMS-producing bacterial communities found in the Pichavaram mangroves. Using different sources of sulfur as the substrate for enrichment (DMSP, sodium acrylate, DMSO etc.), 520 bacterial isolates were isolated from the rhizospheric soils of mangroves species *Avicennia marina* and *Rhizophora mucronata* and also from mangrove water samples from Pichavaram. In addition, these isolates were screened for the presence of genes involved in DMS production (DMSP lyase genes: *dddP*, *dddD* and *dddL*) and DMSP demethylation (*dmdA*). Five isolates (MSSRFAP3, MSSRFAP4, MSSRFAP5, MSSRFAP6 and MSSRFAP7) show the presence of both *dddP* and *dmdA*, suggesting they possess both DMSP cleavage and demethylation activities. Based on 16S rRNA sequence analysis, isolate MSSRFAP3 was identified as *Roseovarius nubinhibens*, MSSRFAP4, MSSRFAP5 and MSSRFAP6 as *R. mucosus* and MSSRFAP7 as *Roseobacter quallaeciensis*. The identification and characterization of DMS-producing bacterial communities from mangrove ecosystems will enhance our knowledge with regard to biochemical pathways governing catabolism of DMSP resulting in the production of the climate-active gas DMS.

303.2 Bio-fertilization and Bio-irrigation for Sustainable Mixed Cropping of Pulses and Finger Millet

Field experiments were undertaken during the year at Kolli Hills to study the performance of three different legumes, namely, pigeon pea (PP), cowpea (CP) and lablab (LL) intercropped

with finger millet (FM), to identify compatible pulse species to achieve bio-irrigation (a process where under drought conditions, a deep-rooted plant lifts water from the moist bottom soil layers to the dry topsoil along the water potential gradient and the shallow rooted plants benefit) in intercropping and mosaic planting pattern. The field experiment was conducted in Kuttikeripaatty (11°16'36.26"N 78°23'58.58), Valapur Nadu, Kolli Hills. The dimensions of the individual treatment plots (3.6 x 7.2 cm) were designed to accommodate an experimentally defined ratio of pulses to FM. A randomized block design with four replicates was used in the study. The varieties used include Surati Kelvaragu (FM), SA1 (PP), C152 (CP) and SA4(LL). *Pseudomonas* sp. MSSRFD41, *Rhizobium* and *Glomus* sp. were used as bio-fertilizer, as mentioned in the previous year's report. Cropping patterns and bio-fertilizer application details are presented in Table 3.2.

The treatments with bio-fertilizer (T1–T10) showed significant straw and grain yield (PP, CP, LL and FM) under mono-cropping, intercropping and mosaic cropping systems compared to 'chemical fertilizer-only' treatments. For FM, an average grain yield of 1.4 ton/ha was obtained with bio-fertilizer treatments; on the other hand, with 50 per cent recommended dose of fertilizer

Table 3.2 ***Details of cropping patterns and bio-fertilizer treatment used in the field experiment at Kolli Hills***

Treatment	Mono-cropping	Intercropping	Mosaic
RDF with bio-fertilizer	T1 (FM), T2 (PP), T3 (CP), T4 (LL)	T5 (FM+PP), T6 (FM+CP), T7 (FM+LL)	T8 (FM+PP), T9 (FM+CP), T10 (FM+LL)
RDF without bio-fertilizer	T11 (FM), T12 (PP), T13 (CP), T14 (LL)	T15 (FM+PP), T16 (FM+CP), T17 (FM+LL)	T18 (FM+PP), T19 (FM+CP), T20 (FM+LL)

RDF: recommended dose of fertilizer.

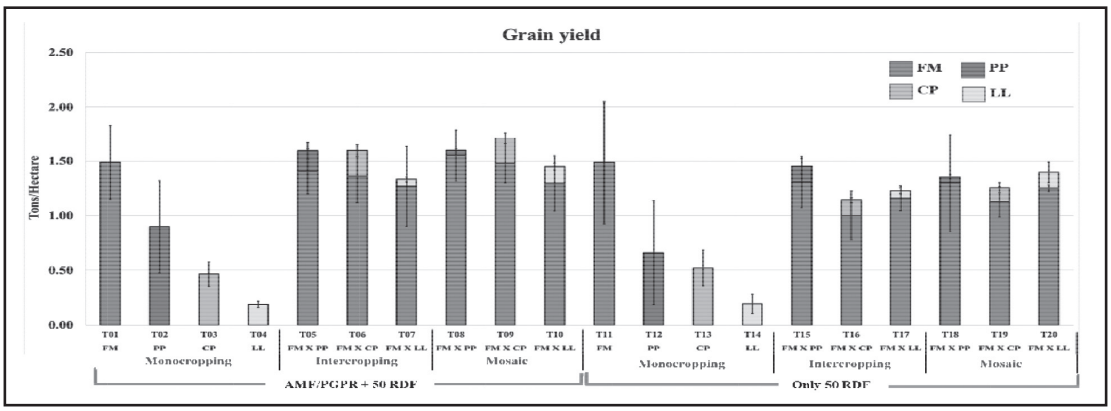


Figure 3.2 Yield data for FM, PP, CP and LL under different cropping patterns and bio-fertilizer treatments (experimental trial at Kolli Hills).

(RDF), an average grain yield of 1.25 ton/ha was obtained. The pod yield of PP, CP and LL was higher under mono-cropping, followed by intercropping and mosaic planting systems. PP–FM intercropping proved to be more compatible compared to CP and LL. The preliminary results of the field experiments indicate that the use of bio-fertilizers significantly enhanced grain yields and reduced the chemical fertilizer application (Figure 3.2).

303.3 Microbe Mediated Bio-fortification of Rice by Enhancing Bioavailability of Iron and Zinc in Soil

Iron (Fe) and Zinc (Zn) are found to be deficient in regular human diet, and this affects more than half of the world's population. Rice, a staple food in many parts of the world, feeds almost 50–58 per cent of the world's population, and meets 13 per cent of the carbohydrate and protein needs of humans, but it is considerably deficient in micronutrients, especially Fe and Zn. Bio-fortification is the process of increasing the concentrations of these essential elements in edible portions of crops. One of the methods of bio-fortifying crops involves use of microbe mediated bio-fortification to enhance the Fe and Zn content.

During this year, three Zn-mobilizing bacterial isolates from rice rhizospheres are being characterized for their systematic position and the Zn-mobilizing mechanism. This pathway-the microbe mediated bio-fortification of Zn content in rice plants, is a simple method to enhance the micronutrient content.

Programme Area 400

ECOTECHNOLOGY

The programme adopts an institutional framework to sustain the developmental interventions on livelihoods and natural resource management initiated through different projects across the field sites. So far, it has promoted six farmer producer organizations and two self-help group federations to support on-farm and off-farm livelihoods among 11200 men and women farmers and agricultural labourers. A research study on exploring the enabling factors for ever-green revolution was initiated during the year with a focus on coastal agriculture. The research study on the gender factor in the political economy of the energy sector was completed and the learnings will be used to develop new research portfolios. The Rice Biopark in Myanmar was inaugurated and a role change process has been initiated by strengthening their capacity to manage individual production units as well as overall organizational management of the biopark. Information education and communication (IEC) interventions were integrated with the Ecotechnology programme and efforts were made to strengthen the nexus between human capital and social, physical, natural and financial capital of livelihoods for better outcomes. A total of 63 public librarians underwent online capacity building on community development as part of the International Network of Emerging Libraries (INELI), and were able to integrate United Nations Sustainable Development Goals (UNSDGs) and their links to state and national priorities through community needs based services.


Regional Public Libraries Conference
Redefining the role of Public Libraries as Knowledge Centres
Sobhana P K
Binoy Mathew
M Kalaiselvi
A Sairam

Sub Programme Area 401

Grassroots Institutions and Sustainable Livelihoods

401.1 Coastal Agro Ecosystem: Mannadipet Region, Puducherry

The initiatives were started within the framework of 'Biovillages for Sustainable Development', in which livelihoods and natural resource management are the key focus areas. Innuyir Grama Sangam (IGS) and Pasumai Farmer Producer Company Ltd. (PAFPCOL) are the two grassroots institutions functioning in this field location. The former concentrates largely on off-farm and non-farm interventions while the latter works on on-farm livelihoods in this region. The institutions are facilitating livelihood capitals such as human, financial, social, natural and physical capitals through subsequent project interventions and linkages with institutions such as National Bank for Agriculture and Rural Development (NABARD), line departments, National Rural Livelihood Mission (NRLM), Krishi Vigyan Kendras (KVKs), veterinary university and formal financial institutions. Similar approaches were adopted in the semiarid agro-ecosystems to nurture sustainable livelihoods.

Innuyir Grama Sangam

IGS works with 3340 women members, organized into 304 self-help groups (SHGs), which is slightly higher than the previous year's membership of 3100. With the support of NABARD and NRLM, IGS organized 3620 trainee days on dairy farming, goatery and forage cultivation. The backward and forward linkages were established for the rearing of improved breeds of Kadaknath and Japanese quail, and this helped to upscale the production by five women's groups. Like in the past year, in collaboration with primary health centres, 480 nutrition gardens were promoted among its members to address malnutrition. The federation has been working independently and has strengthened the systems and processes related to good managerial, organizational, governance and financial practices. MSSRF restricted its role to facilitating new interventions, creating new linkages and monitoring the performance. IGS has successfully demonstrated the pilot testing of 'E-Sakthi' in partnership with NABARD in digitization of the transactions and accounts of the 304 SHGs, to enable the bankers in credit appraisal and linkages, guide the SHGs in accessing wider financial services, and facilitated the convergence of different schemes using Aadhaar linked identity. During the previous year, IGS facilitated Rs 8.16 crores as credit linkage for different livelihood related interventions to 1760 members. To improve the agri-business portfolio, IGS formed the Innuyir Grama Farmer Producer Company in which 524 members were enrolled as shareholders, and they are involved in the cultivation of pulses, groundnut, paddy, dairy and goats. Also, six 'single women' groups from two neighbouring villages joined the collective to improve their access to productive resources and services and entitlements to enhance their lives and livelihoods. The

current strength of the 'single women' groups now stands at 90 with 1094 members from 36 villages. This initiative has helped the State RLM of the Puducherry government to carve out an exclusive scheme to benefit single women's livelihoods.

Pasumai Farmer Producer Company Ltd.

PAFPCOL focused on strengthening the business activities and governance of the institution by reconstituting its board of directors (BoD) and group leaders and expanding its membership. In the past season, the company aggregated 3 tonnes of black gram and 5 tonnes of groundnut and sold at an extended premium price that was 10 per cent higher compared to the rates of the non-shareholding farmers in the villages. They have established an outlet to sell value-added products of debranned black gram dhal, wood-pressed gingelly and groundnut oil, par-boiled rice, cattle feed and groundnut cake under the brand name 'Pasumai'. The company obtained the necessary licenses and certificates to ensure food safety, and the total annual turnover was about Rs 35 lakhs. Ten farmers were involved in seed production of VBN-4 black gram variety in 10 acres of land, which is sufficient to meet the seed requirements for the forthcoming season. In addition, the company extended credit support to 296 farmers to cultivate black gram, groundnut and paddy in 98.4 ha of land. PAFPCOL has developed a market tie-up with Columbia Pacific Communities in Puducherry for marketing the products. The continuous interaction and engagements with the BoD helped to realize role clarity, and they played proactive roles in improving its business turnover and increasing the membership. NABARD has been supporting PAFPCOL for capacitating members in various aspects such as strengthening governance, effective functioning of BoD and business establishment for executive and regular members. PAFPCOL applied for equity grant for 549 members from Small Farmers Agri-business Consortium and for credit guarantee fund by availing credit linkage from Indian Bank.

Assessment of the impact of cyclone Gaja on on-farm livelihoods and restoration strategies

On 16 November 2018, cyclone Gaja caused extensive damage to the lives and livelihoods of farmers in Nagapattinam, Thanjavur, Thiruvarur and Pudukkottai districts. A preliminary field visit was organized to understand the intensity of damage to agriculture immediately after the cyclone and a follow-up visit to study the level of damage on 4 January 2019. Later, based on requests from farmers and the district administration, a two-day travelling workshop was organized between 29 and 30 January 2019 with an interdisciplinary team of nine experts representing agronomy, horticulture, soil science, microbiology and pathology disciplines. A set of restoration strategies categorized into short, medium and long term were developed and shared with the district administration of Thanjavur and Nagapattinam districts.

Also, the storm surge during the heavy wind led to inundation of the fields which are within 1–1.5 km of the sea shore. It caused

apprehension among farmers regarding salinity levels in the fields as well as in farm ponds and their impact on crop productivity in the coming season. Based on their request, soil and water testing was carried out in 138 farmers' fields and 68 farm ponds and open wells in Vedaranyam block. The soil salinity of paddy fields was found to be <4.00 m.mhos/cm and the pH between 6.8 and 8.2; in few farm ponds/wells the electrical conductivity was higher than 7 m.mhos/cm, which is not suitable for irrigation. The results were shared with the farmers in the form of soil health cards and suitability of land for crop cultivation was explained along with the measures needed to use the farm pond water.

401.2 Semiarid Agro Ecosystems: Kannivadi Region, Dindigul District

The initiatives on sustainable agriculture, farmer-to-farmer learning, and eco-enterprises and eco-preneurship continued by institutionalizing the actions with two grassroots institutions: Kulumai Producers' Federation and Reddiyarchatram Sustainable Agriculture Producers' Company Ltd. Subsequent project interventions are being routed through these organizations to ensure sustainability of our work.

Kulumai Producers' Federation

Kulumai Producers' Federation, a community based organization, increased its membership from 3600 to 3800 women farmers during the year. Of this, 72 per cent are landless agricultural labourers and the remaining are small farmers and non-farm labourers. The main goal of the federation is to promote multiple livelihoods among its members by enabling access to productive resources and services through collective actions. In addition, it provides awareness on women's rights, women's health and nutrition-related interventions. Through its community banking services, the federation extended credit support worth Rs 8 lakhs to 33 members for the construction of toilets. Also, it is extending insurance services to 375 senior citizens who could not access any other insurance schemes. Since animal based enterprises are primary on-farm livelihoods in this region, eight animal health camps were organized in collaboration with the local dispensaries to create general awareness among members; nearly 350 cows and 800 goats benefited from this. These camps address priority needs, indicate the areas in which training is needed and support the federation in planning and organizing the programmes.

The federation has been extending support to enable access to productive resources, namely, technology, market, credit, insurance and so on, to strengthen on-farm, off-farm and non-farm livelihoods. Such backward and forward linkages enable women to take up multiple livelihood activities. It has been recognized by NABARD to nurture joint liability groups (JLGs), which have been the base groups for accessing credit from banks in the recent past. During the reporting period, the federation formed 55 new JLGs and access to credit linkage was established with banks. Moreover, 891 members received credit support from banks to the tune of Rs 3.4

crores to initiate livelihood activities related to vegetable/flower farming and vending, milch animal and goat rearing and so on. Also, under the area development programme of NABARD, Kulumai Producers' Federation extended training on clean milk production technologies to 595 members and established three new milk collection centres in partnership with ABT Foods. In addition, it facilitated eight training programmes on first aid services to 30 members and developed capacity to address emergency needs; they now function as para-veterinarians. These members will eventually be enrolled into the Kulumai Milk Producer Company Ltd. (KMPCL) to avail more services.

There was a slight increase in the number of shareholders from 920 to 965 during the reporting period. The annual sales turnover from milk marketing alone is about Rs 2.36 crores, which is 17 per cent higher than in the previous year. The aggregation of milk in the milk collection centres, direct selling to the processing firm and price based on the quality of milk are crucial factors in ensuring sustained market linkage. Apart from marketing support, it has a tie-up with feed mills for good quality animal feed at affordable price. This has helped the producer to reduce the production cost of milk by 10–15 per cent.

Three women's groups are engaged in bio-inputs production such as *Azospirillium*, phosphobacteria, potash mobilizing bacteria, arbuscular mycorrhizae*, Trichoderma viride, Pseudomonas fluorescens, Beauveria bassiana, Paecilomyces lilacinus* and *Bacillus subtilis*. During the past year, they produced 30 tonnes and 2000 litres (*Trichoderma* sp. alone) of bio-inputs worth of Rs 18 lakhs, which generated 1680 employment days, and 4340 farmers used the products in their fields.

Reddiarchatram Sustainable Agriculture Producers' Company Ltd.

Reddiarchatram Sustainable Agriculture Producers' Company Ltd. (RESAPCOL) maintained its shareholder base of 1125 (M: 698; F: 427) as in the previous year. It achieved a significant progress in the sales turnover in input and output marketing from Rs 9 lakh during the past year to Rs 186 lakhs (seed: 20.7 per cent; bio-inputs: 5.0 per cent; biopesticides: 1.8 per cent; output marketing of maize and cotton: 67 per cent; and processing of oil: 5.5 per cent). It supplied cotton seeds covering 1300 acres, maize covering 900 acres and black gram covering 30 acres. Bio-fertilizers, bio-fungicides and pheromone traps were sold to 750 farmers to cover an area of 2350 acres. On the output market side, it aggregated 550 tonnes of maize from 235 farmers and 55 tonnes of cotton from 112 farmers and directly marketed to feed industries and ginning mills. The company has set up a processing unit worth Rs 15 lakhs with oil extraction machinery and flour milling with the support of the Agricultural Engineering Department, government of Tamil Nadu. It organized a training programme on gender mainstreaming for the BoDs, farmer interest group leaders and its staff for 2 days, to enhance its services to women farmers and increase their membership in the company with active participation in company activities. In addition, it facilitated the access to credit

of Rs 24.75 lakhs to its 55 shareholders in partnership with NABARD Financial Services Ltd. to strengthen the on-farm livelihood activities. To further strengthen and upscale the agri-business interventions of RESAPCOL, business plans were prepared with the support of Thiagarajar School of Management and Department of Horticulture, Agriculture College and Research Institute, Madurai.

RESAPCOL has been facilitating horizontal knowledge transfer among farmers using ICT tools, namely, voicemail, website, WhatsApp, Facebook and YouTube. In the reporting period, it developed and disseminated 574 voicemails (agriculture, 320; animal husbandry, 124; entitlement schemes, 25; and corporate literacy on FPO, 105) to 1853 farmers (M: 1368; F: 485). Apart from this, similar to the previous year, 325 contents on agriculture and veterinary topics were shared with the IFFCO Kishan Sanchar network. As part of web based learning through the website www.L3FTN.COM they have uploaded 76 new content pieces in the form of text, audio and video. Use of social media – YouTube and WhatsApp – has picked up; 18 video clips on innovative agricultural technologies, which were fine-tuned to the local context, were shared through YouTube and liked by 12852 viewers. Case stories of the farmers in the form of short write-ups, videos and photographs were shared through Facebook and liked by 67872 users with 20234 friends who mutually shared the information. In the two WhatsApp groups, RESAPCOL shared 176 vegetable market details and 61 weather based advisories to 500 farmers.

Sustainable agricultural technologies

The focus has been on adoption of biological inputs and traps for pest management and drip irrigation technologies for efficient use of available water. A total of 1200 farmers were trained on integrated crop management and application of bio-inputs supported by government departments and other NGOs in the region. Nine farmers with considerable years of experience in using bio-inputs such as growth promoters and insect repellents have now become trainers-cum-entrepreneurs. Similarly, in the area of water management, 3 farmers evolved as local service providers of a simple drip irrigation system at an affordable cost. Efforts have been undertaken in upgrading microbe based biological inputs in the form of capsules and gel formulation, apart from the existing solid and liquid forms, to improve shelf life and field efficacy.

Promotion of local capacity in plant health diagnosis and management

The plant clinic programme has been continued, and it has strengthened the capacities of the 30 plant doctors (M: 22; F: 8) through continuous training, exposure and demonstration of new techniques regarding crop management. At the same time, networks have been nurtured between the plant doctors and the experts. During this year, 670 trainee days were completed for plant doctors and they in turn organized 12 clinics and trained 420 farmers on bio-input preparation and use. Moreover, the 30 plant doctors have adopted their learnings in their field and 2 of them are producing and marketing organic inputs.

Four plant doctors converted their farms in Kannivadi region into organic farms and are producing organic vegetables.

401.3 Semiarid Agro Ecosystems: Iluppur Region, Pudukkottai District

The intervention in the site started with the objective of developing a model for bio-industrial watersheds during 2005–2006 in which promotion of crop enterprises and natural resource management were routed through grassroots institutions and major subsequent intervention of pulses promotion was integrated through the institution.

Iluppur Agriculture Producer Company Ltd.

Iluppur Agriculture Producer Company Ltd. (IAPCL) has 1000 shareholders (M: 278; W: 722), organized into 71 producer groups. It works on the paddy and pulses crop value chains and promotion of dairy and poultry enterprises. The FPO has established contact with 49 buyers for seven different products, green gram and red gram dhal, rice, milk, country chicken, chicks for poultry farming and eggs, that are being sold under the brand 'Patikaadu'. During this period, IAPCL signed an MoA with Tamil Nadu Small Farmers Agri-business Consortium (TNSFAC) worth Rs 60 lakhs as grant to establish a seed processing unit (1 tonne/hour) cum godown with a storage capacity of 500 MTs. Building construction is under progress. An integrated grain processing unit for different pulses, worth Rs 18 lakhs, has also been established with the grant support of TNSFAC and the Department of Agricultural Engineering. So far, in the past seven months, 8.5 tonnes of pulses have been processed using this facility and 299 tonnes of rice processed in a private mill. Under dairy enterprise, 11 milk collection centres are functional, and aggregated milk worth Rs 54.75 lakhs per year was purchased from 286 member farmers (M: 79; W: 207) with a price margin of Rs 3 per litre as compared to nonmembers who sell to private vendors. A mother poultry unit with 172 parent birds was established and operationalized with shed and incubator facility (600 eggs per batch). At the farm level, 19 poultry units are now functional compared to 11 in the past year and the average annual income per unit is about Rs 70000.

The annual turnover was Rs 1.04 crores, and 52 per cent and 39 per cent of the sales were through milk and paddy respectively. The marketing services of the FPO have helped farmers realize premium ranges between 10 and 40 per cent. Four training programmes on financial management of FPOs were organized for 146 agriculture officers of the Department of Agriculture, Tamil Nadu. In total, 159 FPO representatives from various parts of Tamil Nadu interacted with the FPO during the year for cross-learning on the approaches and activities in promoting an FPO. Apart from this, the learnings are being shared with TNSFAC as part of the process of drafting FPO policy for the state.

Land and water management

The fourth phase of agricultural open well restoration was completed in March 2019. A total of 34 farmers renovated their open wells

and installed rain water harvesting structures to collect run-off water around the open wells. By this intervention, 67 farm households gained access to assured water for irrigation, which supports 127.1 acres of land for at least two seasons in a year. The cumulative size of the deepening works in the 34 open wells is 32286 cu. feet, which can store 9.15 cu. m of water in one filling. A third-party impact evaluation was conducted and this indicated that there were positive changes in cropping patterns and systems towards low water requirement crops with two to three crops in a year instead of one, a 65 per cent increase in the adoption of efficient irrigation practices such as use of drip and organic mulches, and 72 per cent increased number of days of work in their own fields due to increase in the number of crops and area under irrigation.

Sustainable farming systems

The water augmentation works were kept as the base for the promotion of the integrated farming system model, which is set to become the successful adaptation strategy to cope with the continuous drought situation in this region. A total of 37 integrated farms have been promoted as model integrated organic farms at the site with various components such as rotational cropping of paddy and pulses, horticulture plantations, intercropping with vegetable and livestock based interventions with dairy animal and poultry. Of the 37 farms, 13 have integrated more than six components, namely, food crops, dairy, horticulture trees and flowers, agro-forestry, goat and poultry, in the farm. Perennial red gram 'Richa 2000' is promoted as border crop and so far 400 farmers received the perennial red gram seeds and dibbled as bund plant. In addition, 7 farmers planted it as pure crop in 10–20 cents of land instead of going for trees like eucalyptus; 16 farmers were involved in paddy seed production (Akshaya – BPT 2231) and produced 26 tonnes, which were procured by the FPO. The demonstration farm 'Patikaadu Integrated Organic Farm' near Iluppur had 3.5 acres under paddy cultivation, 1 acre under pulses, 20 cents under vegetables, 1.5 acres under green fodder and 15 dairy cows and poultry with country chicken birds. The Agriculture Service Centres at Thalinji and Meiyakoundanpatti villages disseminated content through 5380 voice SMSs to farmers on various topics. A total of 17 training programmes on organic farming, integrated farm designing, composting, bio-growth promoters (Panchakavya and Dasakavya), azolla cultivation and pest repellants (fish and plant extracts), forage cultivation and post-harvest processing, supported by the Department of Agriculture under different schemes, were conducted for farmers during the reporting period. A total of 358 members (M: 105; W: 253) were trained.

401.4 Semiarid Agro Ecosystems: Mailam Region, Villupuram District

Similar to the Iluppur field site, the interventions here were initiated during 2005–2006 with an objective of developing a model for bio-industrial watersheds; promotion of crop enterprises and natural resource management under this were routed through

grassroots institutions and subsequently the major intervention on pulses promotion was integrated through the institution.

Nallavur Farmer Producer Company

Nallavur Farmer Producer Company (NAFPCL) has established a value-addition centre (pulse de-stoner with a capacity of 1000 kg/hour, pulse processing machines, pulverizers, groundnut decorticator and two oil extraction machineries with filter) with the support of the Department of Agricultural Engineering. Three value-added social enterprises were started, namely, wood-pressed groundnut and gingelly oil, black gram herbal papad and split black gram and debranned whole dhal. These products were marketed under the brand name 'Mailam Fresh'. Apart from this, it aggregated the black gram, groundnut and moth bean from shareholders and stored them for delayed marketing as whole grains. The value-added products were marketed through Nallavur rural mart and tie-up with few wholesale dealers in Chennai and Puducherry. Also, farmer producer companies and big farmers nearby have availed the services for processing pulses and groundnut. NAFPCL got approval from NABARD for formation of 200 JLGs of which 120 have been formed and so far 50 have been linked with Pallavan Grama Bank and facilitated to avail credit to the tune of Rs 1.25 crores. To ensure timely repayment, 43 special meetings were conducted in farmer producer groups, which improved the repayment rate by upto 80 per cent compared to 58 per cent in the past year. Besides, efforts have been taken by the NAFPCL to establish a resource centre to provide inputs and technical and market services on their own.

Augmentation and efficient use of groundwater

In the Mailam region, almost 85 per cent of the agricultural open wells are now defunct, which led to agriculture areas being fallow. The partially defunct wells were restored to support the small-holders' livelihoods and increase the area under cropping. During the reporting period, 42 individual farmers' wells were restored along with a water recharging system which covered 92.5 acres with assured irrigation. This was integrated with the micro-irrigation systems, that is, rain hose technology, which saves 15–20 per cent water in comparison with other micro-irrigation methods. Therefore, an exposure trip to a best performing FPO in Erode district was arranged for group leaders, executive members and BoDs of NAFPCL. Based on their feedback, 15 farmers from eight panchayats were selected and provided rain hose kits. It is used for cultivating pulses, groundnut, and vegetables and also for floriculture and has helped them use the water efficiently and to increase the area under cultivation by an average of 20–28 per cent.

Sustainable farming systems

Continuous efforts have been made to upscale the pulses and groundnut cultivation. Necessary backward linkages were established with formal financial institutions to access credit through Kisan Credit Card, quality seeds, fertilizers and pesticides for

the shareholders. Technology intervention was fulfilled in a sustainable manner through trained community technical resource persons and with the support of the Department of Agriculture. During this year, 628 acres under black gram and moth bean and 512 acres under groundnut cultivation were promoted in ten villages. A total of 334 farms were brought under the integrated farming systems with integration of crop cultivation and livestock. Plant clinic programmes were organized in four villages to address the problem of pest and disease of groundnut, pulses, floriculture and vegetables, and 96 farmers participated. To ensure the availability of VBN-4 black gram seeds, the FPO has taken efforts to facilitate seed production by 16 farmers in the rabi season with technological intervention. During the past season, 5 tonnes each of black gram and VRI-2 groundnut seeds were procured and stored to meet the needs in the coming season.

401.5 Rice Biopark

The Rice Biopark, built on an area of 0.8 ha as a joint venture of MSSRF and the Department of Agricultural Research, government of Myanmar, has nine enterprises focusing on value addition of different parts of the rice plant. The park was inaugurated by Mr. Ram Nath Kovind, the honourable president of India, on 12 December 2018. Nine master trainers were nominated by the government of Myanmar, and capacity building was done on various aspects of Rice Biopark, including maintaining and managing the modern rice mill, cattle feed block and paper production from paddy straw, production of bio-fertilizers from husk ash, mushroom production using paddy straw, vermicomposting from paddy biomass, spirulina culture and azolla cultivation.

The farmers participated in the training programmes to learn straw processing and production of enriched rice blocks from de-lignified rice straw, rice straw based mushroom production and vermicompost production. Therefore, these items, besides the bio-fertilizer production using rice husk black ash and zero-energy cold storage, have been chosen for replication in the villages located in Nay Pyi Taw Council area with the collaboration of the Department of Agriculture, Department of Agricultural Research and the University of Veterinary Sciences, government of Myanmar.

401.6 New Initiatives

Livelihood enhancement of the small farmers and agro-processing

The Social Development Centre (SDC) of the South Asian Association for Regional Cooperation launched a multi-country project on livelihood enhancement of small-holders through promotion of agro-processing of fruits and vegetables. MSSRF is the country implementation partner for India. The project is for a period of two years, 2018–20. The pilot initiative aims to create rural jobs and promote entrepreneurship at the implementation sites by building new skills, providing access to technologies and establishing value chain models and processes for up scaling. The project is being implemented in Dindigul

district in Tamil Nadu and the Kuttanad region in Kerala. In Dindigul, RESAPCOL is the local FPO partner, and in Kuttanad, the Kudumbashree group at the block level is the local partner. Agricultural products such as coconut and *Garcinia* (*Kodumpuli*) from the Kuttanad region and tomato from Dindigul were identified for agro-processing and value chain development. The potential value-addition technologies for the selected crops were explored and the process of baseline analysis has been initiated in the sites. Simultaneously, mobilization of men and women farmers and base group formation processes have been initiated. A project inception meeting was organized by the SDC and the results framework and work plans have been finalized.

Transforming India's Green Revolution by research and empowerment for sustainable food supply (TIGR2ESS)

A consortium project of Global Challenges Research Fund, UK, TIGR2ESS aims to set the policy agenda for ever-green revolution (EGR) and to develop and strengthen alliances across selected networks of UK and Indian experts to build collaborative, long-term research partnership in sustainable agriculture that will set India on the path to EGR. Out of the six flagship projects (FPs) of TIGR2ESS, MSSRF works on FP1 and FP6. FP1 explores the existing livelihoods of the farmers and the agro-ecosystem and enabling factors and context for an EGR in coastal agro-ecosystems. FP6 aims to study the technology uptake assessment protocols among small-holders. The study sites are Sirkazhi and Thiruvadanai blocks of Nagapattinam and Ramanathapuram districts respectively. Research methodology workshops for both the FPs have been conducted to understand the methodological implication of the research and to evolve the systematic research protocols.

FP1 adopts a qualitative research approach while FP6 follows a participatory action research in partnership with men and women farmers on three innovations in the field. The research protocols for FP1 were field tested at Vanagiri and Yaerampalayam villages of Sirkazhi block among small-holders and agricultural labourers, including youth. It was helpful to modify and finalize the checklist for data collection in consultation with the partner institutions. Concurrently, the team developed detailed site profiles (both block and district levels) and is engaged in literature reviews, explorative field visits and interactions with local stakeholders to select the two study villages in the Sirkazhi block.

For FP6, steps for visual soil structure assessment, ecological engineering and homestead intervention are being taken as these are among the emerging needs of the selected villages. During the village selection visit, the scope of these interventions was analyzed and essential preparation is ongoing in evolving the systematic plan for further intervention. As part of the 'capacity building' process, the team participated in the partners' consultative meetings where they interacted with all FP research teams to mutually explore the scope of research collaboration across

FPs. They also participated in a workshop on R statistical software to strengthen their statistical analysis skills.

Sub Programme Area 402

Climate Change, Energy and Agriculture

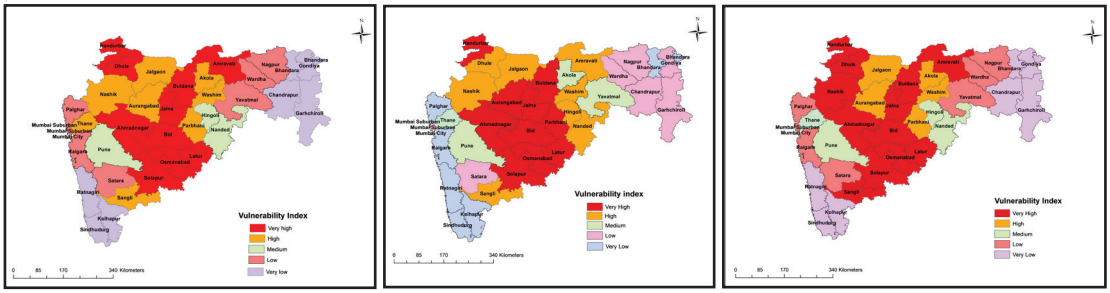
The programme has been involved in the vulnerability assessment of food security and livelihoods to climate change impacts, climate information services and building the adaptive capacities of farmers through appropriate technologies.

402.1 Climate Change Impacts, Vulnerability Assessment: Food Security and Livelihood

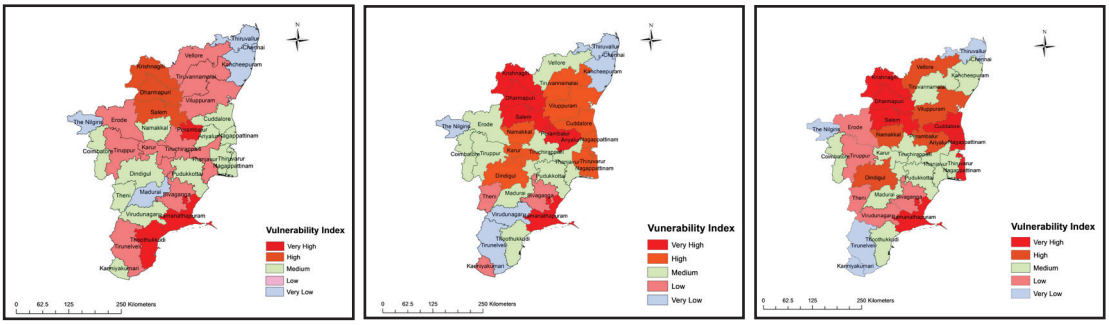
As part of the project 'Climate Change Impacts, Vulnerability and Adaptation: Food Security and Livelihoods in Tamil Nadu and Maharashtra', studies were carried out on the following: (1) the impact of climate change on food production across India at the state level for the periods 1981–2013, 2030s and 2050s, which indicated that climate change overall has a negative effect on food crops. Based on all parameters, rice and maize productivity is expected to decline near mid-century, and the yield loss would be higher by the end of the century. Rice and maize productivity would reduce under both Representative Concentration Pathways 4.5 and 8.5 scenarios with varying magnitudes. (2) With reference to the two states, district-level vulnerability analysis of food production to climate change impacts shows that as the years move on, the vulnerability level increases across the districts (Maps 4.1 and 4.2). (3) At the third stage, district-level vulnerability assessment for livelihoods was carried out using the Hahns Livelihood Vulnerability Indexing (LVI) method, which was developed by considering the International Panel on Climate Change (IPCC) definition of vulnerability to climate impact.

A total of 22 indicators covering socioeconomic, demographic, agricultural and natural resource variables were used. Further, the districts were ranked on the basis of vulnerability index values adopting Shukla's methodology on the extent of vulnerability, which categorized the districts into 'extremely low', 'low', 'medium' and 'high'.

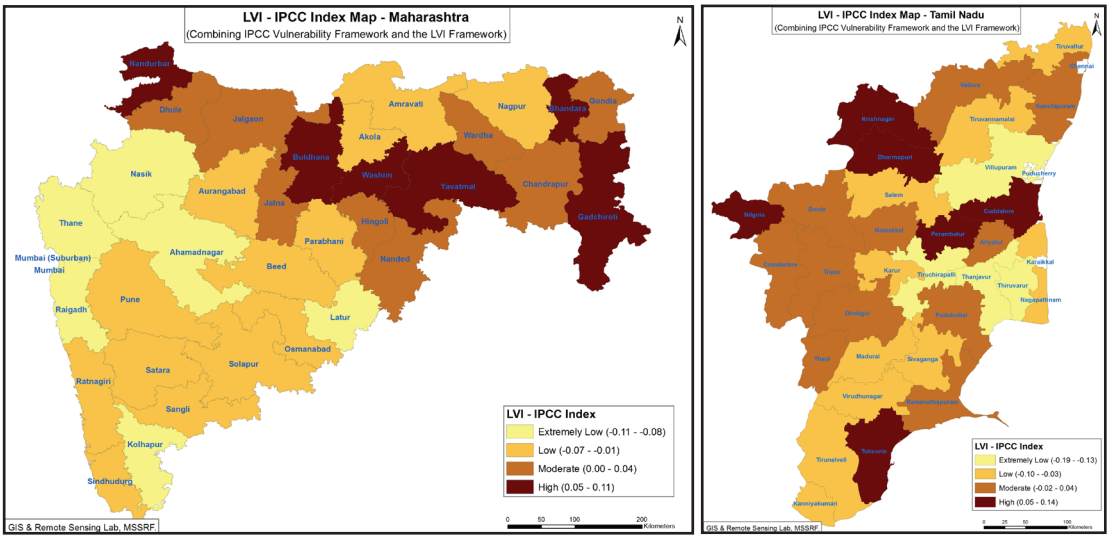
The district-level vulnerability assessment using the LVI-IPCC index takes values from -1 to +1 with -1 being the least vulnerable and +1 the most vulnerable. In the state of Maharashtra, the districts that appear 'extremely low' on the vulnerability scale in the LVI-IPCC method are Thane, Kolhapur, Latur, Nasik, Raigarh and Ahmednagar (Map 4.3). The 'high' category districts are Nandurbar, Gadchiroli, Washim, Yavatmal, Buldhana and Bhandara. The districts that fall in the 'low' category are Sindhudurg, Aurangabad, Pune, Parbhani, Ratnagiri, Sangli, Solapur, Akola, Osmanabad, Satara, Amravati, Beed and Nagpur. Those that fall in the 'moderately' vulnerable category are Dhule, Jalgaon, Jalna, Wardha, Hingoli, Chandrapur, Gondia and Nanded.



Map 4.1 Vulnerability of agriculture in Maharashtra, 1981–2013, 2030s and 2050s.



Map 4.2 Vulnerability of agriculture in Tamil Nadu, 1981–2013, 2030s and 2050s.



Map 4.3 LVI-IPCC index for Maharashtra and Tamil Nadu.

In Tamil Nadu, the districts that appear 'extremely low' on the vulnerability scale are Tiruvarur, Villupuram, Tiruchirappalli and Thanjavur. The 'high' category districts are Nilgiris, Cuddalore, Perambalur, Thoothukkudi, Dharmapuri and Krishnagiri. The districts that fall in the 'low' category are Madurai, Kanniyakumari, Karur, Nagapattinam, Tiruvallur, Virudhanagar, Tirunelveli, Tiruvanmalai, Salem and Sivaganga. The districts that are 'moderately' vulnerable are Ariyalur, Coimbatore, Tiruppur, Dindigul, Erode, Ramanathapuram, Kancheepuram, Pudukottai, Theni, Vellore and Namakkal.

At the fourth stage, by combining the current level of vulnerability to livelihoods as well as projected level of vulnerability of agriculture to climate change, potential adaptation strategies were evolved taking into account different schemes introduced under the National Action Plan on Climate Change.

402.2 Climate Information Services

Agro-advisories based on the medium-range weather forecast have been provided to farmers in six districts (Dindigul, Madurai, Pudukkottai, Ramanathapuram, Sivagangai and Theni) in the southern agro-ecological zone of Tamil Nadu. During the year 2018–19, 624 medium-range weather forecast based agro-advisory bulletins were developed in the regional language (Tamil) as well as in English and issued to the six districts. The advisories were further disseminated using diverse ICT tools: IMD web portal, SMS, audio advisories and voice mails. During the reporting period, 2829495 SMS on important agro-advisories were sent to 862310 men and women farmers of six neighbouring districts on every Tuesday and Friday through the mKisan Portal and voice mails to 1092 male farmers and 536 female farmers. Around 825 audio advisory contents on weather forecast, agriculture, horticulture, soil water conservation and animal health care were developed and disseminated. In addition, to increase the uptake of the information, 10 farmer awareness programmes in Reddiarchathram and Oddanchathram blocks of Dindigul district were carried out in which 527 farmers (M: 461; F: 66) participated. To mutually share the field experiences, issues, extreme weather events and successful moments in agriculture and other natural resources management based activities, six separate WhatsApp social media groups were created with the men and women farmers and members of farmers' collectives of the respective districts and agriculture and livestock experts as members. This platform is being operated to disseminate weather-related information and agro-advisories in the regional language. Farmers are actively participating in this group and exchanging their knowledge.

402.3 Enhancing Adaptive Capacity of the Farmers: Nurturing Climate Risk Managers

To enhance the knowledge of climate information services as well as strengthen the adaptive capacity of the women farmers, a cadre of climate risk managers (CRMs) was promoted. Towards this aim, a stakeholders' meeting with 15 FPOs from six neighbouring

districts and two consultative workshops with the heads and representatives of farmers' organizations were carried out to reiterate the need to have such services at the farmers' collective level. Thirty women farmers were identified from six districts of the south agro climate zone and oriented on their roles in disseminating climate information services. A capacity-building programme for the identified CRMs was organized to enhance their knowledge on adaptive capacity to address the challenges of climate variability and change in their respective locations. In turn these trainees have planned to train 100 women farmers each in their villages/blocks on using the climate information and agro-advisories for their agricultural activities.

402.4 Resilience

The project 'Building Climate Resilience of Indian Small-Holders through Sustainable Intensification and Agro-Ecological Farming Systems to Strengthen Food and Nutrition Security' was initiated in October 2018. The overall goal is to improve agricultural productivity, adaptive capacity and livelihoods of small-holder farmers by building resilience and value chains, in the states of Odisha and Assam. It is a multi-partner consortium project with five partner organizations, namely, Assam Agricultural University, Odisha University of Agriculture and Technology, National Rice Research Institute, International Water Management Institute and Norwegian Institute for Bioeconomy. The Foundation is the lead for gender mainstreaming, capacity building and knowledge management. The inception workshop was organized in Assam and the work plan has been finalized with detailed subtasks. A gender analysis framework was developed and training was organized for the field team to carry out gender assessment in the field. Technical guidance to integrate a gender dimension in the baseline assessment was ensured. As part of knowledge management, five village knowledge centres (VKCs) have been established – two in Odisha (one each in Ganjam and Cuttack districts) and three in Assam (one in Sibsagar and two in Golaghat district); these VKCs are virtually connected to the remaining 14 project villages in the respective field sites. The centres are run by knowledge workers from the local areas, selected and trained for this purpose. A VKC management committee comprising members from the farming community and the local agencies, including KVKs, panchayats, extension and agriculture department and so on, oversee the functioning of the VKCs, and ensure that all farmers get access to the knowledge and services provided, including the training. Need assessment was carried out extensively in all the field sites across diverse sections of the community using participatory tools. Based on the prioritized needs, content creation process and knowledge management portal have been initiated in both states. In each of the field sites, 30 men and women farmers were selected as champion farmers to demonstrate the identified climate smart technologies and lead farmers' field schools to share the knowledge with fellow farmers.

402.5 The Gender Factor in Political Economy of Energy Sector Dynamics

Analyzing the data and writing the final report was the main focus under this project during the reporting period. A series of consultations were held among the team members to synthesize the results of the analysis. The report underwent peer review for quality, by other team members and members of the Technical Advisory Group of the programme. A final programme workshop was organized at Rwanda in October 2018, where the results were presented and feedback from other research programmes was incorporated. As an outcome of the programme's cooperation with Research Area 2 on women managed enterprises in South Africa, a collaborative research paper was developed and submitted to a peer-reviewed journal. A results sharing workshop was organized at the end to disseminate the key findings of the research and the final report has been published by ENERGIA, the Netherlands. The publication of a book covering the different subthemes of the research as separate chapters has been proposed.

Sub Programme Area 403

Jamsetji Tata National Virtual Academy for Rural Prosperity

There are two main components under this: (i) transforming public libraries to life-long knowledge learning centres (LLKLCs) and (ii) village resource centres (VRCs) and VKCs.

403.1 Transforming Public Libraries to LLKLCs

The objectives of the International Network of Emerging Library Innovators (INELI) and Indian Public Library Movement (IPLM) are complementary in enabling the public librarians as community leaders in co-creating the overall objective of repositioning public libraries as LLKLCs, improving access to information and delivering community needs based services.

Online capacity-building programmes

The e-learning courses Cohort 1, Cohort 2 (INELI India) and Cohort 3 (INELI South Asia) were tailored to strengthen the abilities of 43 (M: 29; F: 14) public librarians from India, and 20 (M: 12; F: 8) from eight South Asian countries, as innovative community leaders using the existing moodle platform. Social media such as Facebook and WhatsApp were used extensively to share information among the learners across India and South Asian countries. Thirteen modules were finalized as topics for the online curriculum in the context of building capacities of public librarians.

The key highlights were 20 South Asian INELI innovators from Afghanistan, Bangladesh, Pakistan, Myanmar, Nepal, India, Sri Lanka and Maldives virtually connected through video conferencing in the First International Virtual Convening of Cohort 3 on 20 March 2019 at Chennai. The participants became aware of the INELI programme, were introduced to the mentors and oriented on online curriculum and the Massive Open Online Courses platform.

As an outcome of online training, two INELI innovators facilitated a one-day leadership training workshop for 20 other non-INELI public librarians and 4 INELI innovators, and 4 mentors were selected as trustees of the Indian Public Library Movement. The 20 public librarians who underwent Cohort 2 had participated in the Second International Convening on Building SMART and Resilient Societies during 11–15 November 2018 at Singapore and exchanged their knowledge and experiences. They became aware of the concept of community-owned libraries, evolving sustaining models, developing in-house services using ICTs to the community, engaging excluded sections of the community in library service deliverance, strengthening stakeholder engagement in delivering needs based services through libraries and the potential to adopt a decentralized system through a hub-and-spokes model. Communication materials were produced and shared with key stakeholders in public library field (photos/web content and two videos with INELI innovators' voices and all speeches of Convening II of the Cohort). The INELI Regional Network Vision document was evolved to sustain the INELI cohorts as a network of emerging trailblazers in India and South Asia.

Life-long knowledge learning centres

In line with the Grameen Gyan Abhiyan's goal of establishing 'Every Village a Knowledge Centre', the INELI and IPLM projects span this concept as 'Every Public Library as LLKLC' in India. MSSRF is among the first implementation partners of the IPLM. The implementation was enhanced through synergy of INELI India innovators. This approach allowed the learnings from the online curriculum to be directly applied in the field of community development across 13 state, 13 district, 16 branch and 8 rural and community libraries. The key outcomes were:

- Knowledge exchange convening showcased the role of government in building strong partnership models through line departments in association with the State Central library of Goa. A total of 40 (M: 32; F: 8) and 12 (M: 5; F: 7) library innovators from Tamil Nadu and six northern states respectively became aware of the need to strengthen community needs based services and were introduced to early literacy programmes.

- A total of 104 (M: 83; F: 21) library innovators from seven states of India have registered with the National Digital Library of India portal and in association with Pratham Books are accessing the digital information to meet their information needs.

- A total of 22 library innovators (M: 15; F: 7) from eight states in India were recognized for the leadership capabilities for various services by the government department and the local institutions.

- The first Regional Public Libraries Conference in South India (Kerala, Tamil Nadu, Lakshadweep, Andaman Nicobar, Goa and Telangana), in partnership with the Department of Public Libraries, government of Tamil Nadu, NASSCOM Foundation, IPLM, Kerala Educational Development and Employment Society and Digital Empowerment Foundation,

was conducted and it submitted the outcomes of the conference, along with seven policy recommendations on improving the services of public libraries, to the Department of Public Libraries, government of Tamil Nadu.

- A public library app – Connecting Communities – was developed with the aim of providing access to localized community services (users and nonusers) through public libraries. This has been piloted in 25 public libraries in Tamil Nadu.

- Outreach services were provided for diverse target groups, including kids, school students, youth, senior citizens, marginalized, differently abled, farmers, jail inmates, ex-service army personnel and transgender, and early literacy to toddlers, children, men and women. They involved 85551 people (F: 37717; M: 47834) classified under nine thematic areas: agriculture, education, health and nutrition, disaster relief, employment opportunity, culture & heritage, personal development, pro-nature fisheries, micro-enterprises, women empowerment and civic services.

ICT based knowledge services showcased interventions in public libraries

A total of 15 plant clinic programmes were conducted in three public libraries (Erode, Pudukkottai and Thirukovilour) of Tamil Nadu in which 182 (M: 157; F: 25) farmers participated. Of these farmers, 10 per cent have mitigated crop loss by following control measures. Similarly, a soil health awareness programme was organized in which 200 farmers from eight villages in and around Thiruvannamalai and Thirukovilour public libraries of Tamil Nadu participated. Tele-health services were extended in partnership with Apollo Hospitals and they reached 1786 people (M: 684; F: 1102) through 14 public libraries and 5 VKCs and VRCs. The specialist/expert doctors from Apollo Hospital extended tele-education and consultations in varied topics such as urinary tract infections, anemia, depression, dementia, tuberculosis and women's health and empowerment. These programmes brought awareness on the abovementioned topics and the open forums allowed the participants to enquire on the control measures, symptoms identification, preventive and simple home-based remedies to support their nutritive, physical and mental well-being. In addition, 4 public libraries in Tamil Nadu (Thiruvannamalai, Thirukovilour, Erode, Villupuram) started providing audio agro-advisories to farmers as voice mails, as a test case; 214 farmers have enrolled and are receiving the information.

403.2 Village Resource Centres and Village Knowledge Centres

Modern ICTs are important tools to disseminate demand-driven and value-added information to undertake informed decisions, facilitate learning and knowledge sharing on sustainable production intensification technologies and expand farmers' networks. The IEC initiatives have been using multipronged communication tools, namely, voice/text SMS, phone-in programmes, helpline services, audio-video conferencing, videos, plant clinics and apps for picture based advisories, social media –

WhatsApp and You Tube and imat websites. Currently, there are 3 VRCs and 15 VKCs with a physical set-up and 165 villages are virtually connected through ICT tools, especially mobile telephony. The efforts covered aspects ranging from advisories on agriculture and animal husbandry, health, education and government entitlements and reached 27447 members (M: 15478; F: 11969) (see Table 4.1).

Table 4.1 ***Reach of the VKCs in 2018–19***

Thematic Area	Male	Female	Total
Agriculture	11030	3877	14907
Animal husbandry	507	887	1394
Education	228	462	690
Health	1974	4348	6322
Civic services and govt. entitlement	1739	2395	4134
Overall total	**15478**	**11969**	**27447**

During the year, ICT initiatives were merged with the Ecotechnology programme to mainstream the use of ICTs in agricultural development and farmers' livelihoods. Efforts have been made to integrate the use of ICT tools for technology dissemination with the existing project activities in Puducherry, Villupuram, Iluppur and Kannivadi field sites.

***Plant clinics and picture based advisory system*:** The initiative has continued its activities in Tamil Nadu, Puducherry and Maharashtra. Till date, 25 clinics have been established and its services are reaching 125 villages. During this year, 402 plant clinic sessions were conducted and they diagnosed 5457 samples from 6736 farmers (13 per cent women farmers). In addition, three plant health campaigns and one 'Pest Management Development Guide' workshop were organized to create awareness as well as to validate the content for eight major pests and diseases. The programme has been helpful in enhancing the knowledge of the farmers in distinguishing harmful and beneficial insects and identifying the pest and disease and its damage in various stages of crop growth. The advisories in the plant clinics helped to reduce the use of red-labelled chemicals and increase the use of bio-inputs; they also helped in early diagnosis of the problem and guided them in using the right quantity of pesticides. A study was conducted to assess the benefits of the plant clinics, and this showed that 69 per cent of the farmers followed the recommendations of the plant clinics. Of these, 32 per cent expressed that they have prevented yield loss and 56 per cent stated that they realized higher income of between Rs 4000 and Rs 6000 per acre by adopting these advisories. In partnership with CABI and PEAT Gmbh, the Foundation contributed to strengthening the PLANTIX app, which provides support to farmers in diagnosing pests, diseases and nutrient deficiencies.

***Smart farming*:** At the beginning of the previous year, MSSRF signed an MOU with a Hyderabad based IT start-up, 'Makers Hive', under their smart farming initiative. As part of the initiative, MSSRF works with the organization to address farm issues and enhance farmers' decision-making capacity by using drones and the Internet of Things (IoT) technology. Thiruvaiyaru was chosen as the field site for pilot testing, which is expected to start from the forthcoming crop season.

Recently, the prototype version of artificial intelligence based Automatic Weather Station and a drone which monitors the crop status at regular intervals were tested.

***Soil health management*:** The mobile soil and water testing facility tested 1347 soil samples and 617 water samples and issued soil health cards which helped the respective farmers to adopt integrated nutrient management practices. These soil samples were collected from 1054 farmers, including 401 women, of 206 villages of Tamil Nadu and Puducherry.

***Promoting video-based learning*:** The VRCs are producing videos to promote learning in partnership with Access Agriculture, an international NGO. The themes are identified based on the important issues faced by the farmers. During this year, two videos – 'Managing Mealybugs in Vegetables' and 'Managing Stem and Root Rot in Groundnut' – were produced; two videos on 'Scouting for Fall Army Worms' and 'Killing Fall Army Worms Naturally' were translated into Tamil. The videos were screened at 186 locations and viewed by 6812 farmers, including 2690 women. In the current year, a video on 'Rice Leaf Folder Management' has been proposed as also the preparation of organic inputs, Panchakavya and Dasakavya, for improving growth attributes in vegetables.

***Farm schools*:** The farm school in Thiruvaiyaru facilitated 11 training programmes, and 689 farmers (M: 435; F: 245) learnt advanced agronomic technologies and integrated pest and diseases management measures for paddy and black gram. The farm school in Kannivadi facilitated 12 training events and trained 525 farmers (M: 310; F: 215) on efficient irrigation methods, plant health management and mulching for weed management in vegetables and jasmine cultivation.

Programme Area 500

Agriculture, Nutrition, Health

The Leveraging Agriculture for Nutrition in South Asia (LANSA) research programme formally ended in January 2019. A special issue of Food Policy journal on LANSA research and a LANSA session on Leveraging Agriculture for Nutrition at the Golden Jubilee Conference of the Nutrition Society of India were two key highlights. Advocacy for the Farming system for nutrition (FSN) approach picked up momentum. An MoU was signed with the Odisha University of Agriculture Technology (OUAT), Odisha, and Acharya N.G. Ranga Agricultural University (ANGRAU), Andhra Pradesh, to promote the FSN approach through Krishi Vigyan Kendras (KVKs) in the two states. Work commenced on setting up gardens of nutri-rich plants in four locations across the country.


National Consultation on
Leveraging Agriculture for Nutrition
29th July 2018
ADVOCACY MEETING
NEED AND SCOPE FOR
FARMING SYSTEM FOR NUTRITION IN BIHAR
Sweet Potato Nursery
LANSA

Sub Programme Area 501

Advocacy for Farming System for Nutrition: A Pathway for Addressing Malnutrition in India

MSSRF has been promoting Farming system for nutrition (FSN) as a nutrition-sensitive agricultural approach to address the problem of malnutrition in India. Advocacy of the approach has involved engagement with government officials at national, state and district levels to sensitize them on the importance of and need for mainstreaming the nutrition dimension in agriculture and the scope for undertaking it in ongoing programmes. Workshops to capacitate district-level agriculture officials in the four states of Maharashtra, Odisha, Andhra Pradesh and Bihar and state-level advocacy meetings with officials from agriculture and allied departments, agriculture universities and research institutions in Odisha and Andhra Pradesh were held in May 2018, and have been mentioned in the previous year's annual report. In June 2018, state-level workshops were held in Pune for Maharashtra and in Patna for Bihar. The former was chaired by Mr. Sachindra Pratap Singh, IAS, commissioner, agriculture, government of Maharashtra, and the latter by Mr. Sudhir Kumar, IAS, principal secretary, agriculture, government of Bihar. Following this, a national consultation on leveraging agriculture for nutrition was held at MSSRF, Chennai, on 29 July 2018. The event was inaugurated by Mr. M. Venkaiah Naidu, the honourable vice-president of India. In his inaugural speech, the vice-president emphasized that strengthening agriculture–nutrition linkages can be an important approach in the Indian context where a considerable section of the population continues to be dependent on agriculture for its livelihood. Recommendations on policies for 'Farming System for Nutrition as a Pathway for Addressing Malnutrition in India' based on policy analysis and feedback from state consultations were presented by MSSRF. Dr. Ashok Dalwai, IAS, CEO of the National Rainfed Area Authority, and chairman, Committee on Doubling Farmers' Income, government of India, Mr. R. Balakrishnan, IAS, development commissioner cum additional chief secretary, Planning & Convergence Department, government of Odisha, and Mr. R. Venkatramanan, managing trustee, Tata Trusts, were among the participants in the technical session of the consultation.

***Promotion of the FSN approach through Krishi Vigyan Kendras*:** An MoU was signed with the Acharya N.G. Ranga Agricultural University (ANGRAU), Andhra Pradesh, and the Odisha University of Agriculture and Technology (OUAT), Odisha, for promotion of the FSN approach through KVKs. Each university has identified three KVKs for setting up FSN demonstration model in 2019 during the kharif season, with support from MSSRF. Orientation workshops with representatives from these KVKs and university faculty were held in Lam, Guntur, in January and in Jeypore, Koraput, in February. Building on the approach being recommended by MSSRF, the

Maharashtra Council of Agriculture Education Research (MCAER) has received financial support from UNICEF to promote the FSN approach through KVKs in Maharashtra with technical support from MSSRF. A total of 16 KVKs (4 from each of the four agriculture universities in the state) have been identified in the first phase. A joint workshop was held in Chennai on 20–21 June 2019 to discuss the FSN design and operational plan. The three KVKs under ANGRAU and four KVKs from Maharashtra participated.

***FSN demo plot*:** A demonstration of the FSN approach was setup on 62 cents of land at the MSSRF Regional Centre at Jeypore covering the rabi and pre-summer seasons. A total of 120 farmers (both men and women), officials and staff of the Integrated Tribal Development Agency (ITDA), Rayagada, Malkangiri, Kalahandi and its partner organizations, and NGOs– Centre for Youth and Social Development (CYSD) and Gram Vikas – visited the site during the period October 2018 to March 2019. The visitors were given an orientation on nutrition-sensitive agriculture and the FSN approach.

***Networking*:** MSSRF was invited to conduct sessions on nutrition-sensitive agriculture by the Indian Agriculture Research Institute at a workshop on Extension-Led Nutrition Security in New Delhi in September 2018 and by the National Institute for Rural Development & Panchayati Raj (NIRD&PR) at a workshop on Gender Mainstreaming in Nutrition-Sensitive Agriculture at their regional centre in Guwahati in May 2019.

Sub Programme Area 502

Mahila Kisan Sashaktikaran Pariyojana

The overall goal of the Mahila Kisan Sashaktikaran Pariyojana (MKSP) is improving the socioeconomic status of women farmers by promoting sustainable agricultural practices and livelihood activities, and convergence with extant schemes/entitlements for agriculture, food and nutrition. The project, implemented in vulnerable pockets of Boipariguda and Kundra blocks of Koraput district covered 2552 women farmers over a five-year period ending in December 2018. Most of the women covered are members of 123 self-help groups (SHGs); 1868 women farmers have been organized into 62 producer groups and are engaged in cultivation of vegetables and mushroom, and preparation of six value-added products from finger millet, rice and pulses, such as chakli, mixture, laddu and finger millet flour. The products are sold in the local market. Three cluster-level federations have been formed in Kundra block (Saata Bhauni, Maa Lakshmi and Baba Gupteswar) and one in Boipariguda block (Maa Birakhamba). Jagruti Mahasangh, a consolidated federation with members drawn from the four clusters, has been registered as a farmer producer organization under the Trust Act.

Two social audits of the project were initiated by MSSRF during the current reporting period with participation of the village sarpanch, women members and other community

members. A third-party external evaluation was also done by ASK, an organization with expertise in project evaluation based in Gurugram. Key highlights from the evaluation report are listed below:

***Adoption of sustainable agricultural practices*:** Knowledge of sustainable agricultural practices, comprising pre-cultivation practices, organic seed treatment and nutrient and pest management practices, have been built in the community. Of the 2552 women farmers, 2475 (97 per cent) have adopted one or more sustainable agricultural practices.

***Promotion of kitchen garden for household food and nutrition security*:** To ensure food and nutrition security, structured Annadata kitchen garden models and also basic homestead gardens of fruits and vegetables were promoted. The Annadata model comprises having five to eight varieties of vegetables and perennial trees, such as papaya, drumstick, guava, lemon and amla, that can provide nutritive food to the family throughout the year. These have been adopted and are being practised by 76 per cent of the 2552 women members.

***Access to agricultural schemes and entitlements*:** The majority of the women farmers have received financial support under different government schemes for construction of farm ponds, compost pits and cattle sheds, and for purchase of agricultural implements such as cono weeders, iron ploughs, winnowers and sprayers besides subsidized seeds and incentives for following improved agricultural practices. A total of 1779 women members (70 per cent) have benefited during the project period.

***Access to nutrition and health related government entitlements*:** Children in almost all the member households (95 per cent) have received immunization; 64 per cent of eligible new mothers have availed benefit from the Janani Suraksha Yojana and 60 per cent of adolescent girls received iron tablets and take home ration of fortified premix from Anganwadi workers.

***Drudgery reduction among women farmers*:** Use of drudgery reduction tools such as hand weeders, hand hoes, paddle thrashers and paddy winnowers by women farmers has contributed to some reduction in work hours and in improvement of health, for example, reduction in back pain and body ache. Nearly 56 per cent of the women have access to one or more drudgery reduction tools and the most widely used tools are hand weeders and paddle thrashers.

***Improved social status of women*:** Improved decision-making power at the family level was observed among 71 per cent of the women farmers in terms of education and marriage of children, asset building and healthcare access. A total of 43 women farmers have emerged as model farmers following sustainable agricultural practices.

***Increase in household income*:** Considering income from the primary source, that is, agriculture, secondary sources such as agriculture wage labour and petty business, and additional income-generating activities

such as making value-added products from cereals and pulses and mushroom cultivation, 85 per cent of the women farmers now have an annual household income of more than Rs 18000.

***Recognition of mahila kisans*:** A strong cadre of women farmers as community resource persons (CRPs) at the village level has been created. They are instrumental in spreading knowledge about sustainable agricultural practices, mushroom cultivation, information about government schemes and entitlements related to agriculture, food and nutrition and creating awareness about nutritious food across the region. Most of them are serving as resource persons for government agencies and NGOs. Some of them, for example, Raimati Ghiuria, Rukmani Khillo and Asmati Kaudia, have been recognized as model farmers and awarded by Central University of Orissa, Koraput, Tata Trusts, Mumbai, and ICAR-Indian Institute of Soil and Water Conservation, Sunabeda.

It is expected that based on the capacity strengthening of the women farmers, the momentum generated on sustainable agriculture and food and nutrition security will sustain beyond the project period.

Sub Programme Area 503

Leveraging Agriculture for Nutrition in South Asia

Research under LANSA (Leveraging Agriculture for Nutrition in South Asia) formally ended in June 2018 and the project completion report (PCR) was submitted in September 2018. A few research synthesis and uptake activities continued till the programme formally ended in January 2019. The highlight of the year was a special issue of the journal *Food Policy* based on LANSA research, published in February 2019. The seven papers in the issue contextualize LANSA research on leveraging agriculture for nutrition in South Asia and its contribution to the larger discourse on agriculture–nutrition linkage.

***Research*:** During the reporting period, papers were written based on completed research. One LANSA working paper, two MSSRF research reports and four journal papers were published. Four more journal papers and one research report are in the pipeline. Overall, 17 peer-reviewed journal papers, 12 working papers and a book chapter based on LANSA research in India were published by MSSRF during the period June 2014 to May 2019.

***Research Uptake*:** LANSA hosted a symposium on 'Leveraging Agriculture for Nutrition' at the golden jubilee conference of the Nutrition Society of India (NSI), Hyderabad, in November 2018. The event had over 1000 participants largely from the student and researcher communities; the session gave the audience a flavour of LANSA research evidence generated across the three core research themes of enabling environment of agriculture policy and strategies, pro-nutrition agri-food value chains and nutrition-sensitive agriculture. Two posters based on findings

from the FSN study were presented at the conference and a stall at the exhibition showcased LANSA research in the region.

A regional roundtable event on Women in Agriculture and Nutrition was organized in collaboration with UNWomen in Bangkok on 25 October 2018. The event brought together a diverse group of stakeholders from Bangladesh, India, Nepal, Pakistan and Sri Lanka, including policymakers, representatives from governments, universities and research institutions, international organizations, civil society organizations and grassroots activists. LANSA research in India and Pakistan on women's work in agriculture and the implications for their nutrition was shared along with other research on the theme, and this set the tone for deliberations. A statement of joint recommendations was adopted by the participants to bring transformative change in the lives of women agricultural workers. The Foundation for Agrarian Studies, Bengaluru, partnered with MSSRF to organize an international conference on 'Women's Work in Rural Economies' in Kochi, Kerala, in late 2018. LANSA's cross-cutting work on 'Gendered Time, Seasonality and Nutrition: Insights from Two Indian Districts' was shared at the meet.

Two posters based on the FSN study in India were presented at the annual conference of the Agriculture Nutrition Health (ANH) Academy in Accra, Ghana, in June 2018 and at the NSI conference in November 2018. Evidence from the FSN study was also shared at two workshops: 'Towards Improving Nutrition Outcomes in India' organized by the Indira Gandhi Institute of Development Research (IGIDR), Mumbai, in November 2018, and 'Agriculture and the Imperatives of Food and Nutrition Security' organized by IIT Bombay, Asia Pacific Association of Agricultural Research Institutions (APAARI) and NABARD in Mumbai in early December 2018.

LANSA partnered with the ANH Academy to host a plenary session on agriculture for nutrition and health: evidence-informed policymaking in Africa and Asia at its annual conference in Ghana. The event focused on sharing of research and uptake experiences across continents from donor, researcher and policymaker perspectives. LANSA also co-hosted a communication learning lab on research-to-policy at the ANH Academy conference. It partnered with World Bank's South Asia Food and Nutrition Security Initiative (SAFANSI) at a roundtable event on 'Putting the Lens on the Consumer in Nutrition Sensitive Agriculture and Food Systems in South Asia' in Colombo in June 2018, moderating one of the sessions and sharing insights from LANSA findings on agri-food value chains research in South Asia. These findings were also shared at a workshop on Regional Cooperation and SDGs organized by Research and Information System for Developing Countries (RIS) and UN Economic and Social Commission for Asia and the Pacific (UNESCAP) in New Delhi in October 2018.

LANSA's research uptake strategies to bridge the science–policy interface and thereby influence agriculture policy and practice in South Asia were presented at the 'SDG-Conference: Towards Zero Hunger – Partnerships for Impact' in August 2018 at Wageningen University & Research (WUR), the Netherlands, and at the Global Evidence and Implementation Summit 2018 (GEIS) in October 2018 at Melbourne, Australia. The LANSA website (www.lansasouthasia.org) will be live till September 2019 and papers are being uploaded as they get published.

***Coordination*:** The LANSA project completion report (PCR) preparation exercise was led by MSSRF, and the report was finalized with inputs from all consortium partner leads, and submitted in September 2018. Further responses based on the feedback and report on uptake activities between September and December 2018 were submitted in January 2019, before closure of the programme. An internal participatory 'lessons learnt' exercise was undertaken between June and August 2018. The exercise examined lessons under governance and management, regional dynamics, research design, peer review, research uptake, responsive window grants, community engagement and working in fragile contexts, and the report was submitted with the LANSA-PCR. LANSA country synthesis briefs on each of the four focus countries were produced. Two key issues guide based on evidence from LANSA research were also produced, namely, 'Healthy Diets and Markets' and 'Women, Agriculture and the Nutrition Factor'. These products are available on the LANSA website.

Sub Programme Area 504

Strengthening Livelihood and Enhancing Food and Nutrition Security of Small and Marginal Farmers in Koraput District of Odisha through a Farming System Model

The project builds on the learning from the FSN study under LANSA and was initiated in July 2018. The study area covers all the 39 villages of Mathpada gram panchayat and 8 hamlets in Doraguda gram panchayat under Boipariguda block of Koraput district. The overall objective of the project is to improve the health, nutrition and livelihood status of small and marginal farming communities by ensuring availability of and access to nutrient-rich food in a farming system model. House listing survey in the study area revealed 1575 households; this was followed by detailed baseline survey of 20 per cent sample households covering 315 households, on aspects of both agriculture and nutrition. The data is being analyzed. Village meetings were organized covering the 47 villages with participation of 1046 farmers (M: 533; F: 513) to build rapport with the community before implementation of the project. A meeting with Panchayat Raj Institution (PRI) members was conducted in December 2018 to orient them on the project objectives; 17 PRI members from the project area participated.

***Entry point activities*:** The following activities were undertaken during the reporting period.

- Demonstration of yield enhancement of finger millet with improved seed variety – GPU 67 – and line transplanting instead of traditional farmers' practice of seed broadcasting covered 10 acres and 32 farmers. The average yield was 1130 kg/ha compared to 840 kg/ha using farmers' seed variety and broadcast method.

- Demonstration of crop intensification through pigeon pea intercropping with maize to increase availability of pulses covered 1 acre and 7 farmers. Green pods of pigeon pea and cobs of maize were consumed. The matured pigeon pea is being harvested.

- A total of 14 farmers in two villages were given planting material of beta carotene rich *Kamala Sundari* variety of orange flesh sweet potato (OFSP); this was cultivated on small patches of home garden land ranging from 0.02 acre or 2 cents to 4 cents. They were also made aware that consumption of OFSP would help address vitamin A deficiency. The produce was consumed by the cultivator households and also shared with relatives and other villagers.

- Freshwater fish farming was initiated in four ponds in three villages involving four farmers and stocked in August 2018. Three ponds were of 1000 sq. m size and harvested an average quantity of 34 kg fish per pond. One pond was of 2000 sq. m size and harvested 78 kg fish. The surplus fish, after self-consumption and sharing with relatives and neighbours, was sold at Rs 150/kg within the village.

- During the rabi season, cultivation of black gram and green gram in rice fallows was promoted. A total of 40 farmers from across six villages cultivated green gram under an area of 39 acres and 22 farmers cultivated black gram covering 19 acres. Harvest of the crops is underway.

***Training*:** As part of the capacity building, training programmes were organized on seed treatment with rhizobium culture and soil treatment with phosphobacteria and package of practices for green gram and black gram cultivation and pre-stocking management in fish farming; farmers were also taken on an exposure visit to Banuaguda and Bhejaguda villages in the same block to see demonstration of integrated farming system model. A total of 187 farmers participated in these programmes.

***Plans for kharif 2019*:** One farmer each from six villages has been provided planting material of OFSP to raise a nursery and to multiply planting material for distribution. Community threshing and drying yards of size 35.5 x 35.5 feet have been constructed in five villages; this had come up as a felt need in village meetings. A total of 81 ponds (71 individual ponds and 10 community ponds) across 35 villages have been identified for promotion of fish farming. The average size of a pond is 3000 sq. feet. Finger millet, pigeon pea and maize seed requirement has been assessed through village meetings and the required quantity is being arranged. It is planned to cover about 300 acres under finger millet and 200 acres under maize and pigeon pea intercrop. The National Rice Research

Institute, Cuttack, has provided 10 kg of CR Dhan 310 and 5 kg of CR Dhan 311, both protein bio-fortified paddy seed varieties, for demonstration on farmers' fields.

Sub Programme Area 505

Garden of Nutri-rich Plants

This year, MSSRF initiated the process of establishing genetic gardens of nutrient-rich plants in four districts with high levels of malnutrition, namely, Kanpur Dehat in Uttar Pradesh (UP), Palghar in Maharashtra, Koraput in Odisha, and Tiruvallur in Tamil Nadu (TN). The initiative has been undertaken in collaboration with KVKs and state agricultural universities (SAUs), namely, Chandra Shekhar Azad University of Agriculture and Technology in UP, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth in Maharashtra, Orissa University of Agriculture and Technology in Odisha, and Tamil Nadu Agricultural University in TN.

The basic rationale behind the setting up of the genetic garden of bio-fortified plants is that food-based approaches to address micronutrient deficiencies accompanied by awareness are likely to be more sustainable in the long term. The garden of bio-fortified plants will serve as a one-stop shop for bringing back the 'varietal diversity' into the farms and to fulfil the nutritional requirements of the farmers. It will have different sections with plant collections based on specific micronutrients such as vitamin A, vitamin D, iron and iodine, greenhouses and an interpretation centre. A total of 2000 farm families are to be covered under the project, to enhance their diets through better access to more number of nutritionally rich plant species. The garden of bio-fortified plants will serve as the focal point for promoting food based nutrition security among malnourished rural households by ensuring access, awareness and capacity building.

MSSRF will provide overall guidance for landscaping the garden, collection of nutri-rich plant species for cultivation and promotion, conservation, formation of SHGs among farmers, capacity building and awareness creation and training select men and women to be community hunger fighters (CHFs) and master trainers. The KVKs are responsible for cultivating and maintaining the garden, promoting best practices, imparting training in nursery management and distribution of quality planting materials to farmers. They are also responsible for making the garden a sustainable model with the support of the respective agriculture universities. The SAUs will focus on identifying the nutri-rich plant species and varieties for cultivation and promotion, conservation, providing technical guidance for adding new plants and their propagation, agro-technology development for the cultivation of some nutrient-rich crops, mainstreaming nutrition dimension in the local farming systems and collecting and analyzing data on the role of the garden in eradicating malnutrition.

During the year, the KVKs in the four project sites have identified the sites within the KVK campus for setting up the garden over an area

of 5 acres. The garden in Koraput is being set up in the regional centre of MSSRF at Jeypore. They have also prepared the garden layout and collected 50 species of nutri-rich plants, including unique germplasm such as black carrots, ber apple, five different varieties of annual and perennial moringa, and short-duration red fleshed guava. The crop calendar for round-the-year supply of nutri-rich material has also been prepared. The planting activity in the garden will commence after the onset of monsoon.

Sub Programme Area 506

Monitoring Promotion of Nutrition-Sensitive Fishery

The Foundation has been entrusted with a project by WorldFish, an international, nonprofit research organization and member of CGIAR, for monitoring a three-year USAID funded project being implemented by them on 'Scaling Innovative, Nutrition-Sensitive Fisheries Technologies and Integrated Approaches through Partnerships in Odisha'. The overall goal of the project is to improve food and nutrition security in the state of Odisha through increase in the supply of and access to affordable, safe, nutrient-rich fish and fish products for improved consumption through promotion of small fish in ponds. Social and behaviour change and communication to increase fish and vegetable consumption are also components of the project.

Two blocks each in three districts of Odisha – Balasore (Khaira and Soro blocks), Jagatsinghpur (Jagatsinghpur and Naugaon blocks) and Mayurbhanj (Gopabandhunagar and Khunta blocks) – have been selected for project intervention. About 311 households with backyard fish ponds were identified by WorldFish for promotion of fisheries in the first phase. A random sample of 156 households was selected from the list of 311 households for baseline survey. The survey design and schedules were finalized by MSSRF in consultation with WorldFish and the survey was conducted during December 2018 to January 2019. Data on socioeconomic characteristics, agriculture, home garden and fishery activities, fish management practices, food consumption pattern and nutrition awareness level of the households was collected. Initial results were presented to representatives from WorldFish and USAID in March 2019; the final baseline survey report was submitted in May 2019. Discussion on indicators to monitor during the project period and periodicity of monitoring, based on the activities proposed by WorldFish, is in progress.

Sub Programme Area 507

Education Support Programme

MSSRF had launched its work in the Vidarbha region of Maharashtra in 2006 by providing education support for those children whose parent/parents had committed suicide, for completing their schooling upto the twelfth standard. Over the period from 2006–2007 to 2018–19, the number of orphaned children covered by the programme has come down from 126 to 15 (8 girls and 7 boys). The last set

of children will be completing their high school in 2022. Over the period, many of the girl students who completed the twelfth standard were facilitated to join nursing courses and get assured jobs. Some students have gone on to complete their graduation.

Sub Programme Area 508

Social Science Studies

The Tamil Nadu State Planning Commission has empanelled MSSRF as an agency for policy research and evaluation studies. The Foundation has also entered into an MoU with the International Initiative for Impact Evaluation (3ie), for collaboration in impact evaluation for learning.

508.1 Data Management

MSSRF's management information system (MIS) database relating to community-based interventions as of March 2016, which had been compiled and reported in the previous year's report, was migrated from the external web portal where it was hosted to MSSRF's knowledge management system (KMS). Visualization of the data through infographics was undertaken. The exercise of updating the database as of March 2019 has commenced.

508.2 Research Study for Doubling Farmers' Income

A four-month study on strengthening post-production management and enhancing agri-commodity commercialization to enable farmers to realize higher net farm income was undertaken at the behest of the Committee on Doubling Farmer's Income set up by the Department of Agriculture Cooperation and Farmers' Welfare (DAC&FW), government of India (GoI). MSSRF constituted a research group comprising researchers from ICAR-Central Institute of Fisheries Technology, Tamil Nadu Agricultural University, Indian Institute of Food Processing Technology, IGIDR, Tata Institute of Social Sciences, Indian Institute of Foreign Trade, NIRD&PR and MSSRF to finalize the terms of reference to be addressed under the study. The final report with detailed analysis and recommendations was submitted to the DAC&FW in September 2018.

508.3 Concurrent Evaluation of Implementation of National Food Security Act

The Department of Food and Public Distribution, GoI, engaged MSSRF as the monitoring agency for concurrent evaluation of implementation of National Food Security Act (NFSA) in the union territory (UT) of Puducherry. The NFSA has been implemented in Puducherry since July 2013. The GoI introduced direct benefit transfer (DBT) in public distribution system (PDS) on 21 August 2015 vide the Cash Transfer for Food Subsidy Rules, 2015. Following this, Puducherry implemented the NFSA-DBT from September 2015.

The concurrent evaluation survey was undertaken on a quarterly basis covering one census district (Puducherry, Karaikal, Mahe, Yanam) in each quarter. In each round, the

findings were shared with the district and UT officials for their comments and the final reports submitted to the Department of Food and Public Distribution, GoI.

508.4 Study on Casual Factors Influencing Agriculture Land Use Patterns

A research study on 'Casual Factors Influencing Agricultural Land Use Patterns in Central Tamil Nadu' commenced with support from the State Planning Commission, government of Tamil Nadu. The main objective of the study is to understand causal factors for conversion of agricultural land to non-agriculture use and its impact on food security in Tamil Nadu. The study covers Tiruchirappalli, Pudukkottai and Karur districts, in the central part of Tamil Nadu under the Cauvery delta agro-climatic zone. The districts are representative of areas with assured canal and groundwater irrigation as well as the dry belt in the state.

An analysis of secondary data shows that total cultivable area in Tamil Nadu has declined from 81.61 lakh ha in 1990–91 to 75.50 lakh ha in 2014–15. The proportion of cultivable area to total geographical area has also declined from 62.7 per cent to 57.9 per cent during the same period. Effectively, 6.11 lakh ha of land have moved away from agriculture during the past 25 years, while land under non-agricultural use has increased from 18.35 lakh ha to 21.99 lakh ha during the same period. Designing survey tools and preparation for primary survey to understand the changes is underway.

Communication and Outreach

Library and information services

The library at the M.S. Swaminathan Research Foundation serves the needs of the staff as well as that of scientists and research students from other research and educational institutions.

The library has 18785 books of which 90 were added during the year. In addition, it also has a collection of 585 CDs, 110 journals, 4535 bound journals and 72 newspaper clippings pertaining to 2018–19. Moreover, the library has a collection of technical reports and annual reports from various institutions. A total of 74 MSSRF publications were uploaded during the year in the web based digital repository for public access.

Current Awareness Services (CAS), Selective Dissemination of Information (SDI), Document Delivery, Publication and Distribution Services and Reprographic Services are services offered by the library. The library continued its assistance through Centre for Agriculture and Bioscience International (CABI) to provide full text of research articles to students; around 184 students from national and international universities have benefited from this. Access to electronic databases of India Stat, JSTOR and SAGE are also available for users.

***The Hindu* Media Resource Centre**

The Hindu Media Resource Centre (THMRC) facilitated sharing of information and regular updates through the MSSRF website, monthly e-newsletter and social media platforms, namely, Twitter and Facebook.

The website had 38777 page views during the year with 17682 users. It also served as a contact point for enquiries from media, students, development practitioners, farmers, academics, international agencies and members of the public. In addition to news clippings, social media updates and publications, a total of 62 event and content updates and 32 stories from the field in both English and Tamil were posted on the website during the year. MSSRF's monthly e-newsletter, *e-Synergy*, reached 1705 internal and external stakeholders, including media persons and scientific, academic and student communities.

The MSSRF twitter handle (@mssrf) disseminated information about the Foundation's research work and other general information to the public. The number of followers as of May 2019 was around 3806. Total impressions of 445999 or an average of around 36167 reads every month were recorded on Twitter, with 957 new followers. Prof. M. S. Swaminathan's Twitter handle (@msswaminathan) had 2506200 impressions during the year and 227836 impressions each month for his messages; 6010 new followers got added during the year, taking the number to 33800.

On Facebook, the Foundation had a reach of over 127877 people, with regular posts, campaigns and event updates shared. A total of 6084 people 'liked' the MSSRF Facebook page, and 6132 followers received updates

on a regular basis. At least two live videos of seminars and events are being shared every month on the MSSRF YouTube channel.

***Media outreach*:** More than 351 new stories in newspapers, web editions and television channels featured MSSRF. The stories were covered in many languages, including English, Tamil, Hindi, Bangla and Malayalam. More than 35 press releases were issued to journalists for events, seminars, updates and statements on behalf of the Foundation. Interviews and media coverage were facilitated for various events. Senior staff also participated in exclusive news coverage on 'New Technology for More Productivity of Saline Tolerant Rice Variety – a Boon to the Farmers in the Coastal Areas'.

***Photo-exhibition*:** A photo-exhibition, discussion and social media campaign was organized on #RememberingBorlaug on 25 March 2019, as part of commemorating Borlaug's birth anniversary and his contribution to eradicating hunger and poverty. The event attracted good media coverage and public participation. A blog on the event was published on the World Food Prize Foundation's blog page.

***Capacity building*:** THMRC, in association with the National Biodiversity Authority (NBA), organized a three-day media workshop for journalists at Kakinada, Andhra Pradesh, between 31 May and 2 June 2018. The aim of the workshop was to sensitize journalists on conserving biodiversity as a means to combat climate change. More than 20 journalists from Tamil Nadu, Andhra Pradesh, Odisha, West Bengal, Jharkhand, Chhattisgarh and Puducherry participated in the workshop. Scientists from MSSRF, the NBA and the UNDP GEF (United Nations' Development Programme Global Environment Fund) project briefed journalists about the various aspects of biodiversity conservation.

***Lectures and Seminars*:** THMRC continued to provide media and public outreach support for events across thematic areas. Seminars organized included the subjects of crop insurance, achieving zero hunger, fisheries research, hydroponics, agriculture entrepreneurship, emancipation of small and marginal farmers, climate change adaptation and resilience, and transformative education. Two millennium lectures were organized in February 2019. The first, on 'Building Resilience in the Face of Natural and Socio-economic Shocks' was delivered by Prof Ismail Serageldin, Founding Director of the Bibliotheca Alexandrina, Library of Alexandria, Former Vice President, The World Bank and Former Chairman, CGIAR. The lecture was on 'Vedanta Today' delivered by Dr Karan Singh, Former Union Minister and President (*Sadr-i-Riyasat*) and then first Governor of Jammu and Kashmir state.

Youth in Development

A Regional Conference on Motivating and Attracting Youth in Agriculture was organized on 30–31 August 2018 at the NASC Complex, New Delhi, jointly with Trust and Advancement of Agriculture Sciences (TAAS) and Young Professionals for Agriculture Development (YPARD). The conference covered a wide range of themes, including National Mission on

Youth in Agriculture, Youth Agriculture Nexus, Youth as a Farmer, Agri-Youth Innovation and so on.

Dr. A.K. Singh, DDG (Extn), Indian Council of Agricultural Research (ICAR), inaugurated the conference, which was attended by Dr. Ravi Khetarpal, executive secretary, Asia Pacific Association of Agricultural Research Institutions (APAARI); Prof. M.S. Swaminathan, founder, MSSRF; Dr. R.S. Paroda, chairman, TAAS; Dr. T. Mohapatra, DG, ICAR; Dr. Yash Saharawat, CR, YPARD, government of India, and other dignitaries. The event had 30 invited talks, a public lecture, and 35 oral and 75 poster presentations. More than 250 delegates and 75 researchers from different states attended the conference. Prizes were awarded to the winners of the essay competition, oral presentation and poster presentation.

Publications

Books / Monographs /Manuals /Electronic Material

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Priya Rampal and Rupal D. Wagh. 2018. *Focused group discussion in farming system for nutrition study villages in Wardha*. Research Report No. 46. Chennai: MSSRF. 10 pp.

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Alexis Carr., P. Thamizoli, R. Rengalakshmi and K. Balasubramanian. 2018. "Learning through social media: a Promethean gift?". *CSI Transactions on ICT*. 6(3–4): 301–310.

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Mr. M. Kannan, *Lab Assistant*
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Kalpakkam

Mr. R. Kalaimani, *Scientist*

New Delhi

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Karnataka

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Mr. Manikantha V. Gunaga, *Field Assistant*
Mr. Kiran Dhareshwar, *SRF**
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ECOTECHNOLOGY

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Assam

Ms. Pompi Dutta, *Devp. Coordinator*
Ms. Roshmi Handique, *Devp. Associate*
Ms. Gargee Baruah, *Devp. Associate*

Chennai

Dr. M. Manjula,
Principal Scientist (Social Science)
Dr. S. Malarvannan, *Sr. Scientist*
Mr. P. Lakshmanan, *Devp. Coordinator**
Dr. K. Bhuvaneswari, *Research Associate*
Dr. C.M. Pratheepa, *Research Fellow*
Mr. Vivek Babu, *Project Fellow*
Mr. Paramananda Sahu, Project Fellow*
Ms. J. Rojarani, *Devp. Associate*
Ms. K. Siranjothi, *Devp. Associate*
Mr. S. Kannappan,
Research and Devp. Engineer
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Mr. K. Sunder Vadivelu, *Executive Secretary*
Ms. R. Jayashree, *Assistant Accounts*
Mr. S. Mohan, *Office Assistant*

Kannivadi

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Mr. R. Seenivasan, *Devp. Coordinator*
Dr. B. Selvamukilan, *Sr. Scientist*
Mr. M. Karthikeyan, *Project Fellow*
Mr. K. Rajaram, *Accounts Assistant*
Mr. M. Santhiveeran, *Devp. Assistant*
Mr. V. Sakthivel, *Office Assistant*
Mr. V. Balamurugan, *Project Fellow**

Mr. C.A.S. Britto, *Devp. Assistant*
Mr. J. Sesurayappan, *Devp. Assistant*

New Delhi

Dr. Govind Kelkar, *Lead Researcher (Gender)**
Prof. Dev Nathan, *Political Economist**
Ms. S. Sneha Banerjee, *Research Assistant**

Pudukottai

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Mr. A. Mohamed Bhilal, *Devp. Associate**
Mr. R. Vinoth Kanna, *Devp. Assistant*
Mr. R. Jeevanraj, *Devp. Assistant*
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Puducherry

Ms. D.S. Girija, *Devp. Coordinator*
Mr. M. Senthil Kumaran,
Sr. Technical Assistant
Ms. K. Soundary, *Devp. Assistant*

Odisha

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Mr. Rabindra Behera, *Devp. Associate*

Thiruvaiyaru

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

Villupuram

Mr. P. Nandeesa, *Devp. Coordinator*
Mr. E. Thirumurguan, *Devp. Assistant*

***Myanmar* RICE BIOPARK**

Dr. Hameeda Banu N Itagi, *Principal Scientist*

AGRICULTURE, NUTRITION AND HEALTH

Dr. R.V. Bhavani, *Director*

Chennai

Dr. R. Rukmani, *Director**
Dr. G. Anuradha, *Principal Scientist**
Dr. R. Gopinath, *Sr. Scientist (Social Science)*
Mr. Varunkumar Yadav, *SRF**
Mr. A. Sakthivelan, *Sr. Secretary*
Ms. Priya Rampal, *Post-Doctoral Fellow**
Dr. D.J. Nithya, *Scientist*
Mr. S. Raju, *Scientist (Social Science)*
Ms. R. Surya,
*Research Uptake Assistant, LANSA**

Jeypore

Mr. Akshaya Kumar Panda, *Devp. Coordinator*
Ms. Nimisha Das, *Devp. Associate*
Mr. Sweta Sheloni Khura, *Devp. Assistant*
Mr. Malaya Kumar Nayak, *Devp. Assistant*
Mr. Sita Prasad Senapati, *Devp. Assistant*
Mr. Purna Chandra Samantray,
Devp. Assistant
Mr. Navjot Singh, *Devp. Assistant*
Mr. Haribandhu Harijan, *Devp. Assistant*
Mr. Antarjyami Bisoi, *Devp. Assistant*

THE HINDU MEDIA RESOURCE CENTRE

Ms. Annie Thomas, *Manager**
Ms. Christy Leema Rose Mary E, *Jr. Manager*
Ms. Aparna Narayanan, *Media Associate**

**left during the year*

LIBRARY AND INFORMATION SERVICES

Mr. A. Janakiraman, *Librarian*
Mr. G. Suresh Kumar, *Library Assistant*
Dr. N. Parasuraman, *Principal Archivist and Knowledge Manager*

Ms. Nancy J. Anabel*, Director, IEC**

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Chief Financial and Admin Officer
Ms. Vidhya Subramaniam, *Head - HR*

Ms. A. Uma, *Sr. Executive - HR*
Mr. C.V. Parthasarathy, *Executive Secretary*
Ms. R. Malathy, *Executive Secretary*
Mr. B. Anandakumar,
Assistant Manager-Admin
Ms. Y. Dilhara Begam, *Sr. Secretary*
Ms. J.D. Sharmila, *Secretary**
Ms. T. Sheeba Rajkumar,
Front Office Executive
Mr. K. Suresh, *Office Assistant*

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Mr. Abhishek Vyas, *Manager* *
Ms. K. Selvi, *Associate Manager*
Mr. K. Saravanan, *Assistant Manager*
Ms. R. Kavitha, *Accountant*
Ms. Nalina Muthukumaran, *Accountant*
Mr. R. Suban, *Accountant*
Ms. R. Selvarani, *Accountant*
Mr. S. Karthik, *Attendant*

IT Wing

Mr. R. Rajamanikkam, *Manager – IT Support*
Mr. R. Srinivasan, *Sr. Software Developer*
Mr. R. Guru Prakash,
Sr. Executive – IT Support

SUPPORT SERVICE

Mr. P. Muthukumar, *Electrician*
Mr. B. Sivakumar, *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 Devp.
Professor P.C. Kesavan*
Distinguished Fellow

CONSULTANT

Dr. P. Pillaiyar
Dr. L. Vedavalli
Ms. Priyanka Mohan
Mr. P. Senthilkumar
Mr. P. Dhanaraj*
Ms. Sangeetha Rajeesh
Mr. Dildarkhan Pathan
Ms. Nivedita Shridhar
Mr. M.K. Pavithran

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Individual Donors – National

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Prof. P.C. Kesavan, Chennai

Mrs. Amiya Kesavan, Chennai

Ms. Radha Sankarakrishnan

Individual Donors – International

Dr. Bruce Alberts, USA

Sources of Project Support

Programme Area 100: Coastal Systems Research

National	*International*
Tata Power Co Ltd, Mumbai	Mitsubishi Corporation, Japan
Charities Aid Foundation India, New Delhi	The World Bank, New Delhi
Indian Institute of Tropical Meteorology,	Qualcomm, USA
Ministry of Earth Sciences, Govt. of India, Pune	ORACLE, USA
Indian National Centre for Ocean Information Service (INCOIS), Ministry of Earth Sciences,Govt. of India, Hyderabad	
National Bank for Agriculture and Rural Development (NABARD), Mumbai & Chennai	
Department of Fisheries, Govt. of Puducherry	
EGREE Foundation & Forest Department, Govt. of Andhra Pradesh	
Society for Integrated Coastal Management Ministry of Environment and Forest and Climate Change, Govt. of India	
National Centre for Sustainable Coastal Management, Chennai	
Tamil Nadu Fisheries Development Corporation Ltd., Chennai	
NTPC Tamil Nadu Energy Company Limited (NTECL), Chennai	
Department of Agriculture, Govt. of Karnataka	
HDFC Bank , Mumbai	

Programme Area 200: Biodiversity

National	*International*
Directorate of Agriculture and Food Production, Govt. of Odisha	International Fund for Agricultural Development, Italy
Department of Science and Technology, Govt. of India, New Delhi	Bioversity International, Italy
The National Academy of Sciences India (NASI), Prayagraj (Allahabad)	
National Rural Livelihood Mission (NRLM) Govt. of India, and State Rural Livelihood Mission (SRLM), Govt. of Odisha	
Indian Institute of Millets Research (IIMR), Hyderabad	
Indian Institute of Rice Research (IIRR), Hyderabad	
JSW Foundation, Mumbai	
Kerala Council for Science, Technology and Environment, Govt. of Kerala	
National Biodiversity Authority(NBA), Govt. of India	
NABARD, Chennai and Trivandrum	
Foundation for Rural Entrepreneurship Development, Pune	
Kerala State Biodiversity Board, Trivandrum	
Directorate of Environment & Climate Change, Govt. of Kerala	
Indira Gandhi National Forest Academy, Dehradun	
ATMA, Wayanad	

Programme Area 300: Biotechnology

National	*International*
Department of Biotechnology, Govt. of India, New Delhi	
Council of Scientific and Industrial Researchm (CSIR), Govt. of India, New Delhi	
Department of Science & Technology (DST), Govt. of India, New Delhi	
Science and Engineering Research Board (SERB), DST, Govt. of India, New Delhi	
Department of Agriculture, Govt. of Karnataka	
Biotechnology Industrial Research Assistance Council (BIRAC) Govt. of India, New Delhi	

Programme Area 400: Ecotechnology

Hindustan Petroleum Corporation Ltd., Mumbai

M/s Jain Irrigation Systems Ltd., Bambhori

Indian Meteorological Department, Ministry of Earth Sciences, Govt. of India, New Delhi

Ministry of External Affairs, Govt. of India

NABARD, Chennai

Collaborative Research and Dissemination, New Delhi.

NASSCOM Foundation, New Delhi

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VA Tech Wabag Ltd., Chennai

The Norwegian Institute of Bio-economy Research, Norway

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National	*International*
	Asia Initiatives, USA
	Asia Pacific Network for Global Change Program, Japan
	Bill & Melinda Gates Foundation, USA

Programme Area 500: Food Security

Tata Trusts, Mumbai	International Centre for Living Aquatic Resource Management (ICLARM), Malaysia
Department of Agriculture, Co-operation & Farmers Welfare, Govt. of India	Department for International Development (DFID), UK
State Planning Commission, Govt. of Tamil Nadu	
Directorate of Agriculture and Food Production, Govt. of Odisha	

Others

World Scientific Publishing Co Pvt . Ltd, Singapore

FINANCIAL STATEMENT 2018-19

M.S.SWAMINATHAN RESEARCH FOUNDATION

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

BALANCE SHEET AS AT 31st MARCH 2019

FOUNDATION — **Figs in Rs. Lakhs**

LIABILITIES	Sch. No.	2018-2019 Rs.	2017-2018 Rs.	ASSETS	Sch. No.	2018-2019 Rs.	2017-2018 Rs.
OWN FUNDS				**OWN ASSETS**			
CORPUS FUNDS	1	166.41	164.62	FIXED ASSETS	4	490.70	522.80
GENERAL FUND & OTHER FUNDS	2	3336.84	3290.35	INVESTMENTS	5	5952.81	6308.79
ENDOWMENT FUNDS	3	4803.57	4709.14	CURRENT ASSETS			
CURRENT LIABILITIES	10	1230.00	1224.09	CASH & BANK BALANCES	7	1164.09	677.81
				ADVANCES	8	1929.22	1878.80
TOTAL [A]		**9536.82**	**9388.20**	**TOTAL [A]**		**9536.82**	**9388.20**

PROJECTS

LIABILITIES	Sch. No.	2018-2019 Rs.	2017-2018 Rs.	ASSETS	Sch. No.	2018-2019 Rs.	2017-2018 Rs.
PROJECT FUNDS & OBLIGATIONS	4	1899.88	1724.33	PROJECTS RECEIVABLES	9	600.37	572.35
CURRENT LIABILITIES	10	712.67	717.20	ADVANCES	8	358.73	387.53
				BANK BALANCES	7	1653.45	1481.65
TOTAL [B]		**2612.55**	**2441.53**	**TOTAL [B]**		**2612.55**	**2441.53**
GRAND TOTAL [A]+[B]		**12149.37**	**11829.73**	**GRAND TOTAL [A]+[B]**		**12149.37**	**11829.73**

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 2019

FOUNDATION **Figs in Rs. Lakhs**

EXPENDITURE	Sch. No.	2018-2019 Rs.	2017-2018 Rs.	INCOME	Sch. No.	2018-2019 Rs.	2017-2018 Rs.
SALARIES	15	503.41	430.59	INTEREST INCOME	11	495.22	538.30
ENDOWMENT EXPENSES	16	88.25	140.13	DONATION	12	343.08	189.94
MEETINGS & OTHER RELATED EXPENSES	17	55.92	16.52	DST CORE GRANT	13	0.00	0.00
OTHER ADMINISTRATIVE EXPENSES	18	111.95	80.16	OTHER RECEIPTS	14		
DEPRECIATION ON FIXED ASSETS	5	36.84	41.32	RENTAL RECEIPTS		11.21	07.15
10% OF ENDOWMENT INTEREST INCOME TRANSFERRED TO ENDOWMENT FUNDS		44.43	46.13	CREDIT BALANCE WRITTEN BACK			
				MISCELLANEOUS		37.78	46.05
EXCESS OF INCOME OVER EXPENDITURE FOR THE YEAR TRANSFERRED TO THE GENERAL FUND		46.49	26.59				
TOTAL		**887.29**	**781.44**	**TOTAL**		**887.29**	**781.44**

Provisional (Unaudited)

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