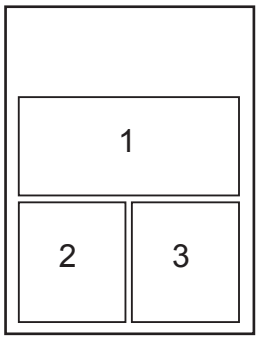
MSSRF

Science for Sustainable Development

M. S. SWAMINATHAN RESEARCH FOUNDATION

2019–2020
THIRTIETH ANNUAL REPORT

CENTRE FOR RESEARCH ON SUSTAINABLE AGRICULTURAL AND RURAL DEVELOPMENT

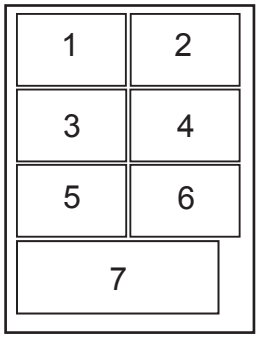


Front Cover

1. Tamil Nadu Chief Minister Thiru Edappadi S Palanisami, Deputy Chief Minister Thiru O Panneerselvam, releasing book on the 30 year journey of MSSRF in presence of Mr N Ram Chairman, Kasturi and Sons and Dr Soumya Swaminathan, Chief Scientist, WHO, 7 August 2019.

2. Andhra Pradesh Chief Minister, Y S Jaganmohan Reddy launching the 'Ryuthu Bharosa Kendralu' (Farmer Facilitation Centre) programme in the state on 10 February 2020. MSSRF is among 11 institutions partnering in this effort.

3. Six eminent scientists were part of a panel discussion organized in partnership with Nature Research to celebrate '150 years of science through the pages of *Nature'*. 6 March 2020.



Back Cover

1. Puducherry Chief Minister Mr V Narayanaswamy, launching the 'Nutrition-Secure Puducherry' Initiative at MSSRF Biocentre, Pillayarkuppam, 2 October 2019

2. Norwegian delegation including Ambassador H.E. Mr. Hans Jacob Frydenlund, Mrs. Gina Lund, Special Advisor, Ministry of Education & Research and Dr Maan Singh Sidhu, Counsellor, Science and Technology hand over a book on Svalbard to Prof Swaminathan after a meeting at MSSRF Chennai, 19 November 2019

3. Dr Soumya Swaminathan, Chief Scientist, WHO delivering the first Dr C Gopalan Memorial Lecture, 5 Jan 2020

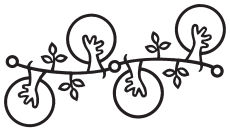
4. Establishment and inauguration of the Humboldtia Garden, an ex-situ conservatory at M S Swaminathan Botanical Garden in Wayanad by Meppadi Range Forest Officer Mr K. Baburaj, 5 June 2020

5. Children from government schools demonstrate use of the 'foldscope' on the occasion of International Children's Day at MSSRF, Chennai, 5 November 2019

6. Training and demonstration of value-added products by a community group in Kolli Hills, Tamil Nadu

7. Farmer Producer Organization facilitates sale of vegetables during COVID-19 related lockdown in Pudukkottai district, Tamil Nadu

Thirtieth Annual Report
2019 – 2020



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Contents

Chairperson's Introduction

This Annual Report comes to you at a historic moment: a global pandemic has affected the lives and livelihoods of millions, with the greatest burden falling on the poorest households. Over the past few months, the staff at MSSRF have stepped up to the challenge, engaging in immediate relief and health education, analysing the impact of the lockdown due to the pandemic on the rural economy and proposing solutions to revive rural livelihoods in the varied sites where we work.

I turn to some of the highlights of the past year.

The Coastal Systems Research programme area, the first one to be started at MSSRF, got a boost with new premises for a village resource centre in Machilipatnam, Andhra Pradesh, with the generous support of Mitsubishi Corporation, Japan. The completion of 10 years of the Fish for All Research and Training Centre at Poompuhar was celebrated with an award for the Fisher Friend Mobile Application – the Mini Innovation Challenge Award from Global Resilience Partnership, Kenya.

Mr R. B. Udhayakumar, Minister for Revenue and Disaster Management and Information Technology, and Mr R. Doraikannu, Minister for Agriculture, government of Tamil Nadu, released the PANNAI (Pest disease Advance Notification and Need-based Agriculture Information) app., developed to provide GIS-based forewarning for pest management in agricultural crops, and a dedicated GeoAgri portal. The PANNAI app. has already connected 10000 farmers with agricultural scientists.

The Biodiversity programme area continued to expand. Ten new seed villages were established in Wayanad, Kerala, to promote on-farm conservation of traditional aromatic paddy varieties. The M.S. Swaminathan Botanical Garden (MSSBG) launched a project to promote ex-situ conservation of the genus Humboldtia (with only nine taxa globally and all from the Western Ghats) in partnership with the Botanic Gardens Conservation International. Botanists at MSSBG described a new species of Sonerila (named *Sonerila sulpheyi*); with this, the number of new species described by colleagues now stands at 20.

In the dryland and tribal areas of Kolli Hills, a multiyear NABARD-funded multi-storey mixed farm project was initiated among 500 marginal and small-farm families. The objective is to enhance incomes, improve supply of nutritious foods locally and ensure environmental sustainability. For the first time, the turnover of the Kolli Hills Agri-Bioresource Producer Company Ltd. FPO, crossed Rs 1 crore.

In Koraput, Odisha, three new farmer producer companies were established: two for quality seed production and one for increased millet production. Over 3000 plants belonging to 27 species were propagated at the Biju Patnaik Tribal Agro-biodiversity Conservation Garden at MSSRF's regional centre in Jeypore.

Studying salinity tolerance in crops continued to be the major focus of the Biotechnology programme: salinity tolerance of 43 rice landraces, including Kagga paddy grown in estuaries of Karnataka, were evaluated at the seedling stage, and they demonstrated high correlation with Na^+/K^+ ratio.

The Ecotechnology programme continued its efforts to transform livelihoods, working with over 13000 women and men farmers in three different agroecosystems. Of high relevance

to the situation today, the programme has expanded e-agricultural extension services to over 60000 farmers using a diverse set of information and communication technology (ICT) tools.

The six-year research programme on Leveraging Agriculture for Nutrition in South Asia (LANSA), the first partnership to be led by an institution outside the UKI, ended in 2019 with an A+ rating from UKAid. The feasibility of a Farming System for Nutrition approach tested under LANSA is now being demonstrated in collaboration with Krishi Vigyan Kendras in Andhra Pradesh, Maharashtra, Tamil Nadu and Uttar Pradesh.

The climate change programme was reactivated in early 2020, with the addition of a Senior Fellow, member of the government of India's delegation to the 52nd Plenary session of the IPCC in Paris, and a group of young scientists. The first project taken up by this group is 'Equity and CBDR&RC in the Context of 2 Deg Global Warming – Implications for India,'for the Ministry of Environment, Forest and Climate Change. The issue is being studied with reference to climate change and agriculture, specifically through yield gaps in agricultural production.

MSSRF has instituted this year, the ***Mina - M.S. Swaminathan Doctoral Fellowship*** that will fund one doctoral student to work at MSSRF on issues of sustainable agricultural development. I am happy to announce that Mr. Manjeet Patel from Madhya Pradesh has been selected as the first *Mina - M.S. Swaminathan Doctoral Fellow*. His research will focus on effects of climate change on the livestock sector.

MSSRF continued to convene interdisciplinary events during the year, starting with the MSSRF @30 International Conference in August 2019, focused on achieving Sustainable Development Goals and strengthening Science for Climate Resilience. *Nature*, the international journal of science, turned 150 last year, and MSSRF, in collaboration with the Nature Research Group, marked this occasion with an event in Chennai featuring six short, agenda-setting talks by leading Indian scientists from different disciplines. MSSRF instituted the Dr C. Gopalan Memorial Lecture to honour the pioneering nutrition scientist, and the first lecture was delivered by Dr Soumya Swaminathan, Chief Scientist, WHO, on 'The New Nutrition Reality'.

The government of Tamil Nadu has renewed the lease of land where the MSSRF headquarters is situated in Taramani, Chennai, for another 30 years. We are very grateful to them and commit ourselves to working towards the goal of a hunger-free India through sustainable agriculture.

Going forward, I welcome our new Executive Director, K. S. Murali, who takes charge in July 2020.

I thank all our staff and scholars for their hard work and commitment. I am very grateful to our Trustees for their advice and to our many well-wishers and donors for their continued support.

G. N. Hariharan, R. V. Bhavani, V. R. Prabavathy, R. Rengalakshmi and B. Jayashree coordinated the preparation of this annual report. Suni Ann Sebastian edited the content, and the printing was done by AMM Prints, Chennai. We are bringing out a web version of the Annual Report for the first time. The design has been done by R. Srinivasan and K. Dileep. I record my appreciation to all of them.

Madhura Swaminathan

Programme Area 100

COASTAL SYSTEMS RESEARCH

Five detailed project reports (DPRs) were prepared and submitted to the National Centre for Sustainable Coastal Management (NCSCM) under the World Bank–supported Enhancing Coastal and Ocean Resource Efficiency (ENCORE) program. A coastal village resource centre has been established at Machilipatnam, Andhra Pradesh, with the support of Mitsubishi Corporation, Japan. A Mangrove Genetic Resources Conservation Centre (MGRCC) was established in the Coringa Wildlife Sanctuary with 25 mangrove species. Cage culture of sea bass was initiated in Krishna district, Andhra Pradesh, to enhance the adaptive capacity of the coastal community to sea-level rise. Fish for all Research and Training Centre (FRTC), Poompuhar completed 10 years of service in providing training and capacity building in fishery resources management, disaster preparedness and sustainable livelihood options. The Centre initiated a new fishery improvement programme for Penaeus semisulcatus *(flower shrimp) to promote sustainable fisheries in the Palk Bay region. The Fisher Friend Mobile Application (FFMA) received the Mini Innovation Challenge Award from Global Resilience Partnership (GRP), Kenya. The Pest disease Advance Notification and Need-based Agriculture Information (PANNAI) app., developed to provide GIS-based forewarning for pest management in agricultural crops, and a GeoAgri portal were launched for November 2019. The holistic rural development initiative in Kuttanad made progress.*

Sub Programme Area 101

Mangrove and Non-Mangrove Coastal Bioshields

Mangrove conservation and management activities continued in the states of Tamil Nadu, Andhra Pradesh and Maharashtra. Mangrove Genetic Resources Conservation Centre (MGRCC) was established in the Coringa Wildlife Sanctuary with 25 mangrove species collected from different parts of the country. Propagation of *Scyphiphora hydrophyllacea* Gaertn., a rare and endemic species in the Godavari mangrove wetland, was done through air layering as propagation through seeds failed. During the launch of YSR *Matsyakara Bharosa*, on the occasion of the World Fisheries Day (21 November 2019), at Komanapalli in Mummidivaramin, East Godavari district, Mr. Jagan Mohan Reddy, the Hon'ble Chief Minister of Andhra Pradesh, was briefed about the activities of mangrove conservation and management as well as Fisher Friend Mobile Application (FFMA) in Andhra Pradesh.

101.1 Mangrove Restoration

***Thiruvalluvar District, Tamil Nadu*:** Desilting and casualty replacement work was completed in the mangrove plantation established in an area of 15 ha in the Koratallaiyar River estuary, Ennore, near the NTPC Tamil Nadu Energy Company Ltd (NTECL) power plant (80°18'43.75"E, 13°13'34.86"N). The rate of survival of the planted mangrove saplings was about 80 per cent; apart from the planted saplings, more than 40000 seedlings of *Avicennia marina* were established naturally. About 10000 matured seeds of *Avicennia* spp. and 5000 propagules of *Rhizophora* spp. were planted in October 2019 to replace the casualties due to increase in soil salinity in summer.

***Krishna District, Andhra Pradesh*:** Desilting of canals in the 200 ha mangrove plantation established in Basavanipalem village of Ramakrishnapuram panchayat, Koduru mandal, in the Sorlagondi Extension Reserve Forest was completed in July 2019. About 40000 *Rhizophora apiculata* and 10000 *R. mucronata* propagules were planted to replace the casualty of the saplings during October 2019. The average height of the *Rhizophora* saplings is about 80 cm. A midterm evaluation of the project on conservation and management of coastal resources as a potential adaptation strategy for sea-level rise underway here was commissioned by NABARD and conducted by Prof. Saudamini Das, NABARD Chair Professor, Institute of Economic Growth, New Delhi, from 8 to 11 September 2019, employing tools such as focus group discussions and socioeconomic questionnaire survey to assess the impact of the project. German Watch, Germany, which co-ordinates the Adaptation Fund NGO Network (AFN), has given the task of independent evaluation to Development Alternatives (DA), New Delhi, one of the network's core partners. The team from DA carried out evaluation activities between 30 September and 2 October 2019 through field visits and interaction with the stakeholders,

and the outcomes were presented in the side event organized at COP25 in Madrid, Spain, on 11 December 2019.

Mr D. Nalini Mohan, IFS, Principal Chief Conservator of Forests (PCCF) and Chief Wildlife Warden, Andhra Pradesh Forest Department, and Mr N. Nageswara Rao, IFS, Conservator of the Forests, Rajahmundry, monitored the mangrove restored site on 25 January 2020. In his feedback, the PCCF stated that the survival rate of the planted saplings was good. He also observed that *Avicennia* sp. was establishing naturally in the restored site in large numbers, which indicates that the site will have a good canopy cover in due course.

***East Godavari District*:** Mangrove Genetic Resources Conservation Centre (MGRCC) was established in the Coringa Wildlife Sanctuary, East Godavari district, Andhra Pradesh, with 25 mangrove species collected from the eastern and western coasts of India. In July 2019, *Nypa fruticans, Xylocarpus mekongensis, Aegialitis rotundifolia* and *Heritiera fomes* were collected from the Sunderbans, West Bengal, and *Bruguiera sexangula*, *Kandelia candel, Aglaia cucullata, Cerbera odollam* and *Cynometra ramiflora* were collected from the Mahanadi delta, Odisha. *Ceriops tagal* propagules were collected from Ratnagiri mangroves, Maharashtra, and *Rhizophora mucronata* from Tamil Nadu in September 2019. The remaining 14 species were taken from the Krishna and Godavari mangrove wetlands (including *S. hydrophyllacea* propagated through air layering). These were planted in the MGRCC between July and September 2019.

***Vegetative Propagation of* S. hydrophyllacea *Gaertn*:** Only few plants of *S. hydrophyllacea*, a rare and endemic species, are found near the Sacramento lighthouse in Kothapalem Reserve Forest (RF) in the Godavari mangrove wetland; attempts at propagation through seeds, stem cuttings and micropropagation techniques having failed and therefore air layering was attempted. About 100 semi-hard straight wooden branches were selected for air layering during May 2019. The bark of the selected branch was removed partially (about 70 per cent) to a length of about 2 cm below the node leaving about 30 per cent of the bark intact for performing physiological functions, since root formation takes at least 2–3 months. Karadix, a commercially available hormone promoting root growth, was used to initiate root formation. The hormone powder was applied all over the wounded portion of the branch using a fine brush. Wet mangrove soil and coconut fibres were used as the rooting medium. A thick polythene layer was wrapped tightly around the medium to retain moisture. Intermittent moistening (once in 20 days) was done to keep the rooting medium wet to enable rooting. Roots appeared after 3 months of layering. Once sufficient roots were formed, about 23 young plants (23 per cent success rate) were removed from the mother plants on 3 October 2019 (after 4 months) and planted in polythene bags containing mangrove soil. The saplings were kept in shade for another 20 days and regular watering was done with less saline water. Thereafter, they were transferred to the mangrove nursery and grown for another 2 months before being planting in the MGRCC.

***Training and Capacity Building*:** Training on mangrove sylviculture practices was imparted to members of Vana Samrakshna Samithi (VSS) and Eco-Development Committee (EDC) in the Godavari mangrove area and the field staff of the forest department of Krishna and Godavari wetlands on 5 October 2019 at the office of the Chief Conservator of Forests, Rajahmundry. A total of 60 members participated in the interactive session. Mangrove sylviculture-related topics, such as the establishment of nurseries having multiple species, fruiting season and identification of matured propagules, identification of suitable areas for nursery and mangrove restoration, restoration of degraded mangroves and vegetative propagation of mangroves, were explained.

***Navi Mumbai, Maharashtra*:** Mangrove restoration work was completed in 3 ha of degraded area identified near Mandala, Mumbai, located close to Thane Creek and the Sion–Panvel Expressway. This area, on which the local community had encroached, was evacuated by the forest department and permission given to restore it in June 2019. Canal digging work was initiated on 29 August and completed on 14 September 2019. About 300 m of main canal and 2150 m of side canals were dug and 3000 matured *A. marina* seeds and 2000 matured propagules of *Ceriops tagal* were planted in October 2019.

101.2 Integrated Mangrove Fishery Farming System

Integrated Mangrove Fishery Farming System (IMFFS) farms have been developed in an area of 25 ha during this year. Six farmers initiated stocking of shrimp, and other farmers are now ready to stock fishes/crabs. About 9000 mangrove saplings were planted along the inner bunds in the intertidal area. Farmers associated with IMFFS have been culturing shrimp, crab and sea bass in these farms.

101.3 Cage Culture

A pilot on cage culture of sea bass was initiated to enhance the adaptive capacity of the local community to sea-level rise. Six floating cages were fabricated using galvanized iron pipes. The cages had inner frames measuring 5 x 5 m and outer frames measuring 6 x 6 m and were fixed so that they floated on eight high-density polyethylene (HDPE) barrels having a capacity of 200 litres each. HDPE braided inner nets (5 x 5 x 3 m with mesh size of 25 mm) and outer nets (6 x 6 x 4 m with mesh size of 40 mm) were used as enclosures for culturing sea bass. Bird nets (80 mm) were placed on top to prevent entry of birds, especially little cormorants. In each cage, about 1000 Asian sea bass (*Lates calcarifer*) fingerlings procured from the Rajiv Gandhi Center for Aquaculture, Thoduvai, near Sirkazhi, Nagapattinam district, Tamil Nadu, were stocked on 11 January 2020. As the fingerlings were very small (5 mm wide and 20 mm long), they were reared inside the cage with a net having a mesh size of 2 mm enclosure (hapa) till 3 months. Regular feeding, based on body weight, was provided using fish meal prepared by grinding low-cost trash fishes. The nets were cleaned regularly to allow unobstructed water flow, especially in the small mesh size enclosures. The fingerlings were transferred into the inner net

of the cage after 3 months by which time the fishes weighed 50 g. Feeding was done twice a day. Now the sea bass fishes have attained sizes ranging from 13 to 19 cm with weights ranging from 76 to 110 g. The survival rate stands at 68–80 per cent.

101.4 Integrated Rural Development Programme

In the Integrated Rural Development Programme, a coastal village resource centre to cater the needs of the coastal community has been established in Machilipatnam, Andhra Pradesh with the support of Mitsubishi Corporation, Japan. Recently, the government high school at Mangalapuram started a digital classroom facility and 50 chairs and 4 tables were provided for the smart classroom. In the primary school at North SC colony of Mangalapuram, a toilet (3.5 x 3.5 x 2.5 m) and a compound wall with gate (length 33 m and height 2 m) were constructed.

In Muthurasupalem hamlet of Mangalapuram, a bore well was dug and connected to the pipeline that supplies drinking water to the entire hamlet, and a pump house with electrical motor was also constructed. In the summer months, Sorlagondi and Mangalapuram villages usually face water scarcity; there have also been outbreaks of waterborne diseases. Bore wells were dug in both these villages; however, in Sorlagondi, the total dissolved solids (TDS) found in the bore water was 1500 mg/L, and in Mangalapuram, it was about 250 mg/L, which made the water unfit for human consumption. Therefore, reverse osmosis (RO) plants were installed in these villages. The TDS of the treated water from the RO plants is between 15 and 20 mg/L, without any microbial contamination. The local community is managing these plants and charges a nominal user fee of Rs 5/20 L of water to maintain the plants. Two bus shelters were also constructed in Mangalapuram village, and the local community, particularly women and school children, find them very useful.

In Mangalapuram, poor agricultural labourers living in the scheduled caste (SC) and backward class (BC) colonies requested permission to construct community halls in their respective hamlets for conducting community meetings, festivals and wedding ceremonies. The villagers provided the land for this. In South SC Colony, a multipurpose community hall measuring 12 x 12 feet and having a concrete roof with a GI sheet roof shed measuring 12 x 36 feet was constructed. Another community hall is being constructed in Muthurasupalem, the BC colony. In North SC Colony, a dilapidated multipurpose building with no doors, windows or compound wall, which served as a library earlier, was renovated and electricity connection provided. A table and 15 chairs were also provided for self-help group (SHG) meetings. Now the local community is using the building effectively.

101.5 Greenhouse Gas Fluxes in the Mangrove Ecosystem

Globally, atmospheric greenhouse gases (GHGs) have been increasing in recent years due to natural and anthropogenic causes. This study in the Pichavaram mangrove ecosystem is part of a collaborative project

with Indian Institute of Tropical Meteorology, Pune, under the MetFlux India project of the Ministry of Earth Sciences (MoES), to ascertain whether the mangrove wetland acts as sink or source of GHGs. An eddy covariance (EC) tower established in 2015 measures the GHG fluxes. Parameters such as atmospheric temperature, relative humidity, wind speed, wind direction, precipitation, photosynthetic active radiation and net solar radiation are measured continuously and pCO_2 and air-water CO_2 flux and methane flux data collected. The study results show that the Pichavaram mangroves act as a sink for CO_2 for most part of the year. Methane emission is also fairly low in the Pichavaram mangroves with slightly higher emission in the wet season.

Sub Programme Area 102

Fish for All Research and Training Centre, Poompuhar

Fish for all Research and Training Centre (FRTC) completed a decade of service aimed at providing sustainable livelihoods and building the resilience of small-scale fishing communities; the centre commemorated the event on 26 December 2019 by launching three new initiatives with key partners. A memorandum of understanding (MoU) was signed with the National Bureau of Fish Genetic Resources (NBFGR), Lucknow, and the Centre of Advanced Study in Marine Biology, Annamalai University, Parangipettai, for research collaboration on marine and food fish species conservation. The Fisher Friend Mobile Application (FFMA) received the Mini Innovation Challenge Award from Global Resilience Partnership (GRP), Kenya. The centre initiated a new fishery improvement programme for flower shrimp to promote sustainable fisheries in the Palk Bay region.

102.1 Capture Fisheries Resource Management and Enhancement

***Fishery Improvement Programme in the Palk Bay Region*:** In collaboration with Tamil Nadu Fisheries Department and Central Institute of Fisheries Technology (CIFT), Cochin, the centre has started a flower shrimp fishery improvement programme (FIP) in the Palk Bay region to help the fishing communities preserve their fish stocks over the long term and also improve the global marketability of their catch given the increasingly high demand for sustainably caught seafood in global export markets. A working committee, involving key stakeholders, has been formed, and the first meeting was conducted during October 2019. Landing centre–specific awareness programmes were conducted in three specific landing centres to orient the fisherfolk on the importance of Marine Steward Council (MSC) certification and sustainable fisheries. The project also initiated the development of a voluntary code of practice for sustainable harvesting of flower shrimp.

One of the working modules of the FIP involves conducting a series of observer programmes in the Palk Bay region to understand the bycatches and endangered, threatened and protected (ETP) species caught during flower shrimp fishing. The first observer programme was conducted during 10–15 February 2020

with CIFT in three selected fish landing centres (Rameswaram, Mandapam and Kottaipattinam) of the Palk Bay region using different bycatch reduction devices (BRDs) in trawler boats. The BRDs include the turtle excluder device (TED), a specialized device that allows captured sea turtles to escape when caught in a fishermen's net; and juvenile fish excluder cum shrimp-sorting device (JFE-SSD) in which the mesh sizes of the cod end used for the experiments are different – upper cod end is 40 mm square mesh and lower cod end is 25 mm square mesh. The catch using BRDs is being compared with that using the control nets that are traditionally used by the trawler fisherfolk in the region for flower shrimp.

***Monitoring of Wave Rider Buoys and Dissemination of Ocean State and Marine Fishery Advisory Services*:** All three shore stations in Colachel, Tharuvaikulam and Puducherry are functioning well and receiving data from respective wave rider buoys (WRBs), which in turn is transferred to Indian National Centre for Ocean Information Services (INCOIS) on an hourly basis. Overall, two WRB maintenance events, four redeployment events and two drift events were reported in these three locations during the reporting period. A community-based monitoring mechanism has been evolved to safeguard the WRBs in these locations. During the reporting period, the Puducherry shore station received data for 320 days while Colachel received data for 287 days and Tharuvaikulam for 355 days. Around 13358 fisherfolk (male: 12451; female: 1117) from 531 villages across Tamil Nadu, Puducherry and Andhra Pradesh were made aware of the functioning of INCOIS and its scientific services, especially ocean state forecast (OSF), high wave alerts, potential fishing zones (PFZs), tuna forecast, tsunami warning and other disaster alerts. A total of 73917 fisherfolk from 632 villages received information on OSF and PFZ on a daily basis through mobile-based information and communication technology (ICT) applications such as FFMA, voice and text messages, district-wise WhatsApp groups and GSM-based public address systems. A total of 190 village-level and one-to-one feedback meetings were organized and 190 feedbacks and 40 case studies collected from fisherfolk from 30 villages on the services provided. Documenting the traditional knowledge was done with 180 fisherfolk on parameters such as prediction of ocean state, fish availability and disasters for scientific validation. The INCOIS–MSSRF 24/7 helpline facility, available in Tamil, Telugu and Malayalam languages, was accessed by 3142 fisherfolk for information on various topics related to their profession.

***Fisher Friend Mobile Application*:** As mentioned earlier, the FFMA won the Mini Innovation Challenge Award from Global Resilience Partnership, Kenya, in November 2019. It was identified as one of the novel solutions for building the resilience of a small-scale fishing community. During the reporting period, four new versions of FFMA were released via Google Play Store and one Fisher Friend KaiOS version was released via JioStore. A total of 15984 new users were added, and the application achieved 2080763

screen views. Three new features requested by fisherfolk – tidal forecast, OSF map and automated weather forecast – were integrated into the application. Three state-level 1-day consultations, involving key stakeholders from Tamil Nadu, Andhra Pradesh and Puducherry, were organized to discuss ways of improving the user interface of FFMA and a set of actions evolved for improvement of the app. Based on this, a joint action plan was developed with scientists from INCOIS for addressing the additional data requirements for improving the user interface of FFMA.

A total of 40 fisherfolk have been selected as FFMA ambassadors and provided with tablets for promotion of the app. Moreover, 724 village-level meetings, 2 district-level awareness meetings and 8 mass campaigns were conducted in which a total of 21282 fisherfolk participated. Seven district-level advisory committee meetings recommended policy advocacy to enhance offshore network coverage and also shared ideas on engaging with the government to increase the use of FFMA. A total of 319 feedbacks and 62 case studies showcasing the economic and livelihood benefits of the users were documented. High dependency of users on the GPS, OSF and PFZ data was observed. Using purposive sampling, success stories of 214 fisherfolk (120 motorized and 94 mechanized) were recorded. The increased income of small-scale motorboat fisherfolk was in the range of Rs 3000–5000 based on FFMA information regarding their catch; in the case of fisherfolk using mechanized boats, this was in the range of Rs 10000–15000. Timely facilitation through the FFMA also helped save assets and lives of 152 fisherfolk from across seven states.

Development of Village-Level Fisheries Resource Management Plan: FRTC promotes participatory management of fishery resources involving the resource user's community for promoting sustainable livelihood and disaster risk reduction under the Fisheries Management for Sustainable Livelihoods (FIMSUL) II project of the government of Puducherry. Village-level co-management committees have been constituted and strengthened in 18 fishing villages. In order to strengthen the livelihood options for fisherfolk, a village-specific livelihood assessment study covering all fishing villages in Karaikal and Puducherry districts was conducted using the five capital (natural, human, social, financial and physical) sustainable livelihood approach. A village-level fishery resource management plan, involving the co-management committee members, was developed in 10 villages of Karaikal district.

***Artificial Reefs*:** A community-based artificial reef programme in collaboration with Tamil Nadu Fisheries Development Corporation (TNFDC), government of Tamil Nadu, was launched on 26 December 2019 in Poompuhar village. A total of 60 individual reef concrete modules weighing 72 tons were constructed with three different designs – for lobsters, groupers and small fishes. A village-level marine council is in place to monitor fabrication and designing of reef modules; a district-level advisory committee has been formed to monitor project activities.

102.2 Post-harvest Management

***Fish Processing Unit*:** This unit processed about 3.5 tons of different fish species for dry fish production and other fish by-products. Overall, 700 kg of hygienic dry fish and 100 kg of other value-added products maintaining HACCP standards were produced by SHGs of fisherwomen. Forty female members of SHGs were involved in production and packaging, and they earned Rs 90155 in all. For secured marketing of the products produced by the women, an MoU was signed between FRTC and Hexitro Private Ltd., Tharangambadi. With the support of NABARD Livelihood Development and Enhancement Programme (LEDP), a 7-day training programme on fish processing and post-harvesting technology was conducted for 30 women from five SHGs for the production of new products and advanced fish processing techniques.

102.3 Culture Fisheries Enhancement and Management

***Promoting Integrated Fish Farming System*:** The centre is promoting and popularizing integrated fish farming system (IFFS) among fish farmers in Sirkazhi and Sembanarkovil blocks. A total of 30 small fish farmers selected as master trainers were trained on various aspects of integrated fish farming through structured training, followed by demonstration in the field. For this purpose, a model integrated fish farm has been established in the FRTC, where cultivation of fodder crops, paddy and vegetables, floriculture, fish culture, *Azolla* culture and so on are integrated. After training and demonstration, component-wise inputs were distributed to all the 30 farmers for replicating this in their farms. A total of 42000 fish fingerlings were given to these farmers for farming in 9.33 acres of fish ponds; vegetable cultivation was started in 1.5 acres and cumbu napier fodder grass planted in 2.5 acres. For further popularizing the concept among the farmers, 30 integrated fish farms were established in 30 villages of the two blocks. A partial harvest was made by harvesting 762 kg of fishes and an income of Rs 114300 earned by 9 farmers. The vegetable yield of 1.4 tons over 3 months yielded a profit of Rs 28618 or an average income of Rs 950/ farmer for 30 farmers. Fodder yield of about 20 tons benefitted 20 farmers with an average income of Rs 750/farmer. All the 30 farmers are harvesting nearly 2 kg *Azolla*/week and using it as fish feed, which has reduced the expenditure on fish feed.

102.4 Training and Capacity Building

***Training Centre*:** During 2019–20, 46 training programmes on co-management of fishery resources, establishment of artificial reefs, use of square mesh for responsible fishing, fish processing and preservation technology and integrated fish farming system were conducted; about 1368 farmers participated in these programmes. The details of these programmes are given in Table 1.

***Village Resource Centre*:** Two village resource centres (VRCs) and two village knowledge centres (VKCs) are operational under FRTC. (See Table 2 for details.) During the reporting period, the VRCs

Table 1: ***Training programmes organized under FRTC (2019–20)***

S. no.	Training topics	No. of programmes	Participants		Total
			Male	Female	
1	Co-management of fishery resources	17	228	206	434
2	Artificial reef and its importance	1	55	0	55
3	Fish value-added products	6	0	294	294
4	Square mesh for responsible fishing	1	15	0	15
5	Integrated fish farming	11	290	9	299
6	Quality dry fish production	2	0	60	60
7	GPS and troubleshooting	4	100	0	100
8	Diesel engine mechanism	4	120	0	120
	Total	**46**	**808**	**560**	**1368**

developed and disseminated 258 content pieces on marine biodiversity conservation and sustainable fishing methods using ICTs. An online course on dry fish production was conducted by the Thangachimadam VRC in Ramanathapuram district with FRTC Poompuhar and 13 fisherfolk participated. A total of 32 audio-conferences and 12 phone-in programmes on diesel engine repair, GPS handling, vegetable cultivation practices, pest management in paddy cultivation, cattle care and management, and nutrition awareness were conducted through VKCs and VRCs, which benefitted 912 users. Tele-medicine programmes were conducted in all VRCs and VKCs; these connected the users to doctors from Apollo Hospital and benefitted 520 users.

Table 2: ***VRCs and VKCs – user details (2019–20)***

Name of the VRC/VKC	Total users	Male	Female
Poompuhar VRC	328	194	134
Thangachimadam VRC	515	263	252
Keezhapoothanur VKC	928	429	499
Pannithittu VKC	544	189	355
Total	**2315**	**1075**	**1240**

***Clean Seas Campaign*:** In collaboration with National Centre for Coastal Research (NCCR), Chennai, FRTC organized International Coastal Clean-Up Day 2019 at Poompuhar, Rameswaram Sangumal and Kodiyakarai beaches on 21 September 2019. The focus of the programme was to create awareness among the fishing communities, beach visitors and general public on the importance of a pollution-free coast and acting as better stewards of our coastal and marine environment. A total of 369 volunteers participated in the clean-up of the three beaches. They collected debris to a distance of about 1 km. The total debris from all the beaches, amounting to about 4.20 tons, included plastic bags, bottles and cups (750 kg), glass bottles (789 kg), cloth (156 kg), ropes (332 kg), boat discards such as thermocol and nets (247 kg), footwear (133 kg) and others (1613 kg). The segregated debris was handed over to the municipality in each location for proper disposal.

***World Fisheries Day*:** The training centre in collaboration with the Fisheries Department of the government of Tamil Nadu organized an event with the theme 'Save the Ocean and Save the Nation' on 21 November 2019. Various competitions focusing on sustainable fisheries were held prior to the event. A rally was held with 200 students and 50 fisherfolk emphasizing the vulnerability of the coastal area and seeking public attention for its protection. A half-day consultation was also organized at FRTC in which experts from various institutions participated and details about the importance of sustainable fishing, technologies and need for collective action for the conservation of marine resources were exchanged.

***Study Tour for Seafood Managers*:** FRTC facilitated a 1-day study tour for seafood managers from 16 countries as part of a 10-day programme by the Sustainable Ocean Leadership Institute (SOLI) to understand the impact of climate change on the Indian seafood industry, organized by the Gulf of Maine Research Institute (GMRI) working with the Global Aquaculture Alliance in October 2019. The main purpose was to understand the perceived and real impacts of climate change on coastal communities, including aquaculture and fisheries production, vulnerability, resilience and response (if any) of these communities to climate change, particularly in response to variation in aquaculture and fisheries production and the complexity of seafood production in India. The study tour offered participants an opportunity to: (i) have first-hand conversations with fisherfolk and those running aquaculture operations to learn what changes they have seen in their occupation between the past and now, and (ii) meet with local scientists to learn what kinds of mitigation and research are being undertaken in India.

Sub Programme Area 103

Remote Sensing and Geographical Information Systems (GIS)

103.1 GIS-Based Forewarning Model for Pest Management

The Pest disease Advance Notification and Need-based Agriculture Information (PANNAI) app., developed to provide GIS-based forewarning for pest management (GFPM) in agricultural crops to small and marginal agricultural farmers of Vedaranyam and piloted tested in 2018–19, and a GeoAgri portal were formally launched on 5 November 2019 by Mr R. B. Udhayakumar, Minister for Revenue and Disaster Management and Information Technology, and Mr R. Doraikannu, Minister for Agriculture, government of Tamil Nadu, respectively. In the PANNAI app., the field measurement boundary (FMB) and land records of farmers have been digitized and land-wise advisories are being given based on the three automatic weather stations installed in project villages. It connects nearly 10000 farmers with the scientific community, especially agricultural experts, to manage the crops. Two hundred android tablets with PANNAI app., installed were provided to progressive farmers of the project villages,

who were trained to use it. Another 200 progressive farmers from Adanur, Kathripulam, Kadinalvayal and Thennadar villages were trained at Tamil Nadu Rice Research Center, Aduthurai, to tackle climate change issues in agricultural crops. Infrared-based drone survey was completed in Vanduvancherry, Thennadar and Kadinalvayal to map the farmlands for the android app., and also to evaluate the health of paddy crop using digital image processing techniques. About 250 soil samples collected from different farmers' fields were analysed for nutrients such as NPK and other micronutrients. Soil health cards were issued to the farmers with the recommended doses of fertilizer required for cultivation of crops. Scientists from Pandit Jawaharlal Nehru College of Agriculture and Research Institute (PAJANCOA & RI), Karaikal, visited the farmlands and advisories were provided to the farmers.

103.2 Quantification of Biomass in Pichavaram Mangroves Using Remote Sensing

Quantification of biomass in the Pichavaram mangrove wetland using remote sensing (RS) technology was initiated. Mangrove species classification has been carried out using IRS P6-LISS IV satellite images for the year 2019, and the geometric errors were rectified using sentinel 2 images as a base in cartographic projection (UTM Zone 44N, WGS84). After the preliminary image classification, species diversity, species location and other landuse/ landcover were collected to reclassify using the sample points collected from the field and accuracy assessment was carried out. Species zonation map was prepared and parameters such as diameter at breast height (DBH), circumference at breast height (CBH) and plant height were measured in 101 random sampling plots.

103.3 Mangrove Community Zonation and Biophysical Characterization of the Tamil Nadu Coast

Space Applications Centre (SAC), ISRO, Ahmadabad, sanctioned a project to update the mangrove community zonation at a scale of 1:25000 for the Tamil Nadu and Puducherry coasts using the LISS IV satellite images and satellite data of IRS P6 L3 and L4 obtained from them. As per the guidelines of SAC, the digital number (DN) values of the pixels in the satellite images were converted to radiance values using model maker from the ERDAS software, and the radiance images were used for preparing the mangrove zonation maps. The hybrid classification technique has been adopted to classify the satellite images for community zonation of the mangroves. Extensive ground truthing and biophysical survey is being carried out in the coastal areas of Villupuram, Cuddalore, Thanjavur, Ramanathapuram, Tuticorin, Kanniyakumari and part of Puducherry state (Karaikal) to validate the processed satellite images and classified land-use divisions and mangroves.

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

MSSRF is the technical agency for the Water Security and Climate Adaptation in Rural

India (WASCA) project being implemented to enhance water security and climate adaptation in Thiruvannamalai and Ramanathapuram districts of Tamil Nadu (see SPA 402.6). GIS and RS technology are being used for composite water resources management (CWRM) at the gram panchayat (GP) level. The soil profile, land use/land cover, drainage, microwatershed and other relevant data for village-level planning are being prepared using ArcGIS from data provided by the Rural Development and Panchayat Raj Department, government of Tamil Nadu, for 429 GPs of Ramanathapuram and 860 GPs of Thiruvannamalai districts. Government officials and engineers of Ramanathapuram were trained in GIS tools such as Google Earth Pro, Bhuvan and ER mapper for the effective planning of GIS-based CWRM. The GIS layers, such as drainage map, landuse/landcover, salt-affected land, ground prospectus map, watershed, geomorphology, geology, lineament, waterbody and so on, are being generated from ISRO-Bhuvan database for Ramanathapuram district. These generated maps are converted into KML format and processed in Google Earth to prepare the CWRM plans scientifically for the GPs.

Sub programme Area104

Holistic rural development programme in Kuttanad

The Foundation is implementing a holistic rural development programme in the Kuttanad region of Kerala comprising Alapuzha, Kottayam and Pathanamthita districts, adjacent districts of Ernakulam and Idukki, and in Wayanad. The Kuttanad region is known for below sea level farming and was badly affected by floods in 2018. Other work in Kerala is reported under SPA 203. The ongoing initiative envisions the livelihood development and building of resilience of agricultural and local food systems in 30 flood-affected villages across the six districts by revitalizing ecological balance through community-based natural resource management and improving livelihood opportunities. The programme has been prioritized with three components: (i) natural resources management (NRM); (ii) skill development and livelihood enhancement; and (iii) education.

***Natural Resources Management*:** During the reporting year in Wayanad, 3995 tree saplings suitable for the riverside were distributed and planted on a 5-km stretch on the banks of Cheriyapuzha, one of the major tributaries of Panamaram River, which runs through five project villages in the district – Kottathara, Panamaram, Vengappally, Achooranam and Pozhuthana. A kilometre stretch in each village was also selected for improving vegetative cover to strengthen the banks and thereby minimize soil erosion and landslips. In order to reduce the climate change impact at the micro level by enhancing the vegetative cover in public places, 250 medicinal plant saplings of 50 species were planted in the government Ayurvedic dispensary in each of the five villages.

A training session on NRM was conducted in seven villages across Wayanad, Ernakulam,

Idukki and Kuttanad benefitting 221 participants, which included farmers, local self-government departments (LSGDs) and Kudumbashree members. Vegetable seed kits with ten seeds each of brinjal, ladies finger, cabbage, green chilli and tomato have been distributed to 2400 households in Idukki.

***School Fruit Gardens*:** Two hundred saplings of 20 local fruit tree species were distributed and planted in five different schools in Wayanad (AUP School, Sugandhagiri; Achooranam Government Higher Secondary School; St. Antony's UP School, Vengappally; Government Higher Secondary School, Karinjakunnu, Kottathara; and Government Higher Secondary School, Panamaram). These gardens are linked to the school climate education programme and monitoring systems.

***Vegetable Farming*:** Summer vegetable farming was promoted among seven farmer groups, across five villages in Wayanad, involving 72 women farmers. They are cultivating 13 vegetable crop varieties on 3 acres and marketing an average of 1200 kg of vegetables every month.

***Community Conservation Plots of Traditional Rice Varieties in Wayanad*:** Three community conservation plots for paddy were established in Panamaram, Kottathara and Vengappally villages. The activity implemented in group farming mode with a total of 25 farmers involved distribution of seeds, manure and training for farmers to produce quality seeds. Farmer groups were created and provided with 10 qtl of seeds of seven traditional paddy varieties (Adukkan, Chettuveliyan, Navara, Rakthasali, Valichoori, Kunjithondi and Paalthondi) and trained in the management of conservation plots. The farmers identified Adukkan and Valichoori as suitable varieties for dry regions with sandy soils; and Chettuveliyan and Kunjithondi for the soils characterized by high clay content. Special paddy varieties such as Gandhakasala and Navara, which are of conservation value, were also preferred by the farmers. The seeds cultivated across 23 acres yielded 3.20 tons of quality seeds.

***Community Weather Stations*:** An agro-meteorological unit (in Ramankary village, Alappuzha district) and a hydro-meteorological data acquisition unit (in Thalayazham village, Kottayam district) have been established in the Kuttanad region. These facilities provide useful information about soil, water and crop conditions, which include air, temperature, humidity, wind velocity, wind direction, soil moisture, soil temperature, leaf wetness, solar radiation, rainfall, water level and so on. The data is expected to help farmers to better understand weather conditions and plan their activities accordingly. The dissemination plan is being discussed with stakeholders and the local media.

***Skill Development and Livelihood Enhancement*:** In Idukki district, 680 dairy farmer households were supported with milk bails as an entry-level activity in the dairy sector. Eighty farmer households in Kallara and Vadayar villages of Kuttanad were supported with rubber floor mats for paving cowsheds.

These mats were found to be effective in preventing incidence of mastitis and other foot diseases. A women self-help group managed mussel cultivation unit has been promoted in Ernakulam. A total of 80 women farmers of Idukki were provided wheelbarrows for their farm operations. Two women farmer groups in Ernakulam were supported for running a dairy products unit and a 10-ha vegetable farm. Provision of agricultural equipment (paddy transplanter and mono block pumpset) helped 60 paddy farmers in Ernakulam district to continue their farm operations on 40 ha of land. Charka stands with seats were provided to 17 women khadi weavers under the Gandhi Grama Seva Kendram of Ernakulam district to support their livelihoods.

***Rain Shelters for Protected Farming of Vegetables*:** Heavy rainfall over more than 7 months across Wayanad makes vegetable cultivation a seasonal activity, affecting regular consumption of vegetables by households. Rain shelter was introduced as a means to cultivate vegetables throughout the year. MSSRF supported eight tribal families to initiate construction of rain shelters for vegetable cultivation. These shelters were constructed in the homesteads to ensure year-round production of vegetables. Five of them are being utilized for vegetable seedling multiplication and as seed germination chamber and three for farm vegetable cultivation. The rain shelter is also used for producing seedlings of cash crops such as arecanut and pepper. This activity has also helped to increase household consumption of vegetables. One of the beneficiaries, Mr Chandran from Panamaram village, earned Rs 7000 per quarter by producing and selling vegetables and seedlings.

***Tailoring as an Alternative Source of Income*:** Training was provided to 72 women stakeholders across five villages for developing their skills in various aspects of stitching and designing and a sewing machine provided to each: Pozhuthana (14), Vengappally (17), Kottathara (21), Panamaram (13) and Achooranam (7). Tailoring groups formed in Vengappally, Panamaram and Pozhuthana villages have ensured continuous supply of cloth bags to Organic Eco Shop at Kalpetta. Consultations are on with the GP to develop the units as full-fledged production units.

***Poultry Units*:** To promote poultry as a livelihood option, 15 units with 20–22 birds were started in each of the five villages of Pozhuthana, Achooranam, Vengappally, Panamaram and Kottathara. A total of 9000 'gramasree' egg layer chicks and cages, together worth Rs 600000, were distributed to 75 most deserving families. The surplus eggs after household consumption were aggregated and marketed through the FPO, resulting in an additional source of income for the families.

Programme Area 200

BIODIVERSITY

In Kolli Hills, Tamil Nadu, a project on multi-storey mixed farm (MSMF) to increase income and improve nutrition status of tribal farm families and enhance environmental sustainability across six panchayats commenced in November 2019. The turnover of the Kolli Hills Agri-Bioresource Producer Company Ltd. (KHABPCOL) crossed Rs1 crore for the first time. In Odisha, two Farmer Producer Organisations (FPOs) were formed in Koraput for finger millet seed production and promotion of millet cultivation respectively; another FPO was formed in Ganjam for green gram seed production. Community Seed Banks managed by women self-help groups were established in three villages. In Wayanad, Kerala, ten new seed villages were established to promote the on-farm conservation of traditional medicinal and aromatic paddy varieties. For conserving threatened plant species, an ex-situ conservatory for the endemic genus Humboldtia was established at the M S Swaminathan Botanical Garden.


வல்லிய ஒரி
ஆண்கள்
சுயஉதவிக்குழு
செம்மேடு


Value Addition of Spices
and Medicinal Plants

Sub Programme Area 201

Community Conservation Programme at Kolli Hills

The project team continued its focus on millet promotion activities by demonstrating yield enhancement trials, organizing millet seed festivals, facilitating millet processing units and extending training on making millet value-added products. The team was engaged in promoting orchard gardens for food and nutrition security and livelihood for tribal farm families. During the reporting period, the team provided technical support for installation of millet processing units and training on value addition for millets at Mandala and Dindori, Madhya Pradesh. The Kolli Hills Agri-Bioresource Producer Company Ltd. was engaged in extending support to tribal farmers by procuring local farm produce.

201.1 Millet Promotion and Value Chain Development

Promotion of improved agronomic practices, such as varietal and technology demonstrations, community seed banks (CSBs) and customized farm implements, training on value addition and linking with urban markets are key activities. The tribal farmers involved in the project were supported by the Indian Institute of Millets Research (IIMR), Hyderabad, under the component of Tribal Sub Plan (TSP), 2019–20.

***Distribution of Millet Seeds*:** Millet seed festivals were conducted during mid-July at nine locations in five panchayats, namely, Valapur Nadu, Devanur Nadu, Gundani Nadu, Thirupuli Nadu and Selur Nadu, and about 30 farmers participated in each programme. More than 500 kg of finger millet seeds were distributed during these festivals, and overall, 300 millet farm families participated.

Improved Agronomic Practices for Yield Enhancement in Millet Cultivation: Two different demonstrations were conducted during the 2019 kharif season on advantage of variety and performance of technology. In the case of technology demonstrations, a cost-and-return assessment was done for 50 farmers in trial fields for both line-sowing and broadcasting methods. The cost of cultivation includes the cost of seeds, manure, labour involved in ploughing, bush cleaning, seed sowing, weeding, thinning, harvesting and post-harvest processing. The returns derived from grain and straw yield were monetized based on the current market value. It is seen that the average grain yield using farmers' practices is 9.76 qtl/ha whereas it is 11.93 qtl/ha using improved agronomic practices. By adopting the line-sowing method of cultivation, farmers got a 22 per cent higher yield when compared with farmers' practices. The study indicated that farmers received Rs 8550/ha as net return under farmers' practices as against Rs 13756/ha using the modified method of cultivation, which indicates an additional income of 61 per cent from the improved practices.

In varietal demonstrations, average-cost-and-return assessment was done of 50 farmers' trials using improved varieties such as GPU28,

GPU48 and ML365 and local varieties such as suritaiklevaraku, sundankikelvaraku and sataikelvaraku. The results showed that average grain yield in demonstration trials using local varieties was 8.06 qtl/ha whereas it was 9.27 qtl/ha using improved variety, which indicates a 15 per cent higher yield with the improved variety. It was seen that farmers earned Rs 2180/ha as net return using farmers' variety and Rs 5139/ha using improved variety cultivation, that is, a 136 per cent increase in income by using improved varieties.

***Training and Capacity Building*:** Training on line sowing, application of bio-inputs and seedling thinning was conducted and 2 field days organized, wherein 86 farmers participated. A traditional food mela was organized, and 20 tribal men and women farmers from Selur Nadu, Devanur Nadu, Valapur Nadu, Thirupuli Nadu, Alathur Nadu, Gundani Nadu and Edapuli Nadu panchayats *participated*. Farmers brought their own local varieties of millet, beans and paddy, and a variety of local fruits, greens, spices and medicinal plants. Millet recipes such as thinaipayasam, samai vegetable biryani, ragipakoda, varaku curd rice, samai pongal and samai sambar satham were prepared in the food festival and methods and techniques of preparation of modern recipes shared with the participants.

***Millet Pulverizer Unit*:** Community pulverizer units established to reduce drudgery in millet processing are being operated by women's self-help groups (WSHGs) and farmers' club in 10 villages, namely Padasolai, Navakadu, Thirupulioorpuram, Thuvarapallam, Vendalapadi, Semputhuvalavu, Puliyampatty, Olaiyaru, Periyakovilur and Kuchakiraipatty. During the year, 8.9 metric tons of millets were processed and used by the local community.

***Production and Marketing of Kolli Hills Natural Foods*:** Kolli Hills Agro Biodiversity Conservers Federation members have been producing millet value-added products under the brand name Kolli Hills Natural Products since 2001. At present, there are 16 value-added products that are being produced and marketed across Tamil Nadu and other parts in India. During the reporting year, 13.45 tons of milled rice and value-added products were sold and an overall gross income of around Rs 9.11 lakhs earned.

201.2 Integrated Tribal Development Programme: Multi-Storey Mixed Farm Development

Multi-storey mixed farm (MSMF) was implemented with the aim of increasing income, enhancing nutrition supply for tribal farm families and ensuring environmental sustainability. The project was inaugurated in November 2019 in six panchayats at Kolli Hills. It began with the participation of 250 farm families in the first batch. Five panchayats, namely, Chitur Nadu (106), Bail Nadu (19), Devanur Nadu (77), Valapur Nadu (37) and Selur Nadu (11), spread across 18 settlements were covered. The following are the key components of the 6-year-long project, which aims to reach out to 500 small and marginal tribal farm families: (i) establishment of

MSMF with crops that could offer additional income and nutri-dense output and ensure sustainability of the farm and adjacent natural resource base; (ii) adoption of in-situ soil conservation measures to arrest further degradation of soil and shaping of the land to make it suitable for the establishment of MSMF; (iii) development of water resources individually or on a community basis to provide protective irrigation for fruit plants; (iv) imparting training and exposure to improve techniques and locally suitable technology interventions to better crop productivity, production and value chain development; (v) development of community health awareness on the importance of basic hygiene and nutritional aspects of food, herbal and kitchen gardens; (vi) drudgery reduction measures for women by supporting activities that will reduce on-farm and off-farm activities; (vii) linkage of participating families with assured marketing systems for a better price and stable income by organizing them as 'farmers' producer companies' (FPCs); and (viii) setting up participatory research and monitoring by stakeholders on the process of MSMF development.

***Establishment of Multi-Storey Mixed Farm*:** During this year, two types of orchard gardens are being promoted in the north and south clusters of Kolli Hills, one at a lower elevation (below 1000 m msl) and the other at a higher elevation (above 1000 m msl). The Model A orchard comprises of horticulture trees of jackfruit (10), nutmeg (10), acid lime (40), sapota (2), amla (2), guava (2) and pomegranate (2) for the south cluster, and in Model B, nutmeg is replaced by mango. Organic inputs to the tune of 150 tons of farmyard manure and 4.25 tons of neem cake for use as nematicide were distributed to 250 farm families for nurturing the tender saplings.

***Soil Conservation*:** The general topography of the land in the project area is undulating with a slope of 5–10 per cent. Few areas have a slope that exceeds 30 per cent. The major soil conservation measures taken up in the wadi farms are compartment bunds and trenches built to arrest further erosion of topsoil and reduce the runoff for *in-situ* conservation of rainwater and for retaining soil moisture over extended periods. In order to harvest rainwater, 250 compartment bunds (each measuring 120 running etreand having a cross-section of 0.54 sq.m) and 5000 trenches (4 x 0.5 x 0.5 m) were established on the uphill side of the plants in each wadi. Trenching is considered to be highly effective in catching surface runoff and recharging deeper soil strata, which become accessible to the roots during summer when there is no rain at all. Fifty mini percolation ponds having a diameter of 15 feet and depth of 10 feet were also established to irrigate wadi gardens at different panchayats.

***Training and Capacity Building*:** A total of 60 training sessions were conducted in which 370 farmers (male: 227; female: 143) participated. The sessions covered project awareness, layout preparation, digging of pits and planting, application of neem cake, ground work for compartment bund and trench building and maintenance of MSMF gardens. Moreover, exposure visits to Jawadi Hills were organized

for 20 tribal farmers to learn and understand the process of development of wadi farms with proper layout and maintenance.

201.3 Empowering Tribal Women through Skill and Eco-preneurship Development in the Eastern Ghats

With the support of Frauen Power, Germany, a 5-day certificate training programme on millet value addition was organized for 30 tribal women farmers at the millet value addition centre in Kuchakiraipatti, Kolli Hills, covering the knowhow and do-how of millets and providing hands-on training on preparation of traditional and modern millet recipes, basic marketing strategies and cost-benefit analysis; it also included an exposure visit to Natural Food shop at Kolli Hills. During the training, participants prepared seven different recipes using millets; these included thinai payasam mix, samai upma mix, thinai laddu, ragi malt, samai pongal, samai vegetable biryani and samai bajji mix. The training programme also emphasized the role of processing units in drudgery reduction and the importance of millets in family nutrition security. It was organized in two batches, and women farmers from four panchayats, namely, Valavanthi Nadu, Ariuyr Nadu, Selur Nadu and Chitur Nadu, participated.

201.4 Technical Support for Developing Millet Value Chain

The MSSRF team extended technical support to the NGO Action for Social Advancement (ASA) for the 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. Key activities during the reporting period were: (i) erection and installation of millet processing units at three identified locations; (ii) conducting on-the-spot training on mill operation for selected members of farmer producer organizations (FPOs); (iii) organizing value chain workshops involving stakeholders of FPOs, quality control, environment, food and nutrition labelling and branding, advertisement agencies, schools, integrated child development services (ICDS) and public distribution system (PDS) officials.

***Establishment of Millet Processing Units*:** MSSRF and ASA conducted several meetings with members and CEOs of Mandla Tribal FPO, Maheshmati Tribal FPO *and* Vindhavasini Kisan FPO at Mandla and Dindori regions. MSSRF also facilitated the transportation of millet processing machineries from Victor Machines Factory, Salem, Tamil Nadu, to Mandla and Dindori via Jabalpur. Each unit comprises of one set of millet de-stoner, grader and de-husker with an electric motor.

Onsite Training for FPOs: Members of Mandla Tribal FPO and Maheshmati Tribal FPO established the millet-processing unit at the existing infrastructure available with FPOs. Vindhavasini Kisan FPO purchased 1 acre of land at Kacharia in the year 2018, and the construction of the infrastructure for housing the processing unit was completed by the FPO during December 2019. A team from

MSSRF visited the site for the erection of pre-cleaning and kodo and kutki millet processing units in three locations in July 2019. With the support of ASA ground staff, base erection and electrification has been completed. MSSRF staff also visited Podi and Shagar in Mandla and provided full-fledged hands-on training to the FPOs on fitting, maintenance and operating.

***Stakeholder Meet and Value Addition and Market Development Orientation Training*:** In December 2019, the MSSRF team convened a 3-day onsite final visit and interacted with the FPO and other stakeholders in three locations. A 1-day training programme on value addition, cooking demonstration, quality control, packaging and market orientation was jointly organized with ASA and other state stakeholders in Mandla. There was representation from Krishi Vigyan Kendras (KVKs), District Agriculture office, Quality Control Department, Women and Child Development Department, other NGOs and the three FPOs.

201.5 Kolli Hills Agri-Bioresource Producer Company Ltd

The Kolli Hills Agri-Bioresource Producer Company Ltd (KHABPCOL) was established in 2016 and has a current membership of 583 tribal farm families. During the reporting period, KHABPCOL received an equity grant of Rs 5.83 lakhs, which is equivalent to its paid-up share capital from SFAC (Small Farmers Agribusiness Consortium) during 2019. This helped to expand the company's business activities.

***Credit Facilities through NABKISAN*:** As part of credit linkage, the KHABPOCOL accessed Rs 2490000 through NABKISAN Finance Ltd. Of this amount, Rs 1500000 has been leveraged as working capital to increase the business turnover with a repayment period of 12 months and Rs 990000 received as term loan for dairy farming by individual members with a repayment period of 30 months. The FPO initiated a rural mart at Solakkadu in Kolli Hills with the financial support of NABARD in January 2020 to link agricultural products with mainstream markets. These facilities have enabled the company to achieve an annual turnover of over Rs 1 crore during 2019–20.

During the year, 11.6 tons of pepper, 17 tons of green pepper, 61.9 tons of mango, 1.65 tons of millets, 2 kg of clove, 10000 pineapple saplings, 14.25 tons of tamarind, 12.68 tons of bio-inputs, 46 tons of pineapple, 3.47 tons of cashewnut, 26.41 tons of coffee and 35.5 tons of banana were procured from the members for primary processing and sale. The annual turnover of the FPO was Rs 681294 during 2017–18, Rs 3112430 during 2018–19 (357 per cent increase) and Rs 10262860 during 2019–20 (230 per cent increase). Accounts for 2018–19 were audited and the returns filed. The net income of the company was Rs 864200 as of 31 March 2020.

201.6 Farmer-Led Extension Strategy for Enhancing Farmers' Income through the Millet-Based Farming System in Hilly and Tribal Areas

A new project was initiated with the support of the National Agricultural Science Fund

(NASF) and jointly implemented with the IIMR in Kolli Hills and Koraput, Odisha. The project has the following objectives: (i) identifying millet farmer facilitators (MFFs) and studying their characteristics to perform effective extension services in hilly and tribal areas; (ii) empowering MFFs through group approach, on-farm training and mobile-based information and communication technologies (ICTs) for enhancing the income of millet farmers; (iii) strengthening decision-making of millet farmers and introducing suitable millet-based farming systems comprising of millet intercropping, livestock and beekeeping for livelihood security of millet farmers; and (iv) assessing the effectiveness of MFFs and devising ways and avenues for extension services and identifying the characteristics of MFFs desired by millets farmers in hilly and tribal areas. To initiate the project in Kolli Hills, two awareness meetings were conducted at Palapadi and Aleripatty hamlets to explain the project objectives to farm families. A total of 64 farmers (male: 34; female: 30) attended the meeting. The project team initiated a discussion on the concept of MFF and floated the idea to see the farmers' reaction to the concept. Following the community-level meeting, cluster-level participatory identification of MFFs has been carried out by the project team. More systematic methods will be followed for the identification of MFFs based on the guidelines of IIMR and will be implemented prior to the kharif 2020 sowing season. In Koraput, awareness meetings were organized in three project villages, namely, Bagraguda, Talalimka and Aminguda. In these meetings, the objectives of the project activities and project deliverables were discussed with village leaders and SHG members and 48 men and 36 women participated. Occupation-wise needs analysis was done in villages and discussion about identification of MFFs initiated.

Sub Programme Area 202

Biju Patnaik Tribal Agrobiodiversity Centre (BPTAbC), Jeypore, Koraput

Activities in Odisha are coordinated through the Foundation's regional centre in Jeypore, Koraput. Ongoing projects continued during the year. Two new FPOs in Koraput and one in Ganjam were formed and registered. In addition to the reporting in this section, new projects on enhancing the income of millet farmers, initiated in Kolli Hills and Koraput, are reported in SPA 201.6. Work under the project on Strengthening Livelihoods and Enhancing Food and Nutrition Security of Small and Marginal Farmers in Koraput District, Odisha, through Farming System Model is reported in SPA 502 and on a garden of nutri-rich plants at the Biju Patnaik Tribal Agrobiodiversity Centre (BPTAbC) campus in Jeypore in SPA 504.

202.1 Socioeconomic Upliftment of Tribal Communities through Cultivation of Small Millets

Support was received from the IIMR under their TSP for the promotion of improved cultivation methods of small millets, especially finger millet. A total of 200 farmers from 11

villages across five gram panchayats (GPs) – Umuri, Mastiput, Manbar, Debighat and Padmapur in Koraput block – were identified for the initiative. About a hundred farmers participated in the demonstration of millet cultivation with traditional and improved varieties of seeds using farmers' practice and improved practice so that they could observe the difference themselves. Demonstrations undertaken were: (i) traditional variety versus improved variety using farmers' practices; (ii) farmer's practice (broadcasting) versus line sowing; (iii) farmer's practice (broadcasting) versus line transplanting (LT); and (iv) farmer's practice (broadcasting) versus system of millet intensification (SMI).

***Traditional Variety versus Improved Variety Using Farmers' Practices*:** Cost-and-return assessment was done on 50 farmers' trial fields for varietal demonstration of both improved variety and traditional variety. Cost of cultivation included seed cost, manure cost and labour cost; for example, cost of ploughing, bush cleaning, seed sowing, weeding, thinning, harvesting and post-harvest processing. The results show that the average grain yield of the traditional variety is 6.76 qtl/ha whereas it is 7.96 qtl/ha in the case of the improved variety. This indicates that the farmer received a 17.75 per cent higher yield by changing the variety from traditional to improved. The net return from the improved variety was Rs 4460/ha as against Rs 3037/ha from the traditional variety, indicating a 47 per cent increase by just changing the variety.

***Farmers' Practice (Broadcasting) versus Line Sowing*:** This trial was conducted in the fields of 10 farmers. It was found that average grain yield using farmers' practices was 4.86 qtl/ha as against 6.89 qtl/ha in the case of line sowing. Therefore, the farmer received a 29.5 per cent higher yield by adopting an improved method of cultivation. The net income using farmers' practices was also negative at Rs 143/ha as against Rs 3615/ha using the line-sowing method.

***Farmers' Practice versus Line Transplanting*:** A total of 41 farmers participated in this demonstration trial. It was observed that the average grain yield using farmers' practice was 6.86 qtl/ha when compared with 20.28 qtl/ha in the case of LT using an improved variety. Therefore, there is a higher yield of 195.6 per cent than with the traditional practice of cultivation. The study also indicated that the net return in the case of farmers' practices is Rs 2856/ha whereas it is Rs 31498/ha when the improved technology of LT is followed.

***Farmers' Practice (Broadcasting) versus System of Millet Intensification*:** A total of 25 farmers participated in this trial. The results of this study show that average grain yield using farmers' practice is 7.32 qtl/ha as against 21.2 qtl/ha using SMI method of cultivation, a 187.3 per cent higher yield. Correspondingly, the average net income received by the farmer was Rs 34585/ha while it was Rs 3075/ha using farmers' practice.

***Training, Capacity Building and Other Support*:** Two capacity-building training programmes on integrated nutrient and pest management were organized for the participating farmers in millet demonstration

trials. A total of 64 farmers (male: 37; female: 27) belonging to 10 villages were trained on the preparation and application of organic basal doses, vermicompost, beejamruta, jeevamruta, amrutjal, handikhata and so on. Three farmers' field days were organized during the pre-harvest and harvest stages of the crop. In addition, 65 farmers (male: 45; female: 20) from 3 villages were invited to the millet demonstration plots. Improved varieties of finger millet, such as GPU-66, GPU-28, ARJUN, KMR-204, ML-365 and CHILIKA, were demonstrated along with the local varieties, such as Batimandia, Jammandia, Badamandia, Chillimandia and Dushramandia. The farmers were very happy to observe the crop performance of different varieties following different technologies and learned which technology of cultivation and which varieties perform well. To reduce the drudgery of women in weeding and for smooth harvesting of millets, 5 cycle weeders and 200 sickles were distributed to 100 farmers from 11 villages under 5 GPs in Koraput block. Besides drudgery reduction, the cycle weeder also helps in softening the soil and enhancing tillers per hill, which enhances yield.

202.2 Odisha Millet Mission

MSSRF is the facilitating agency for Kundra block of Koraput district under the state government initiative to promote millet cultivation and consumption; the programme successfully completed its third year. During the year, 1117 farmers covering 93 villages under 13 GPs were mobilized through a series of capacity-building training programmes and exposure visits to cultivate finger millet in 439 ha by adopting improved agronomic practices such as SMI and LT.

***Crop-Cutting Experiment*:** A total of 23 samples were randomly selected from the 1117 farmers during kharif 2019 for testing dry grain weight. The highest dry grain weight of 8.19 kg/25 sq.m was recorded in the SMI field of Mr Dhanurjay Gouda of Gunthaguda village, Ghumar GP. This was higher than the 7.22 kg recorded in the previous year and works out to an estimated yield of 32.40 qtl/ha; this is a very good yield given the average yield of 16.85 qtl/ha in the block.

***Incentives to Millet Farmers*:** A total of 1116 farmers have been registered to receive incentives from the government as prescribed for adoption of different agronomic practices, such as Rs 5000/ha of land under SMI and Rs 2500/ha of land under LT in first year, Rs 3000/ha and Rs 1500/ha in second year, and Rs 1500/ha and Rs 1000/ha, respectively, in the third year for following such practices. A total amount of Rs 15.71 lakhs is to be received by farmers under this programme for the reporting year.

***Procurement of Millet through Mandis*:** Massive awareness was created on registration and procurement of finger millet through mandis; there was also a hike in the minimum support price (MSP) from Rs 2897/qtl to Rs 3150/qtl. A total of 1185 farmers registered themselves to sell their produce through the mandi and 370 of them sold 1803.20 qtl before the lockdown due to Covid-19 in March 2020. The proceeds of Rs 56.8 lakhs have been

directly deposited into their respective bank accounts.

***Training and Awareness Programmes*:** During the year, 33 training programmes were conducted on SMI, LT, good agronomic practices, preparation and application of organic inputs and seed centre management; 365 farmers (male: 281; female: 84) participated in these programmes. Moreover, 12 awareness programmes on household consumption of millet, registration for selling finger millet in mandi and addressing frequently asked questions (FAQs) on maintenance of grain and procurement guidelines of the government of Odisha were organized in all the villages.

***Finger Millet Seed Production in Rabi 2019*:** To meet seed scarcity during kharif 2020, steps for quality finger millet seed production were initiated in 15 villages under five GPs involving 84 farmers and covering 87.5 acres under improved agronomic practices and crop technologies. Local millet varieties such as Badamandia, Batimandia and Dushramandia and improved varieties such as Arjun and Bhairabi were cultivated. Eight random samples were taken for crop-cutting experiment in an area of 25 sq.m; the highest fresh weight recorded was 15.97 kg/25 sq.m and dry weight was 8.46 kg/25 sq.m.

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 been training farmers on its objectives: improved seed production technologies and sustainable livelihood security through economic empowerment. Koraput district is the site for finger millet seed production and Ganjam district for green gram seed production.

***Ganjam*:** The project area covers two GPs in Chikiti block of Ganjam district, reaching out to 160 farmers across five villages. The focus during the year was to produce certified seeds over an area of 250 acres: IPM 02-03 covered 110 acres and IPM 02-14 covered 140 acres. Four quintals of foundation seeds were procured from Odisha State Seed Corporation Ltd (OSSC) at Rs 115.50/qtl and 21 qtl from Bahuda FPC Ltd at Rs 102.50/qtl for production of certified seeds. Breeder seeds (80 kg of IPM 02-14) were procured from the Centre of Pulses Research Institute (CPR), Berhampur, Ganjam, to produce foundation seeds. Capacity-building training on improved cultivation practices and seed production technology was organized for the participating farmers. Officials from CPR, KVKs, district agriculture department and Odisha State Seed and Organic Products Certification Agency (OSSOPCA) visited the green gram seed production fields at various stages of crop development and provided necessary guidance to the farmers.

The highest recorded yield of the winter crop was 11.95 qtl/ha in case of IPM 02-14 and the total production was 132.4 qtl; the highest yield recorded of IPM 02-03 was 7.5 qtl/ha and 112.5 qtl were produced. In comparison, the yield of the local variety Ganjam Desi, cultivated under the transitional *paira* method, was only 2.08 qtl/ha. Following this, early

summer crop was sown, which yielded 160.1 qtl of IPM 02-14 and 120 qtl of IPM 02-03. This is being processed and graded. Out of the total 525 qtl seeds produced in the two seasons, 218.5 qtl have been sold to a private seed agency at Rs 87/kg. The OSSC has agreed to procure 160 qtl of certified seeds, but the rate has not been announced. The remaining seeds will be procured by the private seed agency at the rate fixed by the government. A total of 80 kg of breeder seeds of green gram IPM 02-14 were provided to two farmers for production of foundation seed on 10 acres; 25 qtl of foundation seed have been produced and will be used for certified seed production in 2020–21.

***Koraput*:** During kharif 2019–20, 210 farmers were involved in certified seed production. Foundation seeds of finger millet (300 kg of KMR-204 and 100 kg of VL Mandua-352) were obtained from OSSC, Jeypore division. The seeds were distributed to 152 identified farmers for certified seed production covering an area of 60.8 ha. The farmers were registered under OSSOPCA, and the seed production activity was carried out under the supervision of the seed certification officer, Jeypore, and close monitoring by us. Crop-cutting experiment showed that average yield of KMR-204 was 16.19 qtl/ha and that of VL Mandua-352 was 11.90 qtl/ha. Moreover, 100 qtl of certified seeds of KMR-204 and 10 qtl of VL Mandua-352 were procured from farmers and sold to OSSC, Jeypore division.

***Soil Testing*:** A total of 128 soil samples were collected from the fields of millet farmers in Koraput and 50 samples were collected from Ganjam and submitted for analysis to the government soil testing laboratories in the two districts. The results of soil analysis showed that the soil pH is acidic in nature and accordingly recommendations were given to farmers.

***Varietal Trial in Finger Millet*:** Two participatory varietal trials in two different locations were conducted with six improved varieties and five local varieties at the village level, and a trial was conducted at the office campus (BPTAbC) in which 20 local and 10 improved varieties were demonstrated. It was observed that the performance of KMR-204 and Arjun was better than that of other improved varieties. At the same time, in traditional check varieties, performance of Kurkutimandia and Batimandia was comparatively better than that of other traditional varieties.

***Farmers' Producer Company*:** FPCs have been formed and registered in both Koraput and Ganjam. Kolab FPC Ltd. in Koraput has 163 member farmers, each of whom has contributed Rs 100 as share capital and Rs 20 as registration fee. In Ganjam, 156 farmers came together to form Bahuda FPC Ltd. in Chikiti.

***Capacity Building*:** In Ganjam, 5 training programmes on seed treatment and integrated pest and disease management, covering 147 farmers (male: 98; female: 49), were organized; an exposure visit was organized to project villages in Koraput, in which 22 farmers (male: 15; female: 7) participated. World Pulses Day 2020 was observed with 150

participants (male: 83; female: 67). In Koraput, 14 training programmes were conducted on seed production, integrated nutrient management, integrated pest management, improved crop cultivation and post-harvest technologies in which 548 farmers (male: 319; female: 229) participated. A farmers' field day was also observed at Machhra, Koraput.

***Documentation*:** A video documentary on alternative seed system model (ASSM) of finger millet has been produced. One training module has been developed on finger millet seed production technology and two modules on improved cultivation practices for finger millet and green gram.

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

Aqua and agriculture integrated farming system models (IFSMs) are being demonstrated under the project, together with income-generating activities for the landless and small-holder farmers.

***Aqua-Based Interventions*:** Five aquaculture models (three individual and two community) involving 24 households were developed during the year covering an area of 4 ha (each unit 0.80 ha). In each model of 0.80 ha, the pond area is 0.70 ha and the remaining area is used for paddy and vegetable cultivation during the kharif season and green gram, black gram and vegetable cultivation during the rabi season. In August 2019, 8000 yearlings of catla, rohu and mirgal fish were stocked. Farmers were also provided with lime, fish feed, ducklings and seedlings of papaya, drumstick, banana, amla, custard apple, yam and vegetable seeds for plantation in the pond dyke and adjacent land as demonstration of IFSM. The first round of harvest has been completed in all five ponds. A total of 912 kg fish were harvested, out of which 82 kg (9 per cent) was used for consumption, 30 kg (3 per cent) distributed to neighbours and relatives and the remaining 800 kg (88 per cent) sold within the village at an average rate of Rs 160/kg.

***Agriculture-Based Interventions*:** During the year, 52 farmers were involved in agricultural interventions during the kharif season, covering an area of 52 acres under paddy, 26 acres under finger millet, 10.4 acres under maize and pigeon pea intercropping as well as in backyard kitchen gardening. A total of 21 farmers were involved in commercial vegetable cultivation covering an area of 10.5 acres. Harvesting of all the crops has been completed and harvest data collected from each farmer. Suma Gold, a high-yielding paddy variety, was introduced under paddy cultivation and under improved agronomic practices yielded 49.5 qtl/ha as compared with cultivation of other high-yielding variety MTU-1001 using farmers' practices, which gave an average yield of 34.3 qtl/ha. In case of finger millet, KMR-2014, an improved variety, yielded 24.6 qtl under LT as compared with farmers' varieties with an average yield of 11.5 qtl/ha. Apart from this, farmers harvested both green cob and matured cob in case of maize and tender pod and matured grain in case of pigeon pea, which was used for their

home consumption. As part of the technology intervention, 16 cycle weeders and 16 sprayer machines have been supplied to 16 villages. Six vermicompost pits have been constructed in as many villages; 12.5 acres involving 26 farmers were covered under green gram and 12.5 acres involving 27 farmers under black gram during the rabi season. Harvesting is under process.

***Landless Families and Group Activities*:** As part of livelihood support, 20 WSHGs involving 212 women were engaged in mushroom cultivation. One activity round of 45 days yielded 2126 kg of mushroom, an average of 106 kg per group. About half (49 per cent) of the produce was used for home consumption and the remaining 51 per cent sold within the village at Rs 130/kg. The cost-benefit ratio of this activity works out to be 2:5. Sheep-rearing has been promoted by giving 400 sheep (1:3 ratio of male and female) to 100 landless families. Utensils have been supplied to 50 WSHGs for making value-added products.

***Trainings and Exposure Visits*:** Different types of training programmes on aquaculture and agriculture were conducted over a period of 24 days. A 2-day residential training programme was organized at MSSRF, Jeypore, on IFSM, and 53 farmers (male: 35; female: 18) participated. Six training programmes on land preparation and care management of commercial vegetable cultivation were conducted and 80 farmers (male: 42; female: 38) participated. In case of animal husbandry, two training programmes on care, management and vaccination of the sheep were conducted with 41 participants (male: 17; female: 24). Ten village-level training programmes were conducted on mushroom cultivation, and 117 female farmers participated in the programme.

202.5 Sustainable Livelihood Enhancement through Empowering Tribal Women

The tribal farm families in this region use traditional practices such as broadcasting of seeds of millet and manual weeding, which are expensive and time consuming. Under the project, women from 600 farm families across four villages in Koraput block are being engaged with to enhance their livelihood security. One more village that had been chosen was dropped due to the very small number of land-holder households.

***Improved Agronomic Practices to Enhance Productivity in Millets and Paddy*:** Improved agronomic practices such as SMI and LT by raising the seedling in the raised bed nursery were demonstrated to enhance the average crop yield. Millet demonstration trials were conducted during kharif 2019 in all four villages. A total of 99 farmers were involved in the cultivation of 59.80 acres using improved agronomic practices along with the farmers' practice of broadcasting. Significant yield difference was observed, with both yield and net income being highest under SMI, followed by LT and finally by broadcasting.

In kharif 2019, LT trials with paddy were conducted in the fields of 38 farmers covering an area of 19.15 acres across four villages

– Mendhaguda, Machhara, Bogeipadar and Padheiguda – using landraces. Farmers are widely using Naveen, an improved variety of paddy. Trials were conducted taking two landraces, that is, Kalajeera and Machhakanta, to promote the conservation, cultivation and consumption of traditional varieties. Crop-cutting experiment was conducted by marking a plot of 25 sq.m. Biometric observations were recorded in all demo fields. The LT method showed a higher yield of 2.08 tons/ha compared with 1.55 tons/ha with farmers' practice. In rabi 2019–20, system of rice intensification (SRI) trials were taken up by 3 farmers, LT by 14 farmers and farmers' practice of broadcasting by 11 farmers.

***Capacity Building*:** Twelve capacity building training programmes on integrated pest and disease management, use of cycle weeder, biofertilizer application, preparation and application of beejamruta, handikhata, jeevamruta, neemastra and amrutjal were conducted for 701 farmers (male: 372; female: 329). Exposure visits to demonstration fields of finger millet and paddy were organized for 105 farmers (male: 42; female: 63). A field day was organized for 65 farmers (male: 27; female: 38) of Mendhaguda, Machhara and Padheiguda in the millet demo field of Ms Padma Balodi from Bogeipadar village. Value-chain orientation training was conducted for four SHGs to prepare millet soup, muruku, kheer, biryani, idli, pakoda, laddu, jackfruit chips and so on. As a follow up, group members prepared millet muruku, pakoda and laddu and sold the products in nearby markets. A team of six tribal women and three staff members went on a training-cum-exposure visit to the eco-preneurship development centre of MSSRF at Kolli Hills, Tamil Nadu. The objective was to train marginal and small women farmers to add value to millet products to enhance consumption in their daily food practices, build their entrepreneurship skills by packaging, labelling and branding of millet value-added products, learn the operating process of millet and paddy processing units and gather the cultivation experience of spices such as black pepper, cloves, cardamom and so on. They also learnt some new millet recipes such as rava dosa and upma mix.

***Community Seed Bank*:** To conserve traditional varieties and provide access to quality seeds to the farming communities, the concept of CSB was introduced and three were established in the villages of Machhara, Mendhaguda and Bogeipadar. The CSBs are being maintained and managed by WSHGs. Ten varieties of millets and six varieties of paddy landraces are conserved in the CSBs. About 73 farmers accessed 150 kg of seeds of finger millet of three landraces – Badamandia, Kurmabati and Batimandia – and 100 kg of paddy landraces such as Kalajeera and Machhakanta from the CSB. Finger millet seeds of 176 kg and 56 kg of landraces of rice have been returned to the CSBs after harvest.

***Formation of Grassroots Institution*:** A farmer producer group named Sabari Producer Group, having 30 female members covering five villages, has been formed and linked with Odisha Rural Development and Marketing Society (ORMAS), which has

provided a revolving fund of Rs 200000 for preparation and marketing of various value-added products of millets and jackfruit. Market linkage has been created by ORMAS. This group was privileged to exhibit and sell their products at a national conclave of tribals organized jointly by the National Academy of Sciences, India (NASI) and Institute of Life Sciences (ILS), Bhubaneswar, during 24–25 February 2020.

202.6 Conservation of Biodiversity

***Biju Patnaik Tribal Agro-biodiversity Conservation Garden, Jeypore*:** The ethno-medicinal plants garden on a campus covering 7.20 acres of land has 724 species, including around 24 rare, endemic and threatened plant species. The garden was established with a focus on the knowledge and use of medicinal plants by nine major tribal communities of undivided Koraput district, that is, Paroja, Bhumia, Bhadra, Gadaba, Kandh, Gond, Soura, Koya and Bonda. In addition, there is a paddy conservation plot with 132 landraces; a millet conservation plot with 46 varieties of finger millets and 8 varieties of other millets, that is, little millet (2), proso millet, foxtail millet, kodo millet, pearl millet (2) and barnyard millet; and a wild food garden containing 62 species of wild fruits, leaf and tuber plants of this region. A nutrition garden having 200 varieties of vegetable and fruit plants has also been established (see SPA 504 for more details). During this reporting year, around 3000 plants belonging to 27 species were propagated and provided to 42 schools, the forest department, NGOs, traditional healers, district headquarter hospital, charitable trusts and individual plant lovers. Besides medicinal plants, the traditional healers and forest departments were also provided with seed materials of some of the medicinal plants.

In addition, around 50000 saplings of different nutri-rich plant species such as papaya, drumstick, amla, guava, custard apple, ST-14 sweet potatoes, wood apple and so on were propagated in BPTAbC, Jeypore, nursery. A total of 15000 saplings were distributed in 10 villages covering 800 households of three blocks in Koraput district, and 2000 saplings were distributed to visitors and community members from parts other than the project area. More than 2500 school and college students and faculty members from Agriculture College, Kalahandi, OUAT, Central University Koraput, Centurion University, Paralakhemundi, and so on, along with progressive farmers from different parts of Odisha, Chhattisgarh and Maharashtra, visited the garden as part of their study tour and exposure visits.

People's Biodiversity Register**:** As a resource agency, MSSRF had undertaken the task of preparation of people's biodiversity register (PBR) with support from Odisha Biodiversity Board (OBB). In this context, MSSRF has formed Biodiversity Management Committees (BMCs) in 37 GPs with 259 members covering 185 villages from Boipariguda, Jeypore, Kundra and Boriguma blocks of Koraput district. This year, the responsibility of preparing BMCs in the district as per the guideline of Ministry of Water Resources was given to the Panchayati Raj Department along

with Department of Forest and Environment. MSSRF is considered a resource agency by the district administration to guide and provide necessary training to the concerned department staff members. A district-level capacity-building training programme was organized for different cadres of forest officers by the divisional forest officer (DFO), Koraput, under the guidance of MSSRF. In another instance, training was given to the project director, District Rural Development Agency (DRDA), district departments of agriculture and animal husbandry, fishery officer, DFO, Koraput and Jeypore, representatives from tribal research institution, tribal healers along with zilla parishad president and other line departments in the presence of the district collector. A 2-day capacity-building training programme was organized at the BPTAbC, Jeypore, for 90 traditional healers, traders and foresters in Koraput on sustainable harvest of medicinal plants of this region and business strategy. Follow up on the proposal for declaration of Gupteswar as 'Biodiversity Heritage Site' and visit of scientists to the Gupteswar area for documentation, were facilitated.

202.7 Grassroots Institution

Over a period of time, MSSRF formed various grassroots institutions for strengthening the workforce at the community level. To begin with, the Panchabati Grama Unnayan Samiti (PGUS) was formed in the year 2003 after the Equator Initiative Award was conferred on tribal communities of the Jeypore tract of Odisha in 2002. Three FPCs and a farmer producer group were formed in 2019 to accelerate the activities at the community level. The PGUS is working in the area of conservation of biodiversity and protective agriculture in 16 villages covering 1086 households. During the reporting year, 70 varieties of paddy landraces and 20 varieties of finger millets were conserved in 6 villages. Around 250 backyard gardens with minimum support of traditional seeds were promoted among farm families in 15 villages to ensure family nutrition. Bahuda FPC Ltd. and Kolab FPC Ltd. were formed under the ASSM project (see SPA 202.3 for details). In Kundra block, Bamandei FPC Ltd. was formed and registered under the Company's Act. A CEO has been appointed to facilitate the FPC activities; the directors of the FPC have decided on a one-time membership fee of Rs 20 and Rs 100/share; there are currently 42 members and the FPC operates under the umbrella of the Odisha Millet Mission (OMM).

Sub Programme Area 203

Community Agrobiodiversity Centre, Wayanad

Activities in Kerala are coordinated through the Foundation's Community Agrobiodiversity Centre (CAbC) in Kalpetta, Wayanad. They are being implemented under three major heads: (i) biodiversity conservation, (ii) education and capacity building and (iii) food and nutrition security. Work under a holistic rural development programme to build the resilience of communities in 30 flood-affected villages across six districts

- Wayanad, Ernakulam, Idukki, Alappuzha, Kottayam and Pathanamthitta is reported under SPA 104

203.1 Biodiversity Conservation

***Medicinal and Aromatic Rice Initiative*:** Ten new seed villages (seven in Sulthan Bathery block and one each in Vythiri, Mananthavadi and Panthaloor blocks) were established to promote the on-farm conservation of traditional medicinal and aromatic paddy varieties and 17 paddy varieties are being conserved. The seed villages act as a platform for exchange of seeds of traditional varieties and sharing farming experience. The farmers from these seed villages were given hands-on training in systematically recording the quantities and varieties of seeds exchanged; awareness on the importance of conserving the traditional paddy varieties as well as the need for carrying out panicle selection of varieties for seed purpose every 2 years through seed villages was emphasized. Across Kerala, 4520 kg of traditional paddy seeds were distributed to 142 farmers (3582 kg through 10 seed villages and 938 kg from CAbC). The farmers received a premium price of Rs 143280 by selling 3582 kg of traditional seeds through the seed villages. A yield-enhancement trial of the traditional paddy varieties through organic cultivation was undertaken using four treatments and farmers' practices: (i) Farmyard manure (FYM) + oilcakes; (ii) vermicompost + oilcakes; (iii) FYM + jeevamruta; (iv) Azospirillum + phosphobacteria + potash-mobilizing bacteria + FYM and farmers' practice. Further, two hands-on training sessions on 'System of Rice Intensification' were conducted for agricultural labourers; the 54 participants (male: 23; female: 31) were trained on various cultural activities such as seed bed preparation, planting and operation of cono-weeder.

***Promotion of Medicinal Plants and Spices*:** Technical support was extended for WSHGs engaged in medicinal plants and ginger value-addition units. Training support (29 training days) included handling of machineries, maintaining quality of value-added products, ensuring hygienic production environment, packaging and storage. The Navachaithanya Herbal Production unit run by a WSHG with 10 members produced and marketed a total of 147 kg of 10 different value-added herbal products either in powder or in liquid form, namely, herbal tooth powder, thali powder (herbal shampoo), henna powder, thaleesapathradi choornam, pain balm, arrowroot powder, uragulika (gastro tablet), murivenna (multipurpose oil), karkidakalehya and turmeric powder, and earned a gross income of Rs 78000 during the year. The electric drier and pulverizer provided to the unit helped reduce the drudgery involved and the time required for the processing of raw materials.

The ginger value-addition unit run by a WSHG named Ardrakam Ginger Initiative produced and marketed 114 kg of different products, namely, ginger tea cuts, ginger candy, ginger paste, ginger-garlic paste, ginger tamarind mix, ginger mixed muesli, dried ginger powder and dried ginger slice. According to the women

who are engaged in ginger processing, the modified ginger peeling machine provided to the group in the first year enhanced the efficiency and the quality of work, saving their time by 50 per cent and considerably reducing drudgery when compared with peeling and washing by hand. Further, a total of 700 kg of organic ginger seed material were distributed to different groups (24 women beneficiaries, 9 tribal farmers) in Wayanad as a means of extending organic cultivation of ginger and to ensure raw material supply for the value-addition unit. Additionally, the unit produced 260 kg of different value-added products from banana, mango, papaya and jackfruit during the off-season of the ginger crop. Overall, the unit was able to generate Rs 1.62 lakhs as gross income during the reporting year.

***Assessment of Agrobiodiversity Loss Due to Flood in Wayanad*:** An assessment of agrobiodiversity loss due to floods in Wayanad was conducted using geospatial tools. The study mapped 432 varieties of 48 crops being cultivated at present and identified the crop varieties both vulnerable and resilient to heavy rain, water logging and flood. The resilient varieties are listed in Table 1.

***Strengthening Local Biodiversity Governance through Participatory Action*:** A participatory natural resource mapping exercise was conducted and the management plan for biodiversity developed in four selected GPs, namely, Pozhuthana, Vengappally, Kottathara and Panamaram. This study has helped to sensitise GPs and build their capacity in conserving both natural and bioresources.

***M.S. Swaminathan Botanical Garden (MSSBG)*:** The different biological components of the MSSBG are: a garden for conserving the wild and crop diversity such as the plant nurseries, Dhanwanthary Ayurvedic garden, wild food conservatory, climbing plants area, aquatic collections, orchidarium, tuber plants area, fernery, butterfly garden, arboretum, RET conservatory, ornamental plants area, vermicompost unit and WEPIC (Western Ghats Endemic Plant Information Center) and the campus is maintained with adequate care. The database of plant species conserved at the community zone was modified according to the BGCI (Botanic Garden Conservation International) guidelines during the period. The garden was augmented with 22 species of wild

Table 1: ***Crop varieties identified as resilient to flood and heavy rain***

S. no.	Crop	Varieties
1	Rice	Thonnooram Thondi, Mannu Veliyan, Mullan Kaima, Chen bavu, Thavalakkannan, Njavara, Palthondi,Chennellu Thondi, Gandhakasala, Malli Kuruva, Ramli and Kakisali
2	Pepper	Ayimberiyan, Kalluvalli, Karimkotta, Karimunda, Thirumuriyan, Thulamundi, Valankotta, Wayanadan Bolt and Vellanamban
3	Banana	Charakadali
4	Dioscoria	Vella kachil, Neelakkachil and Kayyalapoliyan
5	Turmeric	Wayanadan and Kanthi

relatives of crop plants. It has facilitated visits of a total of 8938 plant lovers and students who were made aware of the importance of biodiversity conservation through guided tours and lecture sessions.

***RET and Medicinal Plants Conservation*:** A list of plants from the Western Ghats suited for Miyawaki forest planting (a technique pioneered by Japanese botanist Akira Miyawaki that helps build dense, native forests) was prepared as part of the conservation activities. The M.S. Swaminathan Herbarium (MSSH) with a collection of 3500 voucher specimens was maintained and 653 specimens were given new accession numbers during the year. The database of the nursery plants was modified and all transactions were computerized, which helps in proper documentation and in generation of increased revenue through plant nurseries.

For conserving threatened plant species, an ex-situ conservatory for the endemic genus 'Humboldtia' (Family Fabaceae – Caesalpinioideae) was established at MSSBG. Natural population of eight species of Humboldtia was identified from various protected areas across the Western Ghats, and 632 individuals of these species were procured and maintained at the MSSBG nursery. A new species of Sonerila (named *Sonerila sulpheyi*) was identified, taking the number of new species described so far to 20.

203.2 Education, Communication and Training

Rainfall data and other relevant information were collected on a daily basis from automated weather stations established in three different schools in Wayanad and shared with government agencies and researchers for rainfall data analysis during the 2019 monsoon season. Ten classes were conducted for children on climate change; they were taught to analyse the weather data collected from the weather stations in the schools.

'Every Child a Scientist' programme was initiated in three tribal hamlets in December 2019. The objectives of the programme are: (i) attracting tribal children for environmental education and facilitating a learning environment; and (ii) facilitating holistic development, including extracurricular activities, of tribal children and youth. The programme aids in developing infrastructure for conducting classes, facilitates training in sports (such as football) and arts and in organizing classroom lectures and debates on environment-related matters in selected tribal hamlets and schools.

A study was undertaken on the sacred groves of Meenangadi GP for sensitizing the local community and the panchayat members on the importance of conserving sacred groves. An interim report on the status and challenges of sacred groves and the action plan for conserving these groves has been submitted by MSSRF to the panchayat authority. A study of traditional water harvesting structure, 'Keni', and its functioning was taken up and an action plan for conserving such traditional water structures and assessing the technology used by tribal people to harvest drinking water in a cost-effective manner was developed.

Scientists from MSSRF played an important role in establishing a bamboo garden in Manikavu School with active support from teachers, students, Biodiversity Management Committee and Meenangadi GP. This garden consists of a collection of 36 species of bamboos reported from the Western Ghats. It serves as a training centre for educating students on the importance of biodiversity. Capacity building of 150 GP members on carbon-neutral activities was done with the support of experts from the Centre of Excellence in Energy and Environment at Government Engineering College, Kannur, and TU DELFT, the Netherlands. An action plan for enhancing carbon sequestration through promoting agroforestry and application of biochar in soil has been developed. Furthermore, meeting of experts and stakeholders has been facilitated to chalk out an action plan for converting Wayanad into a 'carbon-neutral' district.

***School Climate Education Programme*:** A school-level climate education programme has been initiated in five schools with members of nature clubs. Each school has been given three to four training and interactive sessions on climate and biodiversity by experts. Each school library has been improved by installing popular science books in the local language worth Rs 10000 in each school. Ten schools in Wayanad were provided with library books.

***Hamlet-Level Education Programme*:** The Paniya is the most backward Adivasi community in Wayanad with a high school-dropout rate in the initial years of schooling. A volunteer was selected from each of five Paniya hamlets and trained for providing hamlet-level education support to children from 238 families. Two community climate volunteers were also selected in each of these villages and trained to assist the community in managing issues related to climate change and crop management.

203.3 Food, Nutrition and Livelihood Interventions

Home Nutrition Garden to Combat Malnutrition: This intervention for addressing malnutrition is anchored in two approaches, knowledge-based and food-based, and covers 450 malnourished and vulnerable tribal families in Wayanad. The base garden consists of 29 crops (including vegetables, leafy greens, tubers and fruits), and 1230 seedlings of selected crops (moringa, citrus, curry leaf, brinjal, okra, guava, passion fruit, ivy gourd, gooseberry) were raised and distributed to the families during the period. This activity helped to enhance the homestead food crop diversity from 5 to 30 species on an average.

Additionally, community conservation plots of different varieties of tubers (23), banana (20) and pulses (32) are being maintained in five tribal hamlets and three non-tribal farmer plots to ensure buffer stock for long-term conservation of varieties. The community conservation plots are being maintained in eight field sites by 46 stakeholder families, and four new community conservation plots were established. The activity helped to ensure supply of diverse seed varieties to 20 farmers who were keen to conserve the varietal diversity. Three community conservation plot

owners were able to distribute 3000 kg of crop as seeds and earned an additional average profit of Rs 50000.

Twenty training programmes on different aspects of home nutrition gardening were organized to spread awareness on good nutrition, and 198 men and 544 women participated. Furthermore, to mainstream understanding of nutrition among the general public, nutri-food festivals and awareness camps were also conducted in association with the district Nutrition Mission. These programmes helped enhance awareness on the importance of 'dietary diversity' and means to enhance access to diverse foods in emergencies.

***Tribal Livelihood, Food, Nutrition and Health Security through Agriculture*:** MSSRF has initiated tribal livelihood, food and nutrition security interventions among the Paniya and Kattunaikka tribes in Wayanad district and Kani tribe in Thiruvananthapuram district.

In Wayanad, a 5-year programme on livelihood interventions was completed among 302 tribal families in Cheeyambam 73 colony in Poothadi GP. Major activities completed during the year included (i) planting of 22067 seedlings of pepper as intercrop in coffee garden by way of replacement due to crop damage following the destructive flood in 2018; (ii) providing veterinary support to 72 families engaged in livestock farming; and (iii) providing training in value addition and marketing of non-timber forest products such as honey, wild gooseberry, wild arrowroot and cultivated agricultural produce such as ginger, turmeric, jackfruit, tubers, leafy greens, fruits and vegetables. Animal husbandry activities were strengthened by providing vaccination and nutritional care through medical camps to cope with climate change–related health hazards. A total of 49 families who had taken loans for cow units and 23 families for goat-rearing repaid their loans on time and Rs 263914 was remitted. As part of capacity building, 35 sessions covering processing and marketing of value-added food products, livestock management, community leadership, women's empowerment and exposure visit were conducted. Collection and sale of wild honey and arrowroot yielded a benefit of Rs 3000 per family while the return from goat-rearing was about Rs 34000/family. A pilot project was initiated in Meenangadi to introduce medicinal plants as intercrop among coffee in order to enhance the income of coffee farmers. MSSRF is working with 150 tribal farmers in cultivating five selected species of medicinal plants with high commercial value.

In Thiruvananthapuram, 500 Kani tribal families from 19 hamlets of Vithura GP are the primary stakeholders. Distribution and planting of 6400 pepper seedlings was completed successfully with the active participation of Village Planning Committees (VPCs). The VPC comprised of 19 members (male: 8; female: 11) who were selected leaders to represent the 19 hamlets. The survival rate of crops such as pepper (85 per cent) arecanut (58 per cent) and clove (60 per cent) during the period was rated good. Toolkits containing five items – two sets of garden hoes, pickaxes, garden knives and a garden basket – were provided to the

500 families for supporting activities in their own farmlands. Seeds of the medicinal herb Curcuma aromatica were distributed and planted in 61 acres of land. Organic manure and vermicompost, to the tune of 19.5 tons, were also distributed for supporting crop cultivation. Training programmes conducted included 14 leadership sessions for VPC team members, 19 sessions for the members of 19 family groups in the intervention site and 6 sessions on food processing and value addition for women groups. A total of 479 females and 190 males benefited from these capacity-building activities.

***Agriculture Production Enhancement through Microbial Inputs*:** The microbiology and the tissue culture laboratories' research activities on biofertilizers and plant growth promoting rhizobacteria, tissue culture of important crops and mushroom cultivation continued. Microbial inputs, such as *Pseudomonas fluorescence, Trichoderma harzianum* and *T. viride*, were produced and distributed to around 1000 farmers to control various pests and diseases affecting the growth of pepper, cardamom, ginger and vegetables. Three WSHGs were trained in the production, use and application of bio-inputs. The production technology for bio-inputs was transferred to the WSHGs, and they took up this an activity for additional income generation. During the reporting period, 2.3 tons of *Trichoderma* spp. and 2.5 qtl of *Pseudomonas* spp. were produced and sold to the farmers. In addition, 12 tons of vermicompost enriched with *T. harzianum* were sold to farmers in Idukki.

Three hundred tissue-cultured saplings of banana were raised in the laboratory and planted in trial plots for yield trials. Varieties tried included Attunendran, Nadannendran and Grand Nain. These saplings were given to six farmers within and outside the district for field trials. Another 300 saplings of banana are being raised in the laboratory for the hardening unit. An entamopathogenic nematode *Heterorhabditis indica* is the latest addition to the laboratory during the reporting period.

During this period, 535 students from various schools and colleges and 441 farmers visited the laboratory for basic knowledge about the functioning of a laboratory and for availing farm input services rendered by the laboratory.

***Sustainable Watershed Development Plan*:** This ongoing project is focused on sustainable development in 30 village watersheds of Wayanad district. Support services were facilitated for Village Watershed Committees (VWCs) with an average of 14 members in each committee in the areas of sustainable farming, capacity building through training sessions and auditing. An area of 6440 ha was covered under sustainable farming, which benefitted around 6200 families. The interventions aided in converting 15 acres of fallow land to land fit for rice cultivation in Periya and Athikolly watershed areas. Farmer groups in the area produced around 5 tons of pulse seeds and distributed 640 kg to 32 farmers. Eleven bi-monthly review meetings were conducted at CAbC for VWC representatives.

***IWMS (Integrated watershed management scheme) Noolpuzha Watershed*:** MSSRF initiated the integrated watershed management programme in five villages of Noolpuzha GP. The goal of the project is to devise a watershed approach to enhance the water availability and water use efficiency in selected villages. A VWC has been formed at the watershed level and a Project Monitoring and Implementation Committee (PMIC) at the district level.

***KFW (Kreditanstalt für Wiederaufbau) Soil Project*:** KFW soil project-integration of watershed development for rehabilitation of degraded soil and climate change adaptation was initiated in November 2019 at Chettipambra and Pannikkal watersheds. The goal is to promote investments in improvement, stabilization and conservation of natural resources, minimize the risk of climate change and increase the productivity and income of communities living in the watershed areas.

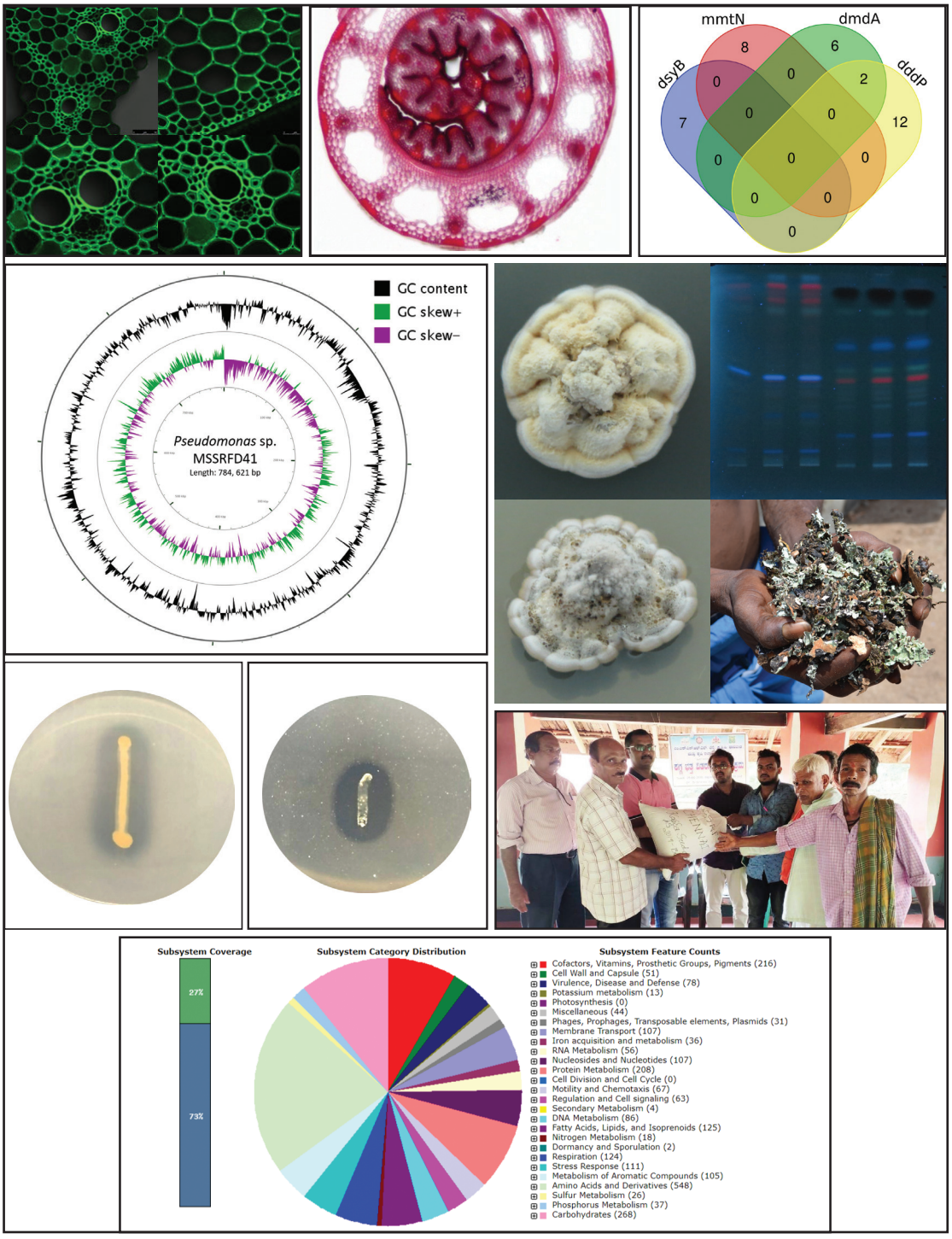
203.4 Grassroots Initiatives

***Wayanad Agri-Marketing Producer Company*:** The outlet for 'Safe to Eat'/Organic Eco Shop at Kalpetta has ensured marketing of quality products such as organic rice, coffee, spices, pulses, seasonal vegetables, fruits, honey and diverse value-added products. The FPC has increased its membership from 80 to 125. It has procured and sold 22000 kg of vegetables, 3500 kg of traditional rice, 1000 kg of scented rice (Gandhakasala), 300 kg of honey and 200 kg of value-added products of coffee and spices during the reporting period. As part of business promotion, Wayanad Agri-Marketing Producer Company (WAMPCo) participated in Pre-VAIGA Fest 2019 in November 2019, organized Onam Chanda during 3–11 September 2019 at Kalpetta, participated in an exhibition during 7–9 August 2019 at Chennai and conducted a Mango Fest during 22–27 May 2019. The turnover of the FPC in 2019–20 was Rs 11.10 lakhs.

Programme Area 300

BIOTECHNOLOGY

The three sub-thematic areas in the Biotechnology Programme at MSSRF use cutting-edge biotechnological tools that address different areas of research, namely, crop abiotic stress tolerance and nutritional enhancement, developing microbial products for promoting crop yield enhancement and isolating novel compounds of pharmaceutical importance from lichen species. Under the subtheme 'Genetic Enhancement', the study of mechanisms governing salinity tolerance in halophytic wild rice Oryza coarctata *using transcriptomic, cell and molecular biological methods has been continued. In addition, mechanisms conferring salinity tolerance to cultivated rice* Oryza sativa *L. landraces have also been elucidated. The subtheme 'Bioprospecting' established additional lichen cultures and subcultures for the biosynthesis of secondary compounds and a lead molecule. The group also carried out a baseline survey on non-timber forest product (NTFP) collectors, especially lichen collectors in the lower Palani Hills. Under the subtheme 'Microbial Diversity', screening and characterization of micronutrient-mobilizing plant-growth-promoting strains and whole genome sequence analysis of the* Pseudomonas *sp. MSSRFD41 have been carried out. Dimethylsulfoniopropionate (DMSP) synthesizing and catabolizing bacterial strains have been isolated and characterized.*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dmdA
dsyB
dddP
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6
0
0
2
7
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12
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0
0
GC content
GC skew+
GC skew−
Pseudomonas sp.
MSSRFD41
Length: 784, 621 bp
Subsystem Coverage
27%
73%
Subsystem Category Distribution
Subsystem Feature Counts
Cofactors, Vitamins, Prosthetic Groups, Pigments (216)
Cell Wall and Capsule (51)
Virulence, Disease and Defense (78)
Potassium metabolism (13)
Photosynthesis (0)
Miscellaneous (44)
Phages, Prophages, Transposable elements, Plasmids (31)
Membrane Transport (107)
Iron acquisition and metabolism (36)
RNA Metabolism (56)
Nucleosides and Nucleotides (107)
Protein Metabolism (208)
Cell Division and Cell Cycle (0)
Motility and Chemotaxis (67)
Regulation and Cell signaling (63)
Secondary Metabolism (4)
DNA Metabolism (86)
Fatty Acids, Lipids, and Isoprenoids (125)
Nitrogen Metabolism (18)
Dormancy and Sporulation (2)
Respiration (124)
Stress Response (111)
Metabolism of Aromatic Compounds (105)
Amino Acids and Derivatives (548)
Sulfur Metabolism (26)
Phosphorus Metabolism (37)
Carbohydrates (268)

Sub Programme Area 301

Genetic Enhancement

Salinity tolerance is a complex and multigenic trait in plant species. Rice, among cereals, is most sensitive to salinity. In this subtheme, mechanisms of tolerance in the naturally halophytic wild rice species *Oryza coarctata* are examined. In addition, natural variation in salinity tolerance seen in coastal cultivated rice landraces (*Oryza sativa* L.) is analyzed.

301.1 Studies Related to Salinity Tolerance in *Oryza coarctata*

***Analysis of Salt-Secretory Microhairs of* O. coarctata:** Halophytic, perennial wild rice *O. coarctata* leaves show the presence of microhairs on their leaf surface furrows that secrete salt under salinity. An in vitro secretory system for *O. coarctata* leaf tissue under salinity established previously was used to examine the effect of plant hormones on leaf secretory volume and Na^+ content in secretions from the adaxial leaf surface. An efficient method for the isolation and enrichment of *O. coarctata* microhairs has been reported previously. The robustness of the microhair isolation procedure was confirmed by generating a transcriptome from microhairs under salinity conditions. A total of 551484 unique transcript sequences with average length of 631 bp were obtained. Functional annotation revealed the presence of transcripts involved in diverse cellular processes, including 310 transcription factor (TF) related transcripts and 1075 transporter-related genes in *O. coarctata* microhairs. Moreover, 3530 differentially regulated transcripts under salinity were identified in the study.

***Transcriptomics (RNAseq) of* O. coarctata *Leaf and Root Tissues*:** *Oryza coarctata* leaf and root tissue specific transcriptomes (RNAseq) generated previously were analyzed in depth. A total of 39878 sequences were annotated and 109716 gene ontology terms assigned. Of these, 7117 sequences were mapped onto the database of the Kyoto Encyclopedia of Genes and Genomes (KEGG). In leaf tissues under salinity, 206 upregulated transcripts were identified; these included several novel, uncharacterized transcripts, in addition to an ethylene responsive factor (ERF)-like TF gene. Also, 63 transcripts were downregulated, including those coding for auxin-responsive protein, nitrate reductase and benzothiadiazole (BTH)-induced ERF-transcriptional factor 4. In salinity-treated root tissues, 153 transcripts were upregulated, including several coding for uncharacterized proteins, a dehydration responsive protein and a DEAD-box ATP-dependent RNA helicase. Moreover, 880 transcripts in roots showed downregulation of expression, including those coding for 3-ketoacyl-CoA synthase, hsp90 and GHR1 protein. RT-qPCR validation of these up- or downregulated transcripts were completed and found to correlate with RNAseq data.

***Examining Apoplastic Barriers in* O. coarctata *Roots under Salinity*:** *Oryza coarctata* rice species have an elaborate rhizomatous system from which arise thin

rhizoid-like roots that help in absorption and anchorage. Microscopic examination of soil-grown *O. coarctata* roots has previously shown strong apoplastic lignified/suberized exodermal and endodermal layers suggestive of a role in controlling ion movement. On the other hand, freshly emerged *O. coarctata* roots in a hydroponic system lack these apoplastic barriers in both elongation and maturation zones and also show root hair development in the absence of salt in the medium. However, inclusion of Na^+ in the medium results in the establishment of strong endodermal apoplastic barriers in the maturation zone and to a lesser extent in the elongation zone. Moreover, exodermal apoplastic barriers are established to more or less equal extent in both zones. This optimized system will now be used to examine Na^+ distribution in both root zones under salinity.

***Examining Lignification and Suberization in the Aerial Shoot Proximal Nodes and Internodes of* O. coarctata *Rhizomes under Salinity*:** In *O. coarctata*, underground rhizomatous tissues form a substantial biomass below ground that anchors the species to the shallow soil in intertidal mangrove communities. Below-ground rhizomes are an important interface in the transition to aerial shoots in *O. coarctata* that should, in theory, control ion movement to aerial shoots. With this background, anatomical regions of the aerial shoot and below-ground rhizome regions have been examined. Distinct anatomical changes observed in leaf proximal internodes of *O. coarctata* under salinity have been documented, and these correlate with reduction of apoplastic barriers under salinity and patterns of Na^+ accumulation observed using the fluorescent dye CoroNa Green.

***Analysis of Transporter Genes and Their Regulation in Wild Rice* O. coarctata:** *HKT1*;5 genes are important determinants of crop salinity tolerance. They encode plasmalemma-localized Na+ transporters, retrieve xylem Na^+ into xylem parenchyma cells and reduce shoot Na^+ accumulation. Transport characteristics of the roots and shoots expressing *O. coarctata HKT1*;5 (OcHKT1;5) were examined in contrast to that from cultivated rice *O. sativa* (OsHKT1;5) in both yeast and *Xenopus oocytes*. OcHKT1;5 is a low-affinity sodium transporter compared with OsHKT1;5. Using homology modelling, critical amino acid residues controlling these distinctive characteristics were identified in OcHKT1;5. Site-directed mutagenesis of *OcHKT1*;5 followed by transport assays of the mutagenized construct in *Xenopus* confirmed the importance of one key amino acid change in conferring this low-affinity sodium-transporting property in OcHKT1;5. Vacuolar-localized OsNHX1 is extensively characterized in *O. sativa* and controls vacuolar accumulation of sodium. The genus *Oryza* consists of 11 diploid or tetraploid genome types (AA, BB, CC, EE, FF, GG, BBCC, CCDD, HHJJ, HHKK and KKL) with cultivated rice, diploid *O. sativa*, having an AA-type genome. Oryza *NHX1* orthologous regions (gene organization, 5′ upstream cis elements, amino acid residues/motifs) from closely related *Oryza* AA genomes were found to group distinctly as compared with NHX1 regions from more ancestral *Oryza* BB, FF

and KKLL (genome-type) species. Further, these sequence-specific differences were found to affect alternative splicing of transcripts generated from the *NHX1* gene that involve two separate intron retention events occurring in the 5' and 3' UTR, respectively. Data shows that the IR event involving the 5′ UTR is present only in more recently evolved *Oryza* AA genomes while the IR event governing retention of the 13th intron of *Oryza NHX1* (terminal intron) is more ancient in origin, also occurring in *O. coarctata* (KKLL).

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

We had previously reported about genotyping rice landraces (*Oryza sativa* L.) from saline coastal regions of India. The relative salinity tolerance of 43 rice landraces at seedling stage, using 13 unbiased morpho-physiological and biochemical parameters related to salinity tolerance, was assessed. Of the 43 varieties, 25 were tolerant, 15 were moderately tolerant, 1 was moderately susceptible and 2 sensitive checks were found to be highly susceptible based on the aforementioned parameters and assignment of standard evaluation scores (SESs) A high correlation was observed with Na^+/K^+ ratio, and cluster analysis classified the rice genotypes into six groups based on their responses to salinity. Saline-sensitive check IR29 was grouped with moderately tolerant rice landraces in Group I while more tolerant landraces were clustered in Groups III and IV. Group II had landraces that were more tolerant than those in Group I while Group VI had landraces that were more tolerant than those in Group II.

301.3 Phenotypic and Molecular Characterization of Saline-Tolerant Kagga Paddy:

The applications to recognize Kagga paddy as a saline-tolerant variety were considered favourably by the Protection of Plant Varieties & Farmers' Rights Authority (PPV&FRA), government of India. The authority has requested additional data on the biochemical parameters for finalizing approval of the applications. Currently, the biochemical data are being generated for submission to PPV&FRA.

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

The functional analysis of the abiotic responsive transcription factors for *Prosopis juliflora*, an extremely drought-tolerant tree species from the family *Fabaceae*, was continued. In the current year, the results of the expression profiling of the selected transcription factors under drought and salt stress, analysed through quantitative real-time PCR (q-RT PCR), were in alignment with the results of transcriptome profiling of *P. juliflora* under the same conditions in both the leaf and root tissues. All transcription factors analysed were found to be induced by drought and salt stress at at least one-time point of treatment. Withdrawal of the stress resulted in downregulation of expression of

all transcription factors, except for TF5 in leaf tissue under drought stress, TF1 and TF3 in leaf tissue under salt stress, and TF1 and TF3 in root tissue under salt stress. The results of the RT PCR analysis confirm the importance of selected transcription factors in drought and salt stress tolerance (Figures 1 and 2).

Figure 1. ***Expression of leaf tissue under 150 mM NaCl.***

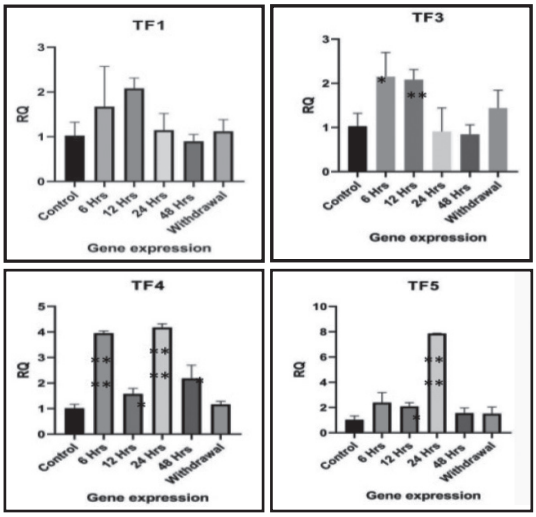
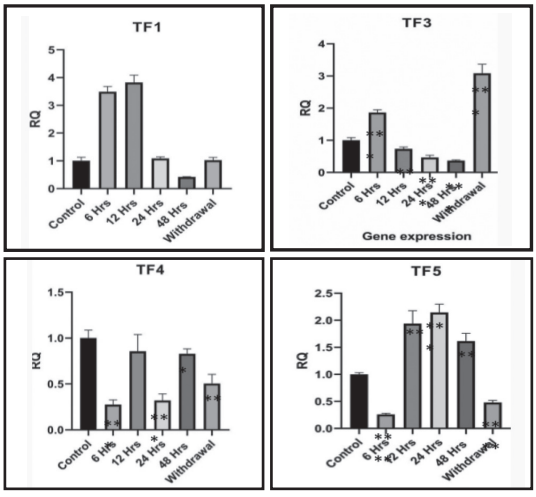


Figure 2. ***Expression of root tissue under 150 mM NaCl.***



Sub Programme Area 302

Bioprospecting

Bioprospecting research serves as a base for industries that include pharmaceuticals, traditional botanical medicines, crop protection and improvement, and cosmetics and environmental monitoring. Hence, MSSRF is involved in bioprospecting of secondary compounds from lichen cultures. In addition, the group is also involved in assessing the socioeconomic profiles of non-timber forest product (NTFP) collectors, including lichen collectors in the lower Palani Hills.

302.1 Bioprospecting of Secondary Compounds

***Lichen Culture Repositories and Secondary Compound Biosynthesis*:** MSSRF has established the mycobiont cultures of *Glyphi scicatricosa*, *Graphis caesiella*, *Graphis lineola*, *Graphis scripta*, *Platygramme caesiopruinosa* and *Trypethelium eluteriae* for the biosynthesis of secondary compounds. In addition, co-cultures, such as *Buellia subsororioides*, *Diorygma junghuhnii* and *Roccella montagnei*, were also successfully established. 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. The

sequence data were confirmed by comparing with the existing sequence available at the National Centre for Biotechnology Information (NCBI). The mycobiont cultures were treated on MY0% (MY medium without sucrose) and MY6% (MY medium supplemented with 6 per cent sucrose) for 4 months and their secondary metabolites analysed using analytical High-performance liquid chromatography HPLC equipped with photodiode array (PDA) detector. The secondary compounds were identified by matching the ultraviolet spectral data with the reference substances from the library and literature survey. The study also quantified the biomass of mycobiont cultures at various time intervals.

302.2 Conservation of NTFP Lichens and Dependent Tribal Livelihoods

Lichens are extensively collected as non-timber forest produce (NTFP) for livelihood by more than 3000 people belonging to the Paliyan tribe of the lower Palani Hills (a biodiversity hotspot), Western Ghats, India. At a time when global multidisciplinary efforts are on to understand, and strengthen, the linkage between NTFP and livelihood and poverty reduction and study extensive NTFP extraction and its impact on ecology and associated biodiversity, implementation of remedial conservation measures and the current markets and opportunities for NTFP to enhance the income of tribal communities by implementing quality control, product diversification and expansion of market, the NTFP lichen collection by the Paliyan tribe has hardly received any attention. Hence, the MSSRF programme assesses the extent of dependency on lichen species for livelihoods by both men and women vis-à-vis the impact on lichen biodiversity in the region and for establishing lichen culture protocols for the biosynthesis of compounds used in food flavouring.

***Assessment of the Extent of Lichen Species Dependency for Livelihoods*:** During this year, MSSRF has carried out the baseline survey on NTFP lichen collectors of Kodaikanal Block in the lower Palani Hills. A total of 23 villages were surveyed and about 110 NTFP lichen collectors included in the study. Paliyars and Pulaiyars were identified as the main NTFP lichen collectors in the surveyed villages. These tribal households solely depend on NTFP lichens as their major source of family income. NTFP lichens were collected throughout the year except during the rainy season (3–4 months). Each person collects approximately 1–5 kg of lichens per day from the forest. These lichen materials were procured by an intermediary at a cost of Rs 100–250/kg based on the size of the thalli and its purity (without tree bark and with the dust particles removed). The intermediary would decide the cost for procuring the collection and marketing the lichen material. In addition, MSSRF also analysed the species composition of NTFP lichens in a commercial spice product (garam masala) collected from the different locations of Kodaikanal Block. *Parmotrema tinctorum* (Despr. ex Nyl.) Hale dominated in all the commercial spice products.

Sub Programme Area 303

Microbial Diversity

Research on diversity assessment of the dimethylsulfoniopropionate (DMSP) bacterial communities of the mangrove ecosystem contributing to the sulfur cycle is continuing. The whole-genome sequence of the *Pseudomonas* sp. MSSRFD41 extensively tested under field conditions was analysed. Further, microbe-mediated biofortification of iron (Fe) and zinc (Zn) in rice by identifying micronutrient-mobilizing bacterial isolates is continuing. In addition, about 37 genotypes of finger millet, including both traditional and improved varieties, were evaluated for abiotic stress tolerance.

303.1 Microbial Community Profiling of Mangrove Ecosystem

***Novel Insights into Bacterial Cycling of Dimethylsulfoniopropionate and Related Molecules in South Indian Mangrove Ecosystem*:** The study on exploring the DMSP-synthesizing and -degrading bacterial communities of the Pichavaram mangroves of South India continued. A total of 950 bacterial isolates from nine different soil samples of the Pichavaram mangroves isolated through enrichment culturable method in DMSP-amended media were selected based on distinctive morphotype and screened for DMSP-synthesizing and -catabolizing genes. Of these, 50 isolates showed positive amplification for DMSP-synthesizing genes with -24 *dsyB* and -15 *mmtN* compared with reference-type strains *Labrenzia aggregate* LZ033 and *Novosphingobium* sp. BW1, and one strain positive for both *dsyB* and *mmtN*. About 66 strains involved in DMSP catabolism showed positive amplification of the following genes – 4 *dmdA*, 16 *dddP*, 33 both *dmdA* and *dddP*, 2 *mmtN* and *dddP*, 8 *dsyB* and *dddP*, 3 *dddD* – compared with reference strains *Ruegeria pomeroyi* DSS-3 (*dmdA* and *dddP*) and *Pseudovibrio* P12 (*dddD*). BOX-PCR-based genetic diversity analysis of the total 106 positive isolates formed 67 clusters indicating the diverse groups involved in DMSP cycling. The taxonomical position determined by 16S rRNA sequencing analysis revealed that the isolates mostly belonged to the Roseobacter group. The majority of the isolates participating in DMSP synthesis and catabolism were isolated from the rhizospheric soils of *Avicennia marina* and *Rhizophora mucronata* indicating the rhizospheric region as active zones of DMSP cycling in the mangrove ecosystem. Thus, the MSSRF study will provide deeper insights into the diversity of DMSP-synthesizing and -degrading bacterial communities associated with the mangrove ecosystems that contribute to DMSP synthesis, which functions as a key marine nutrient in the microbial food web and the global sulfur cycle, a chemoattractant for marine organisms and a major precursor for the climate active gases dimethylsulfide (DMS) and methanethiol (MeSH).

303.2 Whole-Genome Sequencing of *Pseudomonas* sp. MSSRFD41

Pseudomonas sp. MSSRFD41 isolated from finger millet rhizosphere holds several plant-

growth-promoting and disease-protection traits. The whole genome of strain MSSRFD41 was sequenced using both Illumina Hiseq and Pacbio platforms. A total of 378673 PacBio long reads and 21673550 Illumina short reads were obtained in good quality with an average of 50 bp per read. The sequence assembly produced 65 contigs representing one chromosome having an approximate size of 6053738 bp with a G+C content of 62 per cent. Further, several genes coding for plant-growth-promoting traits, such as osmotic tolerance, lytic enzymes, siderophore biosynthesis, cobalt-zinc-cadmium resistance, phosphodiesterase/alkaline phosphatase, acid phosphatase, dicarboxylate MFS transporter and Na^+/H^+ antiporter, were identified. The whole genome sequence data will be deposited at the National Centre for Biotechnology Information (NCBI), and the manuscript is under preparation.

303.3 Microbe-Mediated Biofortification of Rice by Enhancing Bioavailability of Iron and Zinc in Soil Using Plant-Growth-Promoting Rhizobacteria (PGPR)

Microbe-mediated biofortification of rice with zinc and iron can be a viable option to overcome low dietary intake and micronutrients deficiency. India being the second-largest producer and consumer of rice accounts for 22.3 per cent of global production; therefore, the present investigation is being carried out to evaluate the potential of micronutrient-mobilizing plant-growth-promoting rhizobacteria (PGPR) for enhancing the zinc and iron content in the edible portion of rice. The rhizosphere soils of about 12 different rice varieties, namely, ADT37, ADT45, ADT43, ASD16, IR50, IR37, CO51, Vellaikar, Andhraponni, IR32, VellaiPonni and SonaMasuri, cultivated in Cuddalore and Villupuram districts of Tamil Nadu were screened for obtaining potential iron- and zinc-mobilizing bacterial isolates. Different zinc sources (e.g., ZnO_2, $ZnCO_3$, $ZnSO_4$, $Zn_3(PO_4)_2$) and chrome azurols (CAS) agar were used. About 41 zinc-mobilizing, 45 iron-mobilizing and 14 bacterial strains with both zinc- and iron-mobilizing activity were identified by qualitative assay. In addition, these isolates exhibited plant-growth-promoting traits, namely, indole acetic acid (IAA), ammonia production and biocontrol activity against *Rhizoctonia solani*. Further, taxonomic identification and quantification of zinc- and iron-mobilization potential is in progress.

303.4 Screening of Drought and Salinity Tolerance in Traditional and Improved Finger Millet Varieties

Finger millet is a climate-smart, nutri-dense crop widely cultivated in rain-fed semiarid tropics. In this study, 37 different finger millet varieties, both traditional (22) and improved (15), obtained from MSSRF-Jeypore seed bank, were screened for drought tolerance using polyethylene glycol (PEG) 8000 at 10, 15 and 20 per cent, and salinity tolerance at 50, 100, 150 and 200 mM NaCl conc. under in vitro conditions. Among the varieties screened for salinity tolerance, traditional varieties Duseramandia and Tayamandia and improved varieties Arjun, MR-1, HR-911, GPU-48 and

ML 365 showed 90 and 80 per cent seed germination in 150 and 200 mM NaCl conc., respectively. In drought-tolerance assay, traditional varieties Bhairabi and Duseramandia and improved varieties Arjun and HR-911 showed 85 per cent seed germination in 20 per cent PEG, while in 15 per cent PEG, 90 per cent germination was observed in traditional varieties Murdamandia, Birimandia and Kurkutimandia and in improved varieties HR-911, MR-1, Subhara, GPU-28, ML 365 and Arjun. The improved varieties predominantly showed higher levels of tolerance to drought and salinity stress compared with traditional varieties. Further, the significant tolerance level of these varieties to drought and salinity stress needs to be evaluated. Also, comparing of the core microbiome profiles among the tolerant varieties and classifying unique abiotic alleviating traits will lead to the identification of efficient plant-growth-promoting strains to promote eco-friendly agriculture under abiotic stress.

Programme Area 400

ECOTECHNOLOGY

The programme promoted an institutional and systems framework in strengthening livelihoods and natural resource management in action research and in-depth field studies by commissioning projects in different sites. Six farmer producer organizations (FPOs) and two self-help group (SHG) federations are continuing their activities in promoting sustainable livelihoods among 13480 farmers and are also working on the sustainability dimension. One FPO has started working independently along with two SHG federations. The use of information and communication technologies (ICTs) has been integrated in promoting sustainable livelihoods and has reached more than 60000 members across field sites. A new initiative on water resource management and climate adaptation was started, and the preparation of 1287 composite water resources management plans (CWRMPs) at the gram panchayat level is being facilitated along with site-specific climate-resilient water management measures. The research study on evergreen revolution is focusing on five critical research questions along with an action research for developing a soil management decision tool. The International Network of Emerging Libraries (INELI) has nurtured 76 library professionals as innovators to build and sustain the public library movements, and 218031 members covering a diverse cross-section of people were reached.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Sub Programme Area 401

Grassroots Institutions and Sustainable Livelihoods

401.1 Coastal Agroecosystem: Mannadipet Region, Puducherry

The framework of 'biovillage', which encompasses sustainable livelihoods and natural resources management, has been the guiding point of the initiatives of MSSRF. MSSRF launched an initiative titled 'Nutrition Secure Puducherry' at a function on 2 October, Gandhi Jayanti, in the presence of Mr Narayanasamy, the Chief Minister of Puducherry. The InnuyirGramaSangam (IGS) started a new business entity, the IGS farmer producer organization (FPO), apart from its regular functions. The Pasumai Farmer Producer Company Ltd. (PAFPCL) also continued efforts in strengthening the collective actions of small-holders in accessing productive resources for agriculture. The IGS continued its focus on promoting diverse off-farm and non-farm interventions, while the FPOs are working to strengthen on-farm livelihoods. In addition, the Puducherry village resource centre (VRC) is managing the farmers' network with 5200 farmers through virtual connections and two physical village knowledge centres (VKCs). The linkages and partnerships with line departments, research institutions and financial organizations have been continued to add value to the existing initiatives.

***InnuyirGramaSangam*:** The membership base of the IGS increased to 3600 from 3340 in the past year, and it is functioning with 310 smaller groups. Considering the importance of improved nutrition in the region, in the past year, the centre established a demonstration unit of nutri-gardens, particularly with diverse nutri-rich vegetables that can supply necessary nutrients for good health. The garden is now serving as a training point for school students and women members to raise awareness on balanced nutrition. It continued its services to create access to credit for its members to undertake economic activities. During the year, the IGS signed an MoU with Puduvai Bharathiyar Grama Bank for the formation of 1000 joint liability groups (JLGs) to promote on-farm, off-farm and non-farm livelihoods. It has promoted 238 JLGs and leveraged Rs 3.8 crores for allied enterprises such as dairy farming, goatry, forage cultivation and value addition of cereals, pulses and milk. It is continuing its effort in fine-tuning the E-Shakti platform for digitization of credit transactions to ensure the transparency of accounts and have a rigid monitoring system of self-help groups (SHGs). NABARD has provided extension till July 2021 for the completion of the process. Under non-farm activities, the IGS conducted a 1-month tailoring course for 30 women. The work with single women collectives is focused more towards strengthening their economic opportunities by accessing credit and market services. During the early stage of the Covid-19 outbreak, IGS members prepared about 10000 masks and handed them over to the district collector of Puducherry.

***InnuyirGramaSangam Farmer Producer Organization*:** This year, the organization focused on increasing its shareholder base and on empowering its members and board members in particular. A total of 70 trainee days were spent in this effort. Since December 2018, 611 members have joined as shareholders and have started doing business. Currently, the annual turnover is Rs 19.18 lakhs. Two rural marts have been established to sell the produce generated by the SHGs and the farmers to the public. This year they have initiated moringa leaf powder, a brand new iron-rich 'ready-to-eat product'. Apart from this, the FPO has centralized facilities to supply neem seed powder, chicks/ eggs of Japanese quail, Kadaknath poultry, vermicompost, seedlings of vegetables and so on. To strengthen the members' access to reliable plant health services, 15 plant clinic programmes were organized, including a plant clinic session exclusively for women farmers to promote their participation.

***Pasumai Farmer Producer Company Ltd. Puducherry*:** PAFPCL has 549 shareholders (male: 79; female: 470) who are members and is organized into 35 farmer producer groups (FPG). The company extended credit support of Rs 10.5 lakhs to 110 farmers to cultivate black gram in 110 acres. Four project monitoring committee meetings were organized to strengthen business activities. PAFPCL availed a credit of Rs 5 lakhs from Indian Bank for the procurement of pulses and groundnut. For seed purposes, 4 tons of groundnut and 2 tons of black gram were purchased from the shareholders. In addition, 2 tons of black gram were processed and 1 ton of groundnut oil extraction was done, and both the products sold to their members and also through outlets. PAFPCL participated in various exhibitions to expand their visibility and business relations. The board of directors (BoDs) also assessed the production capacity of its shareholders with regard to black gram, moth bean and paddy to establish value-addition centres at the local level. To increase business activities and also fulfil the shareholders' monthly requirement of groceries, PAFPCL plans to start door delivery. A trial was carried out and the profit margin was found to be high in the grocery business. Village meetings were organized to strengthen the loan recovery system, and 87 per cent of overdue loans were recovered. PAFPCL applied to NABARD for establishing two rural marts and the BoD also decided to establish an agriculture service centre at Sorapet village. The license for obtaining seeds, fertilizers and pesticides from the concerned department is under process. An application for one-time financial assistance of Rs 10 lakhs has been submitted to the Department of Agriculture and Farmers Welfare, Puducherry.

***Sustainable Agriculture Technologies*:** Two new initiatives were undertaken to improve ecosystem services in the agricultural landscape and sustain the productivity of important crops. The first focused on improving pest regulation and pollination services by adopting the principle of ecological intensification (EI); it is being studied under the project 'Sustainable Farming through Effective Pollination and Pest Regulation in India (SuperFarm)', launched in collaboration with the University of Reading, United Kingdom.

The project aims to explore opportunities for ecologically intensive farming interventions in economically important crops in North and South India. We will quantify the impact of contrasting landscapes on biodiversity and ecosystem service provision; explore barriers and incentives that influence farmers' behaviour towards more environmentally sustainable practices; and focus on stakeholder engagement from inception through to dissemination of project results.

The second initiative focuses on below-ground microbial diversity through a recently funded Indo-Swiss project that will soon be launched in India in collaboration with the University of Basel, Switzerland, and Tamil Nadu Agricultural University. In dryland agriculture, deep-rooting plants, intercropped within shallow-rooting ones, may act as 'bioirrigators' that can transfer water from deep soil layers to the topsoil for the benefit of the system. Our recent experiments have shown that bioirrigation is facilitated by the presence of arbuscular mycorrhizal fungi, which connect the intercropped plants by a common mycorrhizal network (CMN). The aim of this project is to identify the morphological, physiological and competitive traits that make the plants ideal for bioirrigation in CMN-facilitated intercropping systems.

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

The key focus of the intervention is to improve the resilience of farmers, both men and women, to address the challenges in production and marketing of farm products. Important strategies such as building the capacity of the farmers to take informed decisions and to adopt appropriate technologies, promoting innovation in sustainable agricultural practices, enhancing the farmers' network and encouraging 'eco-preneurship' have been continued with two grassroots institutions at the local level: Kulumai Producers' Federation and Reddiyarchatram Sustainable Agriculture Producers' Company Ltd. (RESAPCOL).

***Kulumai Producers' Federation*:** It has a membership of 293 SHGs (male: 5; female: 288) belonging to 65 villages of Reddiyarchatram block of Dindigul district. Currently, it has a membership of 3958, and during this year, 15 new SHGs, consisting of 158 SHG members, were formed. It has successfully completed the profitable milch animal–rearing and paravet training programmes under Area Development Program Project sanctioned from NABARD to Kulumai Federation. Around 375 milk producers (male: 63; female: 312) were trained on profitable milch animal–rearing in 10 batches, and 30 rural women's SHGs were trained on paravet aspects for a period of 24 days. The final report has been submitted to NABARD. Under Kulumai Social Security Insurance Scheme, 2077 members are availing services; of these, 432 are senior citizens who have limited access to insurance services; and 325 new members were enrolled. Credit support of Rs 2.73 crores was availed by linking 83 SHGs (875 members) with NABARD Financial Services (NABFINS), Dindigul, for initiating various livelihood activities such as milch animal purchase,

goat-rearing, agriculture, country chick-rearing and for house repairing and closing higher-interest external loans. Kulumai also provided credit support of Rs 11.25 lakhs to 45 SHG members for low-cost toilet construction. With the support of Life Insurance Corporation of India, Dindigul branch, life insurance schemes were introduced for its members; around 580 members have joined the scheme, and a premium amount of Rs 34.8 lakhs was collected. Each insured member who is alive will get a maturity amount of Rs 2.5 lakhs after 12 years.

***Kulumai Milk Producer Company Ltd.*:** KMPCL has a membership of 997 shareholders (male: 117; female: 820) with a share capital of Rs 9.87 lakhs. Around 32 new shareholders have joined the company in this reporting period. In collaboration with ABT Foods Pvt Ltd., Kulumai has continued to run 15 milk collection centres, which ensured procurement, storage and timely payment. On an average, a shareholder can get an additional Rs 4–5/litre of milk. Daily milk collection is 2300 litres, and the monthly turnover is Rs 19.32 lakhs. KMPCL supplied 85 tons of good-quality concentrate cattle feed at lower cost in comparison with the products available in the market, thereby helping members reduce their cattle feed expenditure by 10–15 per cent. The annual turnover of the company through various services is Rs 47.5 lakhs. In addition to marketing of milk, KMPCL has introduced monthly grocery supply to its shareholders, starting with a pilot covering 50 families in five villages. Shareholders can get their monthly grocery package at Rs 1500 through this scheme and save up to Rs 350 by avoiding intermediaries. They can repay this money through their JLGs in four equal instalments. Steps have been taken to expand this scheme to all other working villages from 32 to 58.

Five animal health camps were conducted in collaboration with local dispensaries benefitting nearly 325 cows, 550 goats and other animals. These camps have been helpful in imparting milch animal–related interventions, such as training on fodder cultivation and management, inputs, azolla, improvement of milk production and quality standards. Through the animal health camps, people lacking access to veterinary dispensaries due to the clinics being located far away have benefitted and awareness about the importance of vaccination has increased.

***Reddiyarchatram Sustainable Agriculture Producers' Company Ltd.*:** RESAPCOL received support of Rs 60 lakhs from Tamil Nadu Small Farmers Agri-business Consortium (TNSFAC) for establishing a seed processing unit cum storage facility on its premises. Through this facility, RESAPCOL farmers can get additional revenue through pulse seed production. Training programmes on new agricultural technologies, such as battery sprayer, seedling planting machine, simple weeder, fertilizer application machinery and simple drip irrigation technology, were organized by the company to reduce the drudgery faced by women farmers; five rounds were organized and 153 women farmers attended. Training was conducted for farmers

by experts from Krishi Vigyan Kendras (KVKs), agriculture and horticulture departments and MSSRF. It facilitated access to Rs 49.2 lakhs from NABFINS Ltd., to 123 shareholders for the starting of microenterprises such as milch animal–rearing, goat- and country chick–rearing, tailoring, petty shop, agriculture and so on. The value-addition unit processed 3275 litres of groundnut oil worth Rs 5.56 lakhs and coconut oil worth Rs 1.57 lakhs. It has facilitated access to organic and other agriculture inputs, such as *Trichoderma viride*, *Pseudomonas, Bacillius* and so on, to farmers. Pheromone traps and sticky traps worth Rs 12.73 lakhs have been sold to around 836 farmers from various districts covering an area of 2730 acres. More importantly, it aggregated and sold cotton, maize and black gram seeds worth Rs 45.7 lakhs, to cover an area of 1350 acres, 1230 acres and 37 acres, respectively, under each. Procurement of 582 tons of maize was done from 287 farmers and collectively marketed for Rs 1.04 crores. Similarly, 23 tons of cotton from 85 farmers worth Rs 9.66 lakhs were procured. Under this initiative, small and marginal farmers have the benefit of better price and proper weight than other farmers, and the company earned Rs 2.23 lakh as net profit. It successfully organized a women entrepreneurs' conference at Kannivadi on 27 June 2019 to share the experiences of women entrepreneurs trained through the activities of the Life Long Learning of Farmers Project (L3F). Around 1200 women and men farmers participated in this meeting.

RESAPCOL organized an awareness meeting on implementation of MobiMOOC pilot project for the shareholders of FPOs of Dindigul and Karur districts, in which NABARD, KVK, agriculture department officials and 15 FPOs participated. It has organized a 2-day training programme on business plan preparation for BoDs as well as staff of RESAPCOL in collaboration with Thiagarajar School of Management, Madurai. Based on training, RESAPCOL has developed a business plan on cattle feed production. During the reporting period, a total of 584 contents were developed on agriculture (323), animal husbandry (126), corporate literacy/FPC (107) and government schemes (28) and distributed by RSGA to farmers through Mvayoo portal. Agriculture- and veterinary-based voice mails were heard by 3758 farmers (male: 1053; female: 2705). It has developed and uploaded 25 YouTube videos on agricultural practices and experiences of farmers, which were liked by 15732 viewers; 137 postings on modern agri-techniques and success stories of the farmers were uploaded to Facebook and liked by 85325 users, and around 32527 friends mutually shared this information. A total of 185 vegetable market related and 68 weather report related information bits were also shared.

***Sustainable Agriculture Technologies*:** In promotion of the plant doctors' project, 25 men and women small farmers were trained on plant management techniques and technical training was imparted on crop management, that is, nutrient management and identification of pest and diseases. A total of 1547 trainee days were completed for 16 types of vegetable crops, and 10 plant clinics were organized in 8

villages and 210 crop samples analysed. Now, the plant doctors have adequate knowledge of economic threshold levels of pests and diseases, basic knowledge in the diagnosis of pests and diseases, and in farm-level organic and bio-input production and application. They created awareness among 470 farmers in 17 villages on plant health diagnosis and management strategies. The farmers adopted low-cost tools and technology for pest and disease management, such as automatic solar light trap for pest monitoring and low-cost weeder (weed is alternate host for many pests), farm-level organic input production, multicropping system, use of face mask and goggles at the time of pesticide application and so on. To raise awareness among farmers in the region, free organic input distribution and advisory campaigns were conducted in Kannivadi for a month during the peak growing season; 172 farmers (male: 102; female: 70) utilized the material. A total of 600 litres of organic inputs, such as panchakaya, secondary effective microorganisms, coconut and buttermilk solution and amuthakaraisal, were distributed. Based on the usage, 18 farmers produced the organic inputs on their own for vegetable and flower crops. Nearly 1000 ha of maize has been affected by fall armyworm and nearly 30–70 per cent cotton was affected by stem borer in this region. Plant health campaigns were conducted for fall armyworm in maize and stem borer in cotton in which 300 farmers participated.

Four women's groups are producing bio-inputs in both powder and liquid biofertilizer formulations, for example, Azospirillium, phosphobacteria, potash-mobilizing bacteria, *Arbuscular mycorrhizae*, biofungicides such as *T. viride*, *Pseudomonas fluorescens* and *Bacillus subtilis*, and biopesticides such as *Beauveria bassiana, Paecilomyces lilacinus*, *Metarhizium anisopliae* and *Verticillium lecani*. During the year, they produced 15 tons of powder and 150 litres of liquid formulations of bio-inputs worth 9 lakhs and generated 940 employment days, and 1800 farmers used the products in their fields. Moreover, 400 farmers were trained in bio-input application in various districts; these training programmes were organized by government departments, other NGOs and agricultural colleges. The marketing of bio-inputs was institutionalized through RESAPCOL.

401.3 Semi-arid Agroecosystems: Iluppur Region, Pudukkottai District

As a part of a role change strategy in the development of framework since January 2020, the Illuppur Agriculture Producer Company Ltd. has started to work independently. The company has built its capacity in organizational, financial and governance dimensions to work independently since its inception 9 years ago. The BoD has passed the necessary resolution in their board meetings and appraises MSSRF of the progress made at the end of each year.

401.4 Semi-arid Agroecosystems: Mailam Region, Villupuram District

The main objective of the intervention is to enhance the income of small-holders in this region by promoting a pulse-based farming system and diversifying livelihood opportunities

by integrating livestock. Pulses and oilseeds are the main crops in the Mailam region of Villupuram district, and MSSRF is working directly with 1000 farmers (of which more than 84 per cent are women) and indirectly with more than 1500 farmers by way of implementing common property management and dissemination of improved technology intervention in agriculture, horticulture and livestock. Water augmentation is one of the core areas, both at common water bodies and individual open wells. These are very critical for irrigation in this marginalized agroecosystem, where more than 70 per cent of the lands are under rainfed conditions.

***Nallavur Farmer Producer Company Ltd.*:** There is an increase in the number of shareholders of Nallavur Farmer Producer Company Ltd. (NAFPCL) from 932 in the previous year to 1000 (male: 165; female: 835). It has established a processing and value-addition centre for both black gram and groundnut. During the current period, it aggregated 15 tons of black gram for grain and two tons of VBN-4 variety of seeds from farmers who have registered for seed production. Similarly, it procured 4 tons of groundnut (VRI-2) for seed purpose. The company has also established a seed processing unit cum warehouse worth Rs 60 lakhs and with a storage capacity of 500 metric tons, in association with TNSFAC. It has mobilized a credit support of Rs 1.70 crores for integrating livestock in the farming system.

***Augmentation and Efficient Use of Groundwater*:** NAFPCL has put in efforts to identify the needs of the small-holders for restoration of abandoned wells on agricultural lands; over the past 3 years, 122 wells were rejuvenated completely with the support of corporate social responsibility (CSR) funds. Farmers who have benefitted from well rejuvenation were able to cultivate in both the seasons, even though there was seasonal rainfall. Farmers adopted the multi-cropping system, which supports them to balance price volatility, instead of mono-cropping with groundnut and black gram. The company has created a corpus fund to support well-rejuvenation activities for nearly 70 per cent of its shareholders in the coming years. A total of 56 farmers adopted micro irrigation technology for vegetable and groundnut cultivation.

***Sustainable Farming Systems*:** Promotion of pulse cultivation is one of the core areas of focus by ensuring timely credit, inputs and technical intervention to the farmers. During the past year, credit access of Rs 30 lakhs was facilitated for 383 farmers to cultivate black gram in 412 acres and groundnut in 356 acres. Three training programmes were conducted for 108 farmers on integrated farming systems with a focus on pulse cultivation and livestock integration with the technical support of the agriculture department; they act as lead farmers and have organized six plant clinic sessions in which 126 farmers participated. Diversification of crops from casurina to floriculture is being promoted as it ensures money flow among small-holder farmers. However, the big concern is excessive use of pesticides for cultivation. To ensure sustainable income to the small-holders, especially women

farmers, promotion of floriculture was initiated with the support of Asia Initiatives, under the concept of Social Capital Credits (SoCCs). Initial training in floriculture, particularly on the production techniques, has been imparted with the support of the horticulture department. As an impact, there has been a gradual shift from casuarina tree plantation to vegetables and floriculture, which brought regular income as there is availability of family labour. During the past year, 38 acres of casuarina cultivation have been shifted to groundnut and vegetable cultivation. The income has increased by at least 30 per cent after the restoration of wells.

401.5 Rice Biopark

The Rice Biopark established at Myanmar was formally handed over to the Department of Agriculture and Development, government of Myanmar. The necessary protocols in handing over were followed. Moreover, technical support was extended to develop a proposal on capacity building of farmers on different product-based enterprises of the Rice Biopark.

401.6 Livelihood Enhancement of Small Farmers and Agro-processing

The main objective of the intervention is to enhance the income of small-holder moringa and coconut growers in Dindigul (Tamil Nadu) and Kuttanad (Kerala) by enhancing their capacity through improved technologies, establishment of infrastructure facilities and post-harvest practices and to promote a culture of entrepreneurship through value addition. The field-level inception cum planning meeting was conducted in both the field sites to inform the farmers about the programme as well as to integrate the intervention with existing institutions such as RESAPCOL and Kudumbashree in Dindigul and Kuttanad, respectively. Subsequently, village-level awareness meetings were organized at both sites to mobilize the farmers and create awareness on the technological interventions in reducing post-harvest losses through appropriate value addition. A total of 183 moringa farmers and 120 coconut farmers participated in the discussions, and then the mobilized farmers were organized into smaller groups. Following this, an exposure visit was organized to the Moringa Primary Processing Unit established by Tamil Nadu state government at Theni, which helped to understand the machinery requirement as well as processing technologies and opportunities for the farmers. In addition, another 2-day exposure visit cum training programme to Moringa Centre of Excellence, Kanyakumari, was organized in which 50 moringa farmers participated and learnt about the different moringa value-added products, such as moringa leaf powder, soup powder, soap, cookies and so on, production technologies and marketing strategies. Similar programmes were planned for the farmers in Kuttanad to impart knowledge about the machinery for oil extraction from coconut. Simultaneously, 78 farmers were trained on the production technologies to improve the productivity and quality. The necessary machinery for the processing has been explored, and the process of procurement has been initiated.

401.7 Transforming India's Green Revolution by Research and Empowerment for Sustainable Food Supply

MSSRF has been focusing on flagship projects (FP) 1 and 6 in the Transforming India's Green Revolution by Research and Empowerment for Sustainable Food Supply (TIGR2ESS) research consortium of multiple partners from the United Kingdom and India. FP1 focuses on Sustainable and Transformative Agrarian and Rural Trajectories and a protocol has been developed by the partner institutions. A series of research activities in line with this were carried out by MSSRF in the coastal agroecosystem in Sirkazhi block of Mayiladuthurai district, which was carved out of Nagapattinam district in 2020. A framework for data collection focusing on livelihoods, labour relations, markets, environment, women farmers' position and policy issues was collectively evolved. A detailed district and village profile to understand the issues was developed based on secondary data. With reference to primary data collection, preparatory qualitative assessments were done using participatory rural appraisal (PRA) tools to understand the rural agrarian systems, including social, resource and vulnerability mapping. Apart from this seasonal calendar, trend analysis and transect walk were also done to know the seasonality of cropping, labour relations, migration, diversification of livelihoods and so on.

Household-level baseline data was collected to understand the stratification categories based on social, economic and demographic variables. In this phase, 57 focus group discussions (FGDs) and 5 case studies were conducted and the collected data was transcribed as is; the key research questions were synthesized based on this, and further research frameworks have been developed to 'deep-dive' in specific areas. Following this, a consultative discussion was organized and four important areas were identified for further 'deep-dive': migration of men and involvement of women in agriculture, drivers and impact of soil salinity, the impact of shrimp farming and agricultural extension services. Additional data collection is underway. Moreover, a small-scale telephonic survey is being carried out in the study area to understand the difficulties of small farmers, especially women, due to the Covid-19 lockdown, and it is also being digitally documented. The analysis part of the work is under process. To supplement local salinity management issues, a detailed GIS tool based composite water management plan (CWMP) preparation was started to augment water harvesting and storage by understanding the geomorphology, drainage and slope of the field terrain.

At the national level, the environmental degradation due to the increasing soil salinity is the major concern for coastal agriculture. Considering this, studies have been commissioned to understand the drivers and barriers of soil salinity management at the ecosystem as well as farm levels. At the ecosystem level, the issues vary at different locations depending on the agro-ecological landscapes such as backwater regions, river

mouths and estuaries, drylands, marshes and so on. Of these varied ecosystems, agricultural production systems in the wetlands of the low-lying regions of both the east and west coast are the primary zones growing paddy, adopting intensive cultivation practices. The farmers in these regions have been practicing innovative adaptation methods/ models and strategies to manage salinity in crop production and reduce risk by integrating and diversifying the production, especially in delta regions. However, such unique models have been changing in response to the ongoing changes in biophysical, ecological and agrarian systems. So far, limited research has been done to study the site-specific adaptation models of the coastal agriculture practices in line with the framework of Indian Coastal Zone Management in the Indian coast. Therefore, to understand the drivers and hindering factors for better soil salinity management, especially from the adaptation perspective, a research study has been commissioned. At the farm level, farmers have been coping with the increasing salinity by adopting several measures, of which, use of organic amendments and cover crops are the important ones and scientific research is also ongoing to use microbial inputs for management of saline soil. To understand its wider adoption and efficiency, a meta-analysis is being undertaken, using 30 research articles.

In FP6, soil structure score card intervention is being initiated as an action research to support farmers as a decision-making tool in soil health management. Exploratory interviews among farmers have been completed and the baseline questionnaire preparation is ongoing to understand the farmers' practices and knowledge systems on soil health management. The demonstration plots on different soil amendments, which improve the soil structure as well as potential cover crops, are also undertaken to create awareness among the farmers.

Sub Programme Area 402

Climate Change, Energy and Agriculture

Work during the year covered studies on assessment of climate change impacts on food production and livelihoods, followed by consolidating the key learnings from the different pilots focusing on potential adaptation strategies in building resilience among farmers to deal with the changes.

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

Following the detailed analysis of the impact of climate change on the productivity of rice and maize under both RCP 4.5 and 8.5 scenarios at the state level in the near term (2030s), by mid-century (2050s) and end century (2080s) as well as the detailed district-level analysis of vulnerability to agriculture production, food security and livelihoods, the focus was on analysing the existing state-level action plan for climate change in Maharashtra and Tamil Nadu. In addition, existing schemes

and plans of the 'line departments' were also used in the analysis to understand how the development measures were tuned to address the impact on food production and livelihoods. The analysis finds the gap in mainstreaming climate change analysis based on inputs and results in the developmental plans especially in convergence across policy and practice levels.

402.2 Climate Information Services

The Agro-met advisories based on medium-range weather forecast have been helpful to the farmers in reducing the risk in farming by making changes in management decisions on different agronomic practices. During 2019–20, the Agro Meteorological Field Unit (AMFU), Kannivadi, has developed 630 bilingual weather forecast and agro-advisory bulletins based on crop status at biweekly intervals along with two special bulletins on extreme weather events. The Kannivadi AMFU is the nodal point to develop and disseminate agro-advisories in the southern agro-climate zone of Tamil Nadu, covering six districts: Dindigul, Madurai, Pudukkottai, Ramanathapuram, Sivagangai and Theni. The advisories were disseminated to the farmers mainly through mKisan web portal of India Meteorological Department (IMD). During the year, 810 agro-advisories were shared to 188770 men and women on a biweekly basis. In addition, the advisories were sent as voicemails to 5547 farmers (male: 2145; female: 3402) and in text form to 550 farmers though social media (WhatsApp). During the past year, with an objective of increasing the spatial scale, IMD has initiated block-level forecasting system on pilot basis. Since July 2019, 420 block-level Agro Advisory System (AAS) bulletins have been prepared for Reddiyarchatram, Oddanchathram, Palani and Nilakkottai blocks of Dindigul district through the Agromet Decision Support System portal and disseminated to the farmers and agriculture officers of the respective blocks.

Apart from creating access to agro-advisories, awareness programmes were organized on different themes such as climate change and its impact on soil health, cropping systems, crop protection, natural resources and livestock management and use of seasonal forecasts. Such awareness programmes are a means by which the uptake of the forecast and advisories has been promoted among farmers. The training was organized using diverse methods, including face-to-face and remote methods, with information and communication technology (ICT) tools such as audio and video conferences and voice mails, and trained 302 (male: 84; female: 218) farmers. In addition, farmers have been engaged in conversation on issues related to impacts of weather and climate on crop cultivation, livestock farming and soil and water conservation on six different social media platforms. A total of 617 men and women farmers have formed a group and mutually share their experiences and pertinent information. To supplement these efforts in reaching more farmers on weather-based farming and to create an access to agro-advisory services, IMD established digital tools such as the mobile app. 'Meghdoot' and farmers' helpline services. At the field level, four farmer awareness programmes in

Dindigul and Pudukkottai districts reached 278 farmers (male: 152; female: 126) and 70 undergraduate agricultural students to take it forward among more farmers.

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

To strengthen the effort of the adaptive capacity of the women farmers to meet the challenges of climate change, the team undertook a unique approach. The capacity-building initiatives were facilitated among all stakeholders in the whole chain starting from agro-advisory developers to user level, that is, farmers. Here four different sets of stakeholders played a critical role in educating the farmers about the appropriate climate information. Of this, 7 AMFU facilitators and 21 FPOs are at the organizational level, and 32 climate risk managers and 3000 farmers were involved at the grassroots level. The initiative was supplementing the activities of the AMFU-based climate information services and grounded in six districts, namely, Ramanathapuram, Theni, Dindigul, Pudukkottai, Sivagangai and Madurai. With this initiative, a network of women climate risk managers attached to different FPOs from six neighbouring districts were established and connected through social media platform to exchange new information, experiences and challenges from their region.

402.4 Building Resilience through Sustainable Intensification and Agroecological Approach

Another approach of building resilience to the changing climate pattern among small-holders is through sustainable intensification and agro-ecological farming systems, which is being tested in field locations in Assam and Odisha. The capacity-building and knowledge management initiatives were facilitated through five VKCs, which developed a partnership with the consortium members, line departments and stakeholders in the respective locations. The programme adopted a 'Meet the People' campaign, a unique awareness approach in all the project villages to introduce the services of the VKCs. Efforts have been made for the sustainability of the VKCs by attempting a model in which KVK/FPOs in the region take a lead in facilitating the activities right from the planning to the execution phases. Continuous efforts have been made to build the capacity of the farmers on climate smart agriculture (CSA) technologies using diverse ICT tools (Table 1). The plant clinic model has also been extended based on our past experiences from Tamil Nadu, and 20 plant doctors were trained by the Centre for Agriculture and Bioscience International, New Delhi. At the field level to promote farmer-to-farmer learning, 730 champion farmers from the field sites were identified and trained on CSA technologies and practices such as new submergence-/drought-tolerant varieties of primary crops, alternate wetting and drying as well as system of rice intensification methods of paddy cultivation, micro-irrigation technologies, crop diversification with short-duration vegetables and pulses, use of farm machinery services in transplanting, harvesting and processing, eco-friendly pest management practices and

Table 1: ***Overall reach of farmers in Assam and Odisha (taken together) using different ICT tools and demonstrations***

S. no.	List of ICT tools	Number of programmes	Male	Female	Total
1	Audio advisory	440	4179	1121	5300
2	Helpline	1760	1364	396	1760
3	WhatsApp	502	170	56	226
4	Phone-in programme	12	351	177	528
5	Video conference	4	75	77	152
6	Audio conference	23	397	223	620
7	Video-based learning	30	525	343	868
8	Plant clinics	19	283	115	398
9	Demonstrations	85	2315	1323	3638
10	VKC users	5	1471	629	2100
	Total	**2875**	**11130**	**4460**	**15590**

value addition in perishable products. The ICT platform has picked up well in disseminating need-based information, programmes and advisories on pertinent CSA technologies to the farmers, including women.

Stakeholder support is important to address farmers' and users' queries and to reduce the gap in agriculture extension services. In view of this, two stakeholders' workshops were organized and their support was ensured for the appropriate services of the VKCs. Towards this, a writeshop was organized with the support of line department experts and 35 need-based content was developed, which is updated continuously based on the demand from the farmers. So far, 275 text and 600 audio contents have been developed and disseminated. In order to assess the usefulness of the voice SMS initiative, which is one of the regular ICT services accessed, a structured survey was conducted in all the field sites. The study has shown that 89 per cent of the farmers expressed it to be very useful and relevant to them and 59 per cent confirmed that they practised the information received in their field and were benefitted.

Efforts are on to mainstream gender in the different overall project activities. Towards this, a gender-sensitization workshop for all the project partners was organized for 3 days in September 2019. Subsequently, efforts have been made to sensitize the field functionaries, knowledge workers and VKC management committee members on integrating gender approach and prioritizing their action towards women farmers in view of their marginalization in accessing productive resources despite their contribution in agriculture production. Gender analysis was conducted in all the project villages, and it helped to understand the key gender gaps and constant efforts to involve both men and women in project

activities. Because of the continuous efforts, 29 per cent of women are actively engaged in project interventions.

Apart from the above two themes, MSSRF has conducted a detailed value chain analysis in all the four field sites to understand the scope for public-private partnership to promote entrepreneurship in the areas of seed production, vegetable processing and aggregation of products for collective marketing. In the past year, it promoted a buyback arrangement for paddy seeds of two flood/drought-tolerant varieties and vegetable marketing in Assam

402.5 The Gender Factor in Political Economy of Energy Sector Dynamics

With the partnership of ENERGIA, efforts were taken to disseminate the key findings of the project through webinars among researchers and policymakers, both at national and international levels, supplemented with a policy brief. Two papers are under peer review with journals.

402.6 Water Security and Climate Adaptation in Rural India

Water Security and Climate Adaptation in Rural India (WASCA) is an Indo-German programme carried out in cooperation with the Ministry of Rural Development and the Ministry of Jal Shakti, government of India, with the support of the German Federal Ministry for Economic Cooperation and Development (GIZ) to improve water resource management for achieving water security and to adapt to changing climate. As part of this project, water resources management is enhanced through an integrated approach at national, state and local levels and is operational in five states – Madhya Pradesh, Rajasthan, Tamil Nadu, Uttar Pradesh and Karnataka. MSSRF is the technical agency in the state of Tamil Nadu. Here, Thiruvannamalai and Ramanathapuram are the two districts selected for deeper study and action based on the district-level vulnerability ranking done by GIZ and Anna University, Chennai. MSSRF's role is to build the capacity of the field functionaries in preparing a CWMP at the gram panchayat (GP) level by providing scientific inputs using spatial and non-spatial data in GIS platform (see SPA 103.4). It is working towards developing a plan for 438 and 849 GPs in Ramanathapuram and Thiruvannamalai districts, respectively. The Foundation is also engaged in providing inputs for identified hotspots such as mangrove and wetlands restoration, improving cropping systems and water use efficiency, springshed (a method of groundwater management in the mountain regions) and four water (ground, surface, soil moisture and rainfall) concepts and so on as pilots in addressing site-specific challenges.

Sub Programme Area 403

Jamsetji Tata National Virtual Academy for Rural Prosperity

The significant role of ICTs in knowledge management that supports agriculture

development and small-holder livelihoods is dealt with in this section.

403.1 Transforming Public Libraries to Lifelong Learning Centres

Selected public librarians are being capacitated under the project on innovative leadership capabilities, skills and knowledge. With their acquired leadership and innovative thinking skills, they are implementing need-based services through their libraries, and hence redefining the public library as lifelong knowledge centres.

The International Network of Emerging Library Innovators (INELI India and South Asia) strengthens the abilities (attitude, skills and knowledge) of the public librarians as 'innovative library leaders', having understood the need for twenty-first-century skills in innovative design thinking, community need-based services, access to information, relevance of UN-SDGs, social inclusion, gender sensitivity, ICTs, building evidence of change and topics related to social, economic and environmental development. There are three cohorts of 76 library professionals as INELI library innovators from 20 states and union territories of India and 17 from five other South Asian countries, including India (Bangladesh, Myanmar, Nepal, Sri Lanka and Maldives). There are 15 experiential innovators, who are also part of INELI, undertaking the online course. These INELI innovators are the trailblazers of the evolving regional public library movement. The key highlights are:

- A total of 38 public librarians of Cohorts 1 and 2 of INELI India are participating in an online leadership course. Cohort 3, comprising of 17 public librarians from six South Asian countries, are actively participating in the online MOOC platform and have completed six modules; four modules were completed by Cohort 2 and three modules by Cohort 1. Online orientation was completed for the 15 experiential innovators.

- Convening 1 of Cohort 3 was organized in partnership with district central library, Trichy, government of Tamil Nadu. This convening showcased a global INELI innovator and INELI mentor who has redefined the public library as a community hub. A total of 16 innovators were introduced to ongoing community need-based services for target communities such as farmers, women, youth, children, the visually challenged and the physically challenged. The design allowed innovators to capture new models evolving through strategic and sustainable approaches and pillars of partnerships, for co-creating and building inclusive and SMART libraries for community well-being.

- Initiated online MOOC – online leadership course related discussion with 15 experiential innovators of Tamil Nadu.

- Revised nine modules for the online curriculum and upgraded Model from 2.x to 3.1 version hosting the INELI curriculum for better user experience both online (web) and offline (mobile application) and also automated manual tasks, wherever required.

• A total of 17 members of a transition committee are strategically planning and devising action plans for thinking about and building INELI regional network.

• A total of 54 innovators participated in the first regional convening which covered themes such as leadership, risk assessments, organizational development and networking tools for building the regional network.

• Land-to-land concept: 2 INELI innovators facilitated a 1-day leadership training workshop for 20 non-INELI public librarians.

• Agriculture developmental actions and their integration in public libraries: Innovative knowledge services such as plant clinics, soil health, audio advisories, helpline and tele-health and literacy programmes have been integrated into the public libraries and are very well received by the local target communities as shown below:

a. Plant clinic: Three public libraries organized 12 plant clinics, in which 189 farmers (male: 173; female: 16) participated and 190 samples were diagnosed.

b. Soil health: 124 soil samples and 41 water samples were collected and awareness was created on the soil health management.

c. Audio advisories: 58 audio advisory messages were shared through public libraries and covered 209 farmers (male: 196; female: 13).

d. Tele-health and literacy programmes: In a 7-year partnership with the Apollo Hospital, MSSRF has implemented nine tele-health awareness and literacy programmes, imparting awareness on current health issues around communicable, non-communicable and infectious diseases. A total of 15 libraries participated and the outreach was to 1786 members (male: 684; female: 1102) of rural communities.

• A total of 24 selected innovators from 11 states covering 24 districts across India organized outreach programmes of innovative services through their libraries. The overall reach was 218031 members (male: 108539; female: 109492) covering diverse sections of the communities in the region.

• The selected public librarians are facilitating a self-sustaining model through their libraries by evolving a dynamic localized network of diverse stakeholders such as government departments, Raja Rammohan Roy Library Foundation, NGOs, philanthropists, academicians, welfare associations, charitable institutions, individual patrons and readers' forums from 20 states in India across six South Asian countries.

• Two regional INELI network workshops finalized the five major committees engaged in the functioning of these networks effectively and the roles and responsibilities with all the three cohorts and the next steps and key areas of immediate implementation. Asia Network of Library Innovators' Foundation was formalized with 40 members as part of the network to build, drive and run this regional network.

• Developed communication materials (photos/web content and a video of INELI

innovators' voices and all speeches of convening 1 of Cohort 3) for sharing with INELI global and INELI India and South Asia.

403.2 Village Resource Centres and Village Knowledge Centres

At present, 3 VRCs and 13 VKCs with a physical set-up and 328 villages are virtually connected through different ICT tools, especially mobile telephony. Diverse ICT tools, namely, mobile-based audio advisories, webinars, phone-in programmes, farmers' helpline services, audio and video conferencing, video-based learning, plant and e-plant clinics, picture-based advisories, social media apps such as WhatsApp and websites, are being used. During the past year, the initiative reached 27194 members (male: 15838; female: 11356) and accessed advisories on agriculture and animal husbandry, health, education and government entitlements (Table 2).

Table 2: ***Number of farmers who accessed the services of VKCs in 2019–20***

Thematic area	Male	Female	Total
Agriculture	14293	8040	22333
Animal husbandry	542	1158	1700
Health and nutrition	376	1164	1540
Civic services and government entitlement	627	994	1621
Total	**15838**	**11356**	**27194**

The VKC model has been in demand by many civil society organizations and state governments. A greater effort has been invested for the sustainability of VKCs by adopting a framework of five pillars (social, human, infrastructure, physical and financial). This approach helped the VKC management committee, which is managing the VKCs with community ownership even after the project period. During the past year, the Andhra Pradesh government established *Rythu Bharosa Kendralu*s (RBKs) in which they have formed the farmers' knowledge centres (FKC) based on the MSSRF model VRC-VKCs. MSSRF has been recognized as a knowledge and technical partner by Andhra Pradesh state government for running the FKCs and an MoU have been signed with the AP government to facilitate this initiative.

***Soil Health Management*:** The mobile soil and water testing facility tested 705 soil samples and 244 water samples collected from 508 farmers, including 118 women from 94 villages of Tamil Nadu and Puducherry. The results identified the problematic soil as hotspots: 13 alkaline, 23 acid, 114 saline and 134 soils having high calcium carbonate content were identified. Also, overall, it indicates the deficiency of nitrogen and phosphorus. It indirectly shows that soil fertility is low and farmers have to pay attention to improve the soil organic matter and take measures to reduce soil salinity, which is largely due to faulty management practices. Soil health cards were issued to help the farmers adopt integrated nutrient management practices.

***Farm Schools*:** The farm school in Thiruvaiyaru facilitated 13 training programmes, and 349 farmers (male: 213; female: 136) learnt the advanced practices of Kuruvai and Samba paddy cultivation (parallel to kharif and rabi seasons), especially the importance of seed

treatment technology, integrated nutrient management and integrated pest management (IPM) approaches in conservation of beneficial micro-organisms. Also, it introduced the new paddy variety ADT 53 with the support of Aduthurai Rice Research Station, and 31 farmers cultivated the new variety. It was found that 43 per cent of the farmers who regularly attended the farm school training received good grain yield in the Kuruvai season (6 MT/ha) when compared with the Samba season (5.5 MT/ha). The farm school in Kannivadi facilitated 620 farmers (male: 328; female: 292) on the use of various bio-inputs as well as the use of pest traps, including yellow sticky traps, pheromone traps and so on, which protected the cultivation of vegetables and drip irrigation.

***Videos for Farmers to Promote Video-Based Learning*:** The 'videos for farmers' programme is being implemented in partnership with Access Agriculture. Producing and translating the need-based videos on best practices focusing on non-chemical interventions and promoting video-based learning among small-holders are the main activities. The topics of the videos to be developed are identified based on the important issues faced by the farmers in consultation with them. So far, nine new videos have been produced and twelve translated into Tamil. During the past year, two videos, 'Managing the Rice Leaf Folder' and 'Organic Growth Promoter for Vegetables', have been produced. The VRCs are promoting video-based learning. Also during the past year, the videos were screened in 168 locations and seen by 5040 members (male: 3573; female: 1469). The pre- and post-evaluation with the viewers have revealed that 68 per cent of the farmers' knowledge on a particular theme has been enhanced.

***Smart Farming Initiatives*:** MSSRF is collaborating with a Hyderabad-based start-up Makers Hive to use new generation technological tools such as drone and artificial intelligence (AI) to address farm issues. An MoU was signed with Makers Hive and pilot testing inaugurated after the stakeholder meeting at Thiruplanam village under Thiruvaiyaru VRC on 12 October 2019. Subsequently, land for AI-based automatic weather station installation has been identified and the physical device installation completed. Two rounds of drone surveys for digital land mapping have also been done and the soil status of the village analysed with the help of soil testing. Necessary content was developed with the support of the agriculture department and KVKs for further rollout of the initiative in the field.

***Plant Clinics*:** The plant clinic programme has been implemented from 2012 onwards in partnership with the CABI in Tamil Nadu, Puducherry, Assam and Odisha. Trained plant doctors diagnose the crop samples, record plant health issues and provide appropriate recommendations to the farmers. Till date, 37 plant clinics have been established and their services are reaching 1140 villages. During the year, 291 plant clinic sessions were conducted and about 4296 samples from 4298 farmers (male: 3287; female: 1011) diagnosed. In addition, the plant health campaign was

conducted on major pests, such as fall armyworm in maize, gall midge, bacterial leaf blight and shoot borer in paddy, stem and root rot in groundnut, and budworm in jasmine, and the plant health knowledge reached about 16760 farmers (male: 11130; female: 5630). The pest management decision guide preparation workshop, clinic cluster exchange meeting for cross-learning and plant clinic online management system data validation are the other important activities carried out during the past year. In addition, the plant clinic programme organized result-sharing workshop with policymakers and government officials in Puducherry, Tamil Nadu and Odisha. The consolidated learning from the past 8 years of experience was shared. The clinics have been helpful to the farmers for knowledge enhancement among plant health and about the behavioural changes, especially in toxicity levels of pesticides, use of pesticides after confirming symptoms and use of biological inputs for the management. More specifically, 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 the farmers in using the right quantity of pesticides. A study was conducted to assess the benefits of the plant clinics, and it showed about 40 per cent of the farmers who visited the plant clinic shifted the pest management practices from complete chemicals to IPM practices. Reduction in input cost up to 55–65 per cent was noticed. Further, 56 per cent of farmers had an increased income between Rs 4000 and 6000/acre.

In partnership with CABI and PEAT GmbH, MSSRF contributed to strengthening the PlantixApp, which provides support to farmers in diagnosing pests, diseases and nutrient deficiencies. A workshop was conducted on 'field accuracy assessment', and the plant doctors were trained on the process of Plantix testing. More than 52250 pictures have been collected and uploaded on Gatherix software, of which 10500 have been validated.

***Picture-Based Insurance Bundled with Picture-Based Advisories*:** The current crop insurance systems are focusing on abiotic risks. However, the crops have been equally affected regularly by biotic stresses such as insects and diseases, which are increasing due to changes in the climate. In this backdrop, picture-based advisories and insurance systems for agricultural risk management are being considered as better tools to estimate risk. Here, registered farmers regularly share pictures on the crop stand to the experts, who in turn diagnose, analyse and extend advisories as well as confirm the rate of loss due to the identified pests to farmers and insurance providers, respectively. This helps to provide improved financial services at a lower cost and assist farmers in getting personalized advisories to manage the production risks and improve the sustainability of insurance services in a timely manner.

The study was conducted in 50 villages of Pudukkottai, Thiruvaiyaru region of Tamil Nadu and Puducherry, where regular plant clinics are organized during two seasons; paddy in both the seasons and groundnut in

the second season. Farmers with smartphones were requested to register their field sites (geo-tagged) through the UzhavarCam app, which in turn is linked to a web portal (https://pbinsurance.org/tn/index.html). Farmers took repeated pictures at weekly intervals and close-up images of crop problems, whenever they observed it. Out of the total 1000 farmers targeted, 500 received advisories and the rest continued to use plant clinics. The objective is to see the synergy between plant clinics and picture-based advisory and compare the efficiency rates of the two. The farmers received information related to prevention/alert/warning, weather, varieties, sowing, nutrients, pests and disease management during the entire crop cycle.

In the first season, 1180 overview images (Puducherry, 322; Pudukkottai, 354; Thiruvaiyaru, 504) and 373 close-up images were received. Appropriate advisories according to the problems were given after proper diagnosis. Field volunteers were assigned to motivate the registered farmers to send the images at weekly intervals, and as a result in the first season 64.3 per cent of registered farmers sent repeated pictures.

Based on the experiences and findings of the previous season, it was decided to work closely with 250 farmers (5 each in 50 villages) for the second season with an addition of physical crop-cutting experiments (CCEs) in paddy. Here, to maintain the uniformity and regularity in sending the crop stand, an agent model was adopted in the second season to ensure the receipt of the pictures. Young, educated farmers were motivated to support other farmers in capturing the crop stand on a regular basis.

The CCEs were carried out in 30 villages of Pudukkottai and Thiruvaiyaru covering 147 sites. Farmers were enrolled based on the repeated pictures taken by them during the first season. In case of lesser number of repeated images, new sites based on satellite images were chosen. A total of 3028 overview images (Pudukkottai, 1689; Thiruvaiyaru, 1339) and 488 close-up images have been received. Appropriate generic and specific advisories were given, which helped the farmers to reduce the crop loss. The standard protocol was followed for CCEs and the data was uploaded in the survey CTO app. Grain yield, biomass weight, grain moisture and biomass moisture were recorded. Similarly, 250 groundnut farmers have been registered from 50 villages of Pudukkottai for CCEs. More than 87 per cent of the farmers sent repeated pictures and 30 per cent sent close-up images of the pests and diseases. The data collected are being analysed to understand the efficiency of the picture-based advisories approach in assessing crop damage and to use it as an authenticated measure to estimate yield loss. Based on this, the introduction of picture-based insurance services for both paddy and groundnut has been planned.

Programme Area 500

Agriculture, Nutrition, Health

Work under this programme area focuses on leveraging of agriculture for nutrition and health through research, implementation and demonstration at the community level, and advocacy with different stakeholder groups. The LANSA research programme that ended in early 2019 received an A+ rating from the funding agency UKAid. Three more KVKs were identified by the Acharya N.G. Ranga Agricultural University (ANGRAU) for setting up demonstration of the Farming System for Nutrition (FSN) model. An MoU was signed with the Maharashtra Council of Agriculture Education Research (MCAER) to provide technical support for promotion of the FSN approach. In Koraput, 96 men and women selected from across 47 villages underwent training on the Community Hunger Fighter approach.








Sub Programme Area 501

Leveraging Agriculture for Nutrition

Work under this programme area focuses on leveraging of agriculture for nutrition and health through research, implementation and demonstration at the community level and advocacy with different stakeholder groups. The 6-year research programme Leveraging Agriculture for Nutrition in South Asia (LANSA), led by MSSRF, which ended in early 2019, was given an A+ rating by the funding agency UKAid. The communication received in August 2019 says: 'LANSA opened space for nutrition-sensitive agriculture deliberations among policy makers, practitioners and academics throughout the region. Evidence from LANSA research has been widely cited in academic and public discourse, raising awareness around the subject.' During the year, a series of meetings were held with the National Institute for Research in Tuberculosis (TB) and the Central Leprosy Teaching and Research Institute to develop joint proposals on leveraging agriculture to improve dietary diversity and thereby resilience against diseases such as TB and leprosy. Work on promotion of a Farming System for Nutrition (FSN) approach as a pathway to addressing the problem of malnutrition in India continued during the year.

***Promotion of the FSN Approach through Krishi Vigyan Kendras*:** Three Krishi Vigyan Kendras (KVKs) under the Acharya N.G. Ranga Agricultural University (ANGRAU), Andhra Pradesh, set up FSN demonstration models in their respective campuses. The KVKs are located in three different agroecological zones – Undi in West Godavari district (hilly), Reddypalli in Ananthapur district (semi-arid) and Rastakuntubai in Vizianagram district (coastal) – and they set up nutrition-sensitive crop and animal husbandry demonstrations in an area of 1 acre and nutrition gardens of fruits and vegetables on 2 cents of land at their campus. Project coordinator and home science subject matter specialist (SMS) from the three KVKs participated and shared the results of their work at a workshop in Lam on 10 January 2020. Following discussion and feedback, each KVK was requested to finalize its presentation and prepare a report, including the cost of setting up the demonstration and returns and details of nutrition awareness activities conducted. The lockdown because of the Covid-19 pandemic precluded field visits planned in March–April to witness the rabi demonstration by the KVKs.

ANGRAU identified three more KVKs – Amadalavalasa in Srikakulam district, Darsi in Prakasam district and Utukur in in YSR Cudapah district – for setting up the FSN demonstration in 2020–21, with support from MSSRF. An orientation workshop for the project coordinators and SMSs from these three KVKS was convened in Lam on 11 February 2020. Project coordinators and SMSs from KVK Undi, Rastakuntubai and Reddypalli were also invited to participate in this workshop and share their experiences. The workshop was inaugurated by Prof. Damodara Naidu, the vice

chancellor of ANGRAU; the deans of research and home science also spoke, indicating the university's active support for promoting the FSN approach as a pathway to addressing the problem of malnutrition. Following explanation of the concept of FSN and group work, the three KVKs were asked to develop the plan for FSN demonstration on 1 acre of land and nutrition garden demonstration on 2 cents of land in the kharif season and share, for feedback. The KVKs will be setting up the demonstrations this year.

In the case of Maharashtra, a formal MoU was signed with the Maharashtra Council for Agriculture Education and Research (MCAER), Pune, in December 2019, for MSSRF to provide technical support for the promotion of the FSN approach by KVKs under the four agriculture universities in the state, in a project supported by UNICEF. Nineteen KVKs are included in the first phase: four KVKs each under Vasant Rao Naik Marathwada Krishi Vidyapeeth, Parbhani, and Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli; five KVKs under Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola; and six under Mahatma Phule Krishi Vidyapeeth, Rahuri. In addition to setting up demonstration on campus, each KVK has also undertaken to promote the approach among households in an adopted village. A workshop was held with scientists from these KVKs at MCAER on 13 December 2019. Each KVK shared information about the kharif demonstration and other work done by them.

***Research Products*:** Two impact briefs on the FSN study under LANSA were produced: Evidence from the FSN study, and Nutrition Awareness under the FSN study. Two films were also produced for advocacy and sharing; the first, titled 'Farming System for Nutrition: A Novel Approach to Address Malnutrition', documents the results of the study, and the second, titled 'Advocacy for a FSN Approach', documents the advocacy efforts and the results thereof. Both films are available on MSSRF's YouTube channel. A manual on nutrition awareness, for use by trainers and field practitioners, has also been developed.

***Networking and Dissemination*:** We were invited to serve as the resource people on nutrition-sensitive agriculture at training workshops organized by North Eastern Regional Centre (NERC) of the National Institute of Rural Development and Panchayati Raj (NIRD&PR), Guwahati, in May 2019; NIRD&PR, Hyderabad, in August 2019; and Indian Agriculture Research Institute (IARI), New Delhi, in August 2019.

As a part of disseminating the concepts of nutrition-sensitive agriculture and the FSN approach among academicians and researchers, particularly students, MSSRF provided technical resource support to the Economics Department of Stella Maris College, Chennai, to curate a national seminar on 'Pathways to Address SDG2 of Zero Hunger' held at the college on 13–14 September 2019. Invited talks on the subject were delivered at conferences organized by AMET University, Chennai, in August 2019;Dharmamurthi Rao Bahadur Calavala Cunnan Chetty's Hindu College, Pattabiram, in December 2019 and

February 2020; International Consultation on Promoting Nutrition-Sensitive Approaches organized by Azim Premji Philanthropic Initiatives and Department of Panchayati Raj and Drinking Water, government of Odisha, in Bhubaneswar in October 2019; Nutrition Spectrum 2019 organized by PHD Chamber of Commerce and Industry and Northern Regional Workshop on POSHAN Abhiyan organized by Observer Research Foundation (ORF) in New Delhi in November 2019; Dhaka Global Dialogue organized by ORF in Dhaka in November 2019; and National Seminar on Doubling Farmers' Income by 2020: Challenges, Opportunities and Way Forward organized by Career Point University in Hamirpur, Himachal Pradesh, in February 2020.

Sub Programme Area 502

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

The project promotes an FSN approach to improve the livelihood and nutrition status of small farm households. Covering 1575 households, it is being implemented in all 39 villages of Mathapada gram panchayat and 8 hamlets of Doraguda gram panchayat in Boipariguda block of Koraput district. Research reports based on the house listing survey of all 1575 households and baseline survey of 20 per cent sample households were finalized. These reports helped in the selection of farm households for undertaking different FSN interventions.

***Crop Interventions*:** Interventions were promoted in kharif 2019 to enhance understanding of nutrition-sensitive agriculture among members of the community. Building on entry-point activities undertaken in 2018-19, cultivation of nutrient-dense crops, namely, finger millet, quality protein maize (QPM), pigeon pea, biofortified rice and orange flesh sweet potato (OFSP) crops, was promoted. The interventions are discussed in the following sections.

Finger Millet: Yield enhancement of finger millet through use of improved varieties (KMR-204, Chilika, Arjuna, GPU-66 and ML-365) and better agronomic practices covered 344 acres and involved 858 farmers. Seeds were provided to the farmers at 2 kg/acre and application of NPK fertilizers in the ratio of 40 kg:20 kg:20 kg per hectare along with guidance on improved agriculture practices, namely, nursery raising and transplanting with proper spacing as against broadcasting of seeds. Harvest data of the improved varieties promoted has been collected from four quadrates of 2 x 2 sq.m in fields of 35 farmers (7 farmers for each variety). Another data set following the same method was collected from the fields of 30 farmers who cultivated farmers' varieties using traditional practices. The area and yield data under different varieties are shown in Table 1.

Table 1: ***Number of farmers, area and grain yield***

S. no.	Varieties	No. of farmers	Area (acre)	Yield (kg/ha)
1	KMR-204	184	75	1839
2	Chilika	250	98	1630
3	Arjuna	60	24	1236
4	GPU-66	120	50	1683
5	ML-365	244	97	1589
6	Farmers' varieties	30	14	1295
	Total	**888**	**358**	

As shown in the table, the yield of all varieties except Arjuna was higher than that using farmers' varieties at 1295 kg/ha, ranging from ML-365 variety at 23 per cent higher yield to KMR-204 at 42 per cent. In the case of Arjuna, it was about 5 per cent lower at 1236 kg/ha. Around 70 per cent of the produce was retained for home consumption, 3 per cent kept for seed purpose and remaining 27 per cent sold either at the local market at Rs 25/kg or at the mandi at Rs 31.50/kg. Sale at the mandi was done by a few farmers who had surplus production.

Intercropping of Pigeon Pea with Maize: Crop intensification was introduced through intercropping of pigeon pea with maize in a 1:1 ratio; aimed at increasing the availability of pulses, the intervention covered 112 acres and involved 825 farmers. Pigeon pea seed NTL-30 (Durga) was provided to farmers at 4 kg/acre and maize seed (HQM-1 and NMH-51) at 8 kg/acre. Improved agronomic practices included line sowing at 60 x 30 cm in case of maize and 60 x 60 cm in case of pigeon pea and recommended intercultural operations. Combining the normal fertilizer recommendation for maize and pigeon pea, a blanket recommendation was given for application of NPK in the ratio 50 kg: 40 kg:30 kg per hectare; that is, sum of half the recommended dosage for each crop with basal application and at different phases of the crop. Harvest data has been collected from 20 farmers. Average production of maize green cob was 3856 kg/ha, maize (seed yield from matured cob) was 648 kg/ha; yield of pigeon pea tender pod was 458 kg/ha and seed yield from matured pod was 344 kg/ha. The bulk of maize green cob and pigeon pea, both as tender pod and grain, was used for home consumption. Details of the utilization of the produce are given in Table 2.

***On-Farm Demonstration of Performance of Biofortified Rice*:** Demonstration of high-protein rice varieties developed by Indian Council of Agricultural Research – National Institute of Rice Research (ICAR-NRRI),

Table 2: ***Utilization of produce (in percentage)***

Food grain types	Household consumption	Distribution to neighbours and relatives	Saved for seed purpose	Sale
Maize green cob	73	11	0	16
Maize grain	30	8	0	62
Pigeon pea tender pod	65	7	0	28
Pigeon pea grain	94	0	6	0

Cuttack (CR Dhan-310 on 0.52 acres and CR Dhan-311 on 0.36 acre), and high-zinc variety developed by ICAR-Indian Institute of Rice Research (IIRR), Hyderabad (DRR Dhan-45 on 0.27 acres), was undertaken in a farmer's field at Musapadar village, covering 1.15 acres in all. Pratikshya, a non-fortified high-yielding rice variety, was cultivated by the farmer in the remaining 4.85 acres of lowland. Seed, fertilizer and pesticides were supported from the project along with technical guidance. Other inputs, such as farmyard manure and labour for land preparation, nursery preparation, transplanting, weeding and harvesting, were taken care of by the farmer.

Fertilizer application of NPK at 80 kg:40 kg:40 kg per hectare, recommended by the Odisha University of Agriculture and Technology (OUAT), was adopted. Basic agronomic data on plant height, number of tillers/hill, number of panicles/hill and 1000 grain weight were recorded (see Table 3). Crop-cutting data from four quadrates (2 x 2 sq.m) from each of the varieties were recorded. Grain yield was recorded after sun drying for 36 hours.

The yield of the biofortified varieties was not satisfactory compared with a yield of 3020 kg/ha from the farmers' variety; this was due to attacks of blast, stem borer and stem rot. The farmers' variety Pratikshya was less affected compared with the biofortified varieties; DRR Dhan-45 was also affected by false smut; it was the first time that biofortified rice varieties were demonstrated in Koraput district. Farmers were made aware of the nutritional importance of these varieties through organization of farmer's field day. Moreover, 1150 kg of seeds (665 kg of CR Dhan-310, 350 kg of CR Dhan-311 and 135 kg of DRR Dhan-45) have been procured from the farmers for the next cropping season.

***Orange Flesh Sweet Potato Cultivation*:** Six OFSP nurseries were established to supply planting material to farmers for cultivation either in their nutrition gardens or in their farm lands. Around 100000 cuttings (planting materials) were supplied to 156 households for growing in their backyard area or farm lands at a cost of Rs 0.30/cutting. Harvest data from four quadrates (2 x 2 square metres) from 10 farmers were recorded; average yield of OFSP tuber in this local condition was 7.68 ton/ha. Data on utilization collected from 50 farmers revealed that around 58 per cent of the produce was used for home consumption, 5 per cent distributed to relatives and neighbours and remaining 37 per cent sold in the local market at Rs 10–15/kg.

Table 3: ***Morphological and yield data of different rice varieties***

Variety	Plant height (cm)	No. of tillers/hill	No. of panicles/hill	1000 grain weight (g)	Grain yield (kg/ha)
CR Dhan-310	117.2	21	15	24	3240
CR Dhan-311	119.8	19	13	27	2544
DRR Dhan-45	107.7	14	11	28	1850
Pratikshya	112.5	22	16	25	3020

***Pre-rabi and Rabi Crop Interventions*:** Horse gram (a high-protein local variety pulse crop of 100–110 days) was promoted as a pre-rabi crop covering 136 acres and involving 640 farmers. Each farmer on average cultivated 0.2 acre and the yield was 1364 kg/ha. Green gram cultivation was undertaken in an area of 60 acres and involved 77 farmers with Nayagarh Local variety. Harvesting of the crop has been completed and threshing and cleaning are in progress.

***Nutrition Garden Intervention*:** Fruit-bearing plants, such as guava, custard apple and amla, procured from the forest department at Rs 1/plant, was distributed to 450 farmers. Seedlings of papaya and drumstick were distributed to 785 and 648 farmers, respectively. Apart from fruit-bearing plants, seeds of seasonal vegetables, such as amaranthus, spinach, coriander, Indian spinach, bitter gourd, broad bean, cluster bean, ridge gourd and cucumber, were distributed to 150 households to grow in their nutrition garden during the rabi season wherever water facility is available.

***Fish Farming*:** Freshwater fish farming was promoted in 78 ponds (68 individual and 10 community ponds involving 265 farmers (68 individual and 197 in community pond)). Out of the 78 ponds, 24 were renovated through participatory approach, with support from the project and farmers providing labour. Apart from technical support, lime, fish yearlings and floating fish were also supplied to the farmers. The community ponds are managed by women's self-help groups (SHGs), youth clubs and so on. Also, the first round of harvest has been completed in 71 ponds (62 individual and 9 community ponds). Harvest and utilization data have been recorded. From these 71 ponds, 3437 kg of fish have been harvested, out of which 1008 kg (29 per cent) was used for home consumption, 165 kg (5 per cent) distributed to neighbours and relatives and the remaining 2264 kg (66 per cent) sold within the village at an average rate of Rs 150/kg.

***Nutrition Awareness and Community Hunger Fighters*:** Nutrition awareness and building community capacity are core components of the project. During the reporting period, several awareness programmes were organized, starting with a programme on 'Basics of Nutrition' for staff on 7 June 2019; 10 staff members and 14 volunteers participated. Programmes to observe World Breast Feeding Week were organized in four locations covering the project villages in August 2019. The importance of immediate initiation of breastfeeding in the first hour after birth, value of feeding colostrum and exclusive breastfeeding for first 6 months after birth were emphasized in these meetings; a total of 66 mothers participated. National Nutrition Week was observed in collaboration with the Integrated Child Development Services (ICDS) Project, Boipariguda, Dalapur village, on 7 September 2019; 14 ICDS workers and 92 mothers participated. An awareness programme on the importance of OFSP was organized in Miluguda village on 20 November 2019. The benefits of consumption of OFSP and also how it can be consumed were explained.

As part of building community-level understanding and uptake, community hunger fighters (CHFs), an adult nutrition literacy programme with people's participation at its core, developed by MSSRF, is underway. People working on the project were oriented on the concept of CHFs through a workshop in Chennai in September 2019. Several meetings were then held across all 47 villages to engage with the community, explain the CHF concept and request them to identify suitable men/women to undergo training to become CHFs. A total of 96 men and women were selected by the community from these villages for the training. Residential training workshop on concept and practice of CHFs was organized during 3–11 November 2019 and 23–24 December 2019 at MSSRF, Jeypore, to train the identified men and women in batches; 92 CHFs participated in the programme and were trained on concepts such as good health, dietary diversity, role of different nutrients in maintaining good health, nutritive value of various food groups, agricultural planning with various types of land for dietary diversity, infant and young child feeding (IYCF) practices, shortlisting key messages and ways of taking them forward in the community.

A second module of a 3-day residential training programme, was organized from 22 to 30 January 2020 and 72 CHFs were trained in three 3-day sessions. The module began with a refreshing of the concepts discussed in the first module; participants were then asked to make a quantitative estimation of the food requirement of a family of five and list bottlenecks in agricultural production and challenges in accessing government entitlements.

An awareness programme on accessing government entitlements was organized on 31 January 2020 for all the CHFs, in which 66 CHFs participated. Mr Loaknath Dalabehera, OAS (SB), sub-collector, Jeypore, was the chief guest and government officials from different departments, such as Agriculture, Fishery, Animal Husbandry, Women and Child Development, Health and Family Welfare, Panchayati Raj and District Industrial Centre, participated in the programme and explained about accessing different schemes and entitlements. As a follow-up, MSSRF is working with the CHFs to develop village-wise plans and facilitate approaching different departments for access to entitlements.

***Training and Other Support*:** An FSN demonstration model has been established at the MSSRF campus in Jeypore covering an area of 0.4 acre as a demonstration to increase and spread awareness among farmers. Cycle weeders have been provided to the community across all the project villages to reduce drudgery and save time of women farmers in weeding of different field crops – 39 such weeders have been provided to 32 cluster locations, to be accessible to farmers from all 47 villages. The importance of the crops and vegetables being promoted was explained to the farmers at the household level, at the time of giving of seed/seedling and follow-up action. A farmer's field day was organized to create awareness on the importance of biofortified rice CR Dhan-310 and CR Dhan-311 (both high-protein varieties) and DRR Dhan-45

(high-zinc rice variety) in the demonstration field at Musapadar on 20 November 2019; 70 farmers (male: 57; female: 13) from 19 project villages participated. A training programme on 'Nutrition Gardening' was organized on 13 January 2020 at MSSRF, Jeypore, to train farmers on the importance of nutrition garden and different aspects of the maintenance of the gardens; 48 farmers attended the training session.

Five short video films documenting success stories for dissemination among farmers and other stakeholders have been developed: Orange Flesh Sweet Potato for Food and Nutrition Security, Fresh Water Fish Farming for Nutrition and Livelihood Security, Demonstration on Biofortified Rice, and Budra Murjia and Madana Murjia (a famer couple successfully practicing FSN in Semiliguda model village for FSN).

Sub Programme Area 503

Monitoring Promotion of Nutrition-Sensitive Fishery

MSSRF is the monitoring partner in a project led by WorldFish to promote fishery for nutrition security in Odisha. The project is underway in seven blocks across three districts of Odisha: Jagatsinghpur and Naugaon blocks in Jagatsinghpur district; Khaira and Soro blocks in Balasore district; and Gopabandhu Nagar, Khunta and Kaptipada in Mayurbhanj district.

A 4-day workshop on 'Monitoring and Evaluation' for the WorldFish staff working on the project was organized in July 2019. The objective was to revise the theory of change (ToC) of the project in line with ongoing activities and develop the indicators for monitoring. Resource persons from an external agency, Association for Stimulating Know-how (ASK), facilitated the conduct of the workshop. Based on the revised ToC, logframe and project output and outcome indicators were finalized. This helped firm up the indicators for regular monitoring. WorldFish had reached 748 households across the three districts in 2 years. A sample of 26 per cent or 195 households was drawn from this, using stratified random sampling technique, for regular monitoring of activities. In addition to individual ponds, fishery is also being promoted in community-managed ponds. Two community ponds from each district have also been listed for regular monitoring. Three educated local youth from each district have been engaged as volunteers and given training to monitor the activities and collect data on a regular basis. Each volunteer has been assigned a set number of households and community ponds to monitor. Data is recorded in the pond-monitoring book designed by WorldFish. The monitoring report for the 6-month period October 2019–March 2020 covering pre-stock management, stocking and post-stock management has been submitted.

Sub Programme Area 504

Garden of Nutri-rich Plants

During 2019–20, in all the four nutri-gardens, located in KVK Palghar (Maharashtra), KVK

Kanpur Dehat (Uttar Pradesh), KVK Thiruvallur (Tamil Nadu) and MSSRF, Jeypore (Odisha), soil samples were collected at different points for nutrient analysis and reclamation work was done. Nutri-gardens with green leafy vegetables, vegetable crops and fruit trees were established as per the layout proposed with different sections based on particular micronutrients – vitamin A section, vitamin D section, iron and iodine section, and so on – and bee hives installed in the garden. Mother nurseries were established at all sites. Elite species from germplasm collections were selected and planted in nurseries, and routine maintenance care is followed.

In each of the sites, 25 small and marginal farmers from 10 villages were selected to form 10 farmers' SHGs (FSHGs). These FSHGs will be part of this programme and will participate in the horticultural trainings to make their farms enriched with nutri-rich plants. Further, in each KVK, master trainers were identified and drawn from progressive farm families, faculty of KVKs and state agricultural universities and other organizations to provide training on various aspects of developing the nutrition garden.

In addition, awareness programmes were conducted on nutrition-based farming systems in 10 villages in each focus district. MSSRF, Jeypore, and the KVKs of Palghar and Kanpur Dehat organized exhibitions of nutri-rich wild vegetables. Tribal and farm families visited and interacted with the organizers. All the participating institutions distributed saplings of nutri-rich trees and seeds of nutri-rich plants and crops to farmers.

Sub Programme Area 505

Social Science Unit

505.1 Monitoring and Evaluation

A 3-day workshop on 'Monitoring and Evaluation' (M&E) was convened in June 2019 at Jeypore for the staff working on three different projects supported by the Rashtriya Krishi Vikas Yojana (RKVY). The workshop was facilitated by Mr Prakash Kumar Layak, senior manager, Capacity Building Domain, ASK, Gurugram, and 25 staff members participated. The objective was to emphasize/strengthen the importance of project monitoring, develop the M&E plan for the respective projects they were working on and monitor project progress accordingly.

A 1-day meeting of economists and social scientists from across all programme areas was convened in early July 2019 to discuss the importance of generating quality data and project monitoring. The need for a separate M&E unit independent of the programme areas was emphasized by all present.

505.2 Concurrent Evaluation of Implementation of National Food Security Act in Puducherry Union Territory

The Department of Food and Public Distribution extended the engagement of MSSRF as the monitoring agency for concurrent evaluation of implementation of National Food Security Act (NFSA) and direct benefit transfer (DBT) in public distribution system (PDS) in Puducherry

Union Territory (UT) for another year, that is, 2019–20. Concurrent evaluation was undertaken on a quarterly basis in all four census districts (Puducherry, Yanam, Mahe and Karaikal), covering one district in each quarter, and has been completed. The findings were shared with the district and UT officials for comments and the final reports submitted to the Department of Food and Public Distribution, government of India.

505.3 Study on Casual Factors Influencing Agriculture Land Use Patterns

The State Planning Commission, government of Tamil Nadu (recently renamed as State Development Policy Council), has entrusted a research study on 'Casual Factors Influencing Agricultural Land Use Patterns in Central Tamil Nadu' to MSSRF. The main objective of the study is to understand causal factors leading to the conversion of agricultural land to non-agriculture land and its impact on food security in Tamil Nadu. It also makes an attempt to understand the food availability scenario due to shift from agricultural land to non-agricultural usage in the selected districts of Tamil Nadu. The study was undertaken in Tiruchirapalli, Pudukottai and Karur districts in the central part of Tamil Nadu under the Cauvery Delta agro-climatic zone. Three blocks, namely, Annavasal (Pudukottai district), Uppiliyapuram (Tiruchirappalli district) and Karur (Karur district), were identified based on the rate of conversion of land from agriculture to other purposes during the past 15 years. Intensive study was conducted in the three blocks: Ariyur, Narthamalai and Ammachathiram gram panchayats in Annavasal; Okkarai, Kottapalayam and Erkudi gram panchayats in Uppiliyapuram; Vangal, Achamapuram and P. Kadambakurichi gram panchayats in Karur blocks. A total of 100 farmers were identified from three top villages under these panchayats, where the rate of agricultural land conversion was high during the past 5 years, and a survey was conducted with the sample households to understand the reasons for their converting their agricultural land into non-agricultural land during the past 15 years. In addition to household survey, focus group discussions with farmer groups and discussions with farmer organization representatives, government officials and real-estate brokers were also held to get the complete picture.

Uncertain water availability, inability to meet expenditure (including education and health) from agricultural income, high value of land and non-farm employment opportunities emerge as the four major reasons for the conversion of agriculture land. Diminishing scope for earning good income from the land was the major push factor for this conversion across the three blocks. Apart from the field study, a food availability prediction model has been developed for rice, maize, green gram and black gram for Tamil Nadu. The model gives the status of availability of selected food crops in 2020 and 2050 – and draws attention to the decline in availability in the future.

CROSS-CUTTING THEME

CLIMATE CHANGE

Global warming and its impact on the natural resource sector and other sectors dependent on it has been a long-standing and recurrent theme in the work of the Foundation since its very inception and is an integral part of the underlying vision that informs its work. Several programme areas of the Foundation are invested in projects that to various degrees relate to climate change and its consequences within the scope of their general mandate. However, in the years since, climate change has emerged as a significant and overarching theme across the board in domestic and international/global environmental governance and policymaking, in the study of natural resources and its relation to society in various dimensions, especially the socioeconomic dimension, in state and civil society action for poverty eradication, the enhancement of incomes and livelihoods, and coping and mitigation of disaster and climate risk. Climate change has come to be seen increasingly as a necessary element in the context of older themes in natural resources such as biodiversity and agrobiodiversity, protection of ecosystems and ecosystem services, and the health of soils and land. Increasingly in the past decade, the global, regional and local in the context of climate change have become ever more strongly linked, with new techniques and methods of analysis, handling of big data from large data sets drawn from many sources and a new interdisciplinary thrust which influences action by all actors engaged in these issues.

The mandate of the Climate Change Group is to respond to these developments while focusing on climate change as a cross-cutting theme in the work of the Foundation, informing its work through independent research and actions that provide important insights and at the same time drawing from the practical and conceptual learning achieved in various programme areas. Field projects for interventions may be taken up, thereby leveraging the existing capacities of the Foundation. The activities of the group are specifically directed towards providing new policy insights and policy directions that will enhance interventions in the field, focused on the welfare of the poor and marginalized, as well as enabling reaching out to policy influencers and policymakers at various levels, especially in central and state governments.

The current projects being undertaken by the Climate Change Group are described in this section.

The Development-Adaptation Linkage and Yield Gaps in Agriculture

One of the challenges for developing countries is to adequately understand the linkage between the demands of development and that of climate change adaptation. In many studies, current conditions are taken as the baseline for climate change adaptation, ignoring the significant development deficits that contribute to current climate variability. Such conflation undermines both development and climate change adaptation and creates confusion in climate policy and climate action. As part of the Ministry of Environment, Forest and Climate

Change (MoEFCC), Govt. of India funded project 'Equity and CBDR&RC in the Context of 2 Deg Global Warming – Implications for India', this issue is being studied with reference to climate change and agriculture, specifically through yield gaps in agricultural production.

Studies on yield gaps in the context of climate change and agriculture have been driven primarily by agronomy-based considerations, especially crop-modelling studies. On the other hand, studies in vulnerability of agriculture have focused on socioeconomic factors, with little explicit account of the need to increase yields. A common feature of both classes of studies is the treatment of current levels of productivity as given, and then determining the impact of climate change on production or on incomes and livelihoods. The impact of climate change tends to be confused with that of current climate variability, given the relatively low productivity of Indian agriculture at present. Such low productivity very frequently arises, across many crops and regions, not because of climate change, but because of a variety of other factors, which may be broadly described as developmental in nature.

Similar gaps between potential and actual productivity arise in other sectors as well, within the general definition of agriculture, as in the case of plantation crops, milk production and livestock, or inland and marine fisheries. Quantifying the extent of such productivity gaps is critical to making the right distinctions between development deficits and adaptation proper.

The yield gap is defined as the gap between the actual yield and the potential yield. The potential yield (Yp) is the yield of a crop cultivar when grown without water, nutrients and biotic stress (van Ittersum and Rabbinge, 1997)[1]. It is widely used as a benchmark for estimating yield gaps only for fully irrigated crops. For rain-fed crops, water-limiting yield (Yw) is considered the most relevant benchmark.[2] However, for the purposes of our study of yield gaps in major crops across different climatic zones in India, with the district as the spatial unit, we take the maximum attained yield in every climatic zone as the basis[3]. The yield gap for other districts in the same climatic zone is estimated relative to this maximum. For the climatic classification of districts, we use the revision undertaken in 2017 by the ICAR (Raju et al. 2018)[4], based on a moisture index that accounts for both average precipitation and average annual potential evapotranspiration

1. van Ittersum, M.K., and R. Rabbinge (1997). Concepts in production ecology for analysis and quantification of agricultural input-output combinations. Field Crops Research, 52(3), 197–208. https://doi.org/10.1016/S0378-4290(97)00037-32

2. Yw is defined as being similar as Yp, but crop growth is also limited by water supply and hence influenced by soil type and field topography. See https://www.yieldgap.org/glossary.

3. Other global studies take the 90th or 98th percentile of the yield distribution as the maximum attained yield.

4. Raju, B.M.K., R. Nagarjuna Kumar, C.A. Rama Rao, J. Samuel, K.V. Rao, A.V.M. Subba Rao, Md. Osman and N. Swapna (2018). Unreaped yield potentials in major rainfed crops and scope for bridging yield gaps – a decision support system. ICAR, Central Research Institute for Dryland Agriculture, Hyderabad. https://www.icar-crida.res.in:8129/.

(averaged over 1971–2005). The yield gaps for six major crops, namely, rice, wheat, maize, sorghum, soybean and pearl millet, have been studied, based on the average yield of districts over 2008–11 (these years are chosen for purposes of comparison with the similar estimates being undertaken by the ICAR). For rice and wheat, only districts with acreage >5000 hectares were included, while for the rest only districts having an acreage >3000 hectares for the crop were included in the analysis.

One of the overall striking results is the presence of considerable yield gaps in different climatic zones in all the crops. As an illustration of the results obtained, Figures 1 and 2 show, respectively, a boxplot of the distribution of yield gaps in rice across districts by climatic zones and a map of the districts illustrating the regional distribution of these yield gaps.

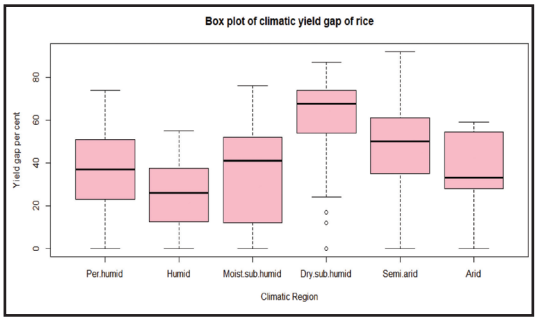


Figure 1:Climatic yield gap of rice across climatic zones.

A simple linear regression with good explanatory value shows that the yield gap for rice not only depends on water availability and water use (and fertilizer use) but is very significantly and positively correlated with the percentage of small and marginal farmers in the district among all cultivators (data being obtained from the Agricultural Census of 2011). Yield gaps are also particularly significant in maize.

A parallel project in the Ecotechnology programme area has calculated the projected decline in yield at the all-India and state levels based on current yields under two climate scenarios. Comparison of the yield gap results with these projections shows that, prima facie, closing yield gaps is one of the most significant adaptation actions to be undertaken (see Figures 3 and 4). For instance, the median loss of yield in maize, across both a moderate and an extreme scenario of global warming (both giving higher than 2-deg temp rise), does not exceed 10 per cent. However, the median yield

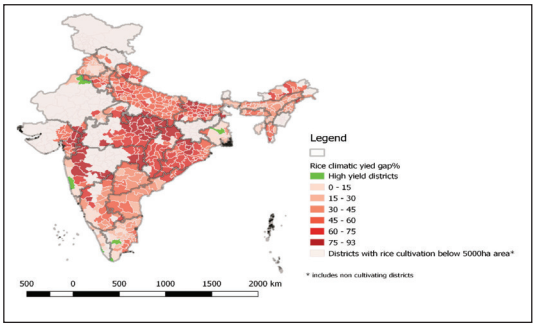


Figure 2: Climatic yield gap of rice across districts.

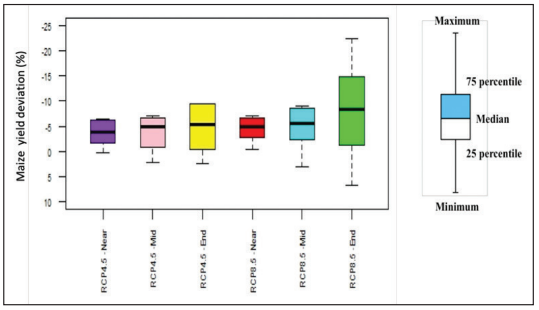


Figure 3: Maize yield gap deviation under RCP scenarios.

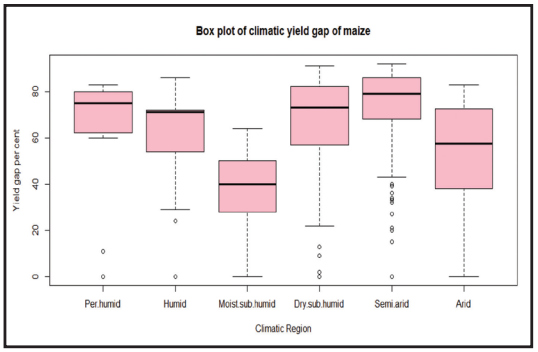


Figure 4: Climatic yield gap of maize across climatic zones.

gap across most climatic zones is higher than 50 per cent, accounting for more than 80 per cent of the cultivated area of this crop. Similar observations, even though perhaps not as striking, can be made for the other crops. More detailed comparisons between projections and current yield gaps at the district level are to be carried out to study this issue further. These and related questions will be further pursued in the latter half of the project.

Shared Socioeconomic Pathways and Their Implications for India and Other Developing Countries

The global collective action nature of climate change has begun to have serious implications for climate action at the national, regional and local levels. In climate science, in the assessment reports of the Intergovernmental Panel on Climate Change (IPCC) and in international negotiations, increasing reliance is being place on scenarios of climate mitigation and adaptation for the future, based on complex 'integrated assessment models' describing potential development pathways, referred to as shared socioeconomic pathways (SSPs) for the future. These development pathways describe the evolution of key future economic and environmental variables for the world while keeping emissions within the limits of the global carbon budget so that temperature increase can be kept below 2°C (while making every effort to restrict it to 1.5°C) as agreed to in the Paris Agreement. These SSPs, while ostensibly global in character, also have implications for regions and individual countries in their detailed structure. It is not evident that the United Nations Framework Convention on Climate Change (UNFCCC) principles of climate action 'on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities' have been duly incorporated in the construction of these pathways, and whether the pathways allow for meeting the development needs of the global South, including India.

The model pathways suggested by these studies have also been used to project the natural resource management pathways for various regions and countries. In doing so, the emphasis has been shifting from regarding natural resources and related sectors as the site of climate adaptation to their being regarded as having a key role in climate mitigation. Such a shift has serious consequences for a large population in the global South that is dependent on natural resources, ecosystems and ecosystem services for their well-being.

Despite its undoubted importance, the SSPs have been understudied in their implications

for developing countries. A component of the MoEFCC project referred to previously in this section pays attention to a careful analysis of the assumptions, methodology and outcomes of the SSPs.

Some of the interim findings of the study are as follows:

i) Equity is not adequately embodied in the assumptions of such models, and as a result they are not reflected in the outcomes. In these models, equity is supposedly based on the future convergence, towards mid-century or later, of the per capita gross domestic product (GDP) of developed and developing countries. This, however, is not an adequate measure of equity in many important ways, especially in climate mitigation and adaptation.

ii) As a consequence, the outcomes of these models project that all developing countries should reduce emissions at the same rate as developed countries soon after 2020. This requirement is even stronger for restricting the global temperature increase to 1.5°C instead of the targeted 2°C. This approach, referred to as 'contract and converge' in the climate policy literature, has long been rejected as a possible equity-based approach to climate mitigation on a global scale.

iii) An overwhelming majority of pathways for restricting the global temperature increase to either 1.5°C or 2°C maintain that countries must undertake 'negative' emissions, meaning that carbon from the atmosphere must somehow be absorbed and sequestered. However, the means of doing this are very speculative, and currently, there are no feasible means of large-scale implementation. Thus, these pathways for future climate action offer a very tenuous basis for restricting temperature increase. The reason for such speculative modelling is clearly the need to allow developed countries in particular to postpone serious and drastic emissions reduction into the future, without any commitment to such action in the short term.

iv) While the proponents of SSP claim that a large number of consultations have been conducted, these by themselves do not add value, as there are no norms of diversity of ideas, and a plurality of approaches and methodologies to inform projections for future pathways is missing. The SSPs are all based on one typical methodology alone, which is the computation of growth in terms of economic models drawn from neoclassical economics, based on very specific assumptions about the behaviour of economic agents. This methodology is contested both within and outside the climate policy literature.

v) It is in this context that the SSP projections further specify the extent of agricultural land, the scale of livestock activity, the extent of forest cover and so on that are to be considered necessary for achieving the 1.5°C or 2°C target. Such projections are made for both developed and developing countries. Such targeting effectively turns natural resources into targets of mitigation, ignoring the impact of global warming on these resources and livelihoods dependent on them, which had led to these sectors being considered targets of adaptation. The renewed emphasis on 'nature-

based solutions' in climate policymaking, ignoring the continuing and overwhelming role of industrial emissions in global warming, is a consequence of this shift in emphasis.

Natural resource projections under the SSPs are also model-dependent and use global models of vegetation cover, species extent and ranges, biodiversity and so on. A detailed study of this part of the SSPs and their implications, based on India's experience and ground realities and comparing these projections to trends in India for the relevant variables, will be taken up further in this project.

This component of work is being carried out in collaboration with researchers from the National Institute of Advanced Studies, Bengaluru.

Annex-I Watch: Developed Country Performance in Patenting Climate Change Mitigation Technologies

One of the key requirements for meeting the climate challenge is the development of technologies for climate change mitigation. Such technologies are ubiquitous in their potential uses and need to be deployed on a large scale, particularly in developing countries that cannot take a fossil-fuel intensive pathway to development. It is well recognized that innovation in such technologies depends considerably on developed countries taking the lead. A key indicator of whether such innovative activity is indeed taking place is the patenting activity from key countries.

In this component of the MoEFCC project, among several streams of study, one particular stream focused on innovation in climate change mitigation technologies. In particular, the patenting data from the OECD Stat database on patenting as well as from PATSTAT (database of the European Patent Office) were studied with respect to the climate change mitigation technologies (CCMTs) identified by the UNFCCC. (Annex-I in the subheading refers to the developed countries under the UNFCCC who have special commitments and responsibilities.)

The key findings are as follows:

i) The share of CCMTs in all patenting activity is falling. It has reduced from 11.4 per cent in 2011 to 7.2 per cent in 2016.

ii) Patenting activity in CCMTs, including major renewable energy technologies, from the leading developed countries in innovations rose to a peak between 2009 and 2011 and has declined significantly thereafter. This is illustrated in two representative graphs (Figures 5 and 6).

iii) In contrast, China, which is the leading developing country in innovation, as reflected in patenting data, has steadily rising output in terms of patent application, even outperforming developed countries in some areas.

iv) The inescapable conclusion is that post-Copenhagen with legally binding commitments to mitigation for developed countries being taken off the agenda (in contrast to the Kyoto Protocol), and with the Paris Agreement following through, the pressure for innovation has dramatically ceased. This has serious

implications for the validity of commitment to net-zero by mid-century, for the scale of future climate impact due to inadequate technological effort for mitigation and its consequences for the health of the planet in general and natural resources in particular.

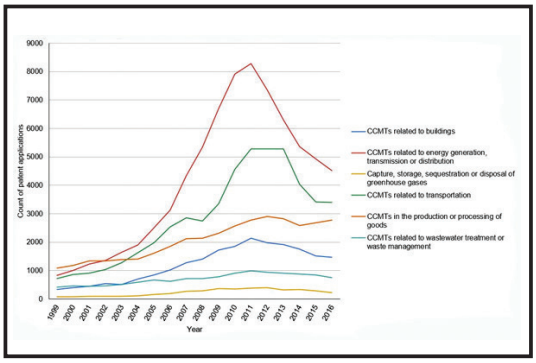


Figure 5: Patent counts of selected climate change mitigation technologies worldwide.

This study is to be extended to technological innovation and 'green technologies' related to the natural resources sector.

This work was carried out in collaboration with Ms Arohi Patil, formerly of the Tata Institute of Social Sciences, Mumbai.

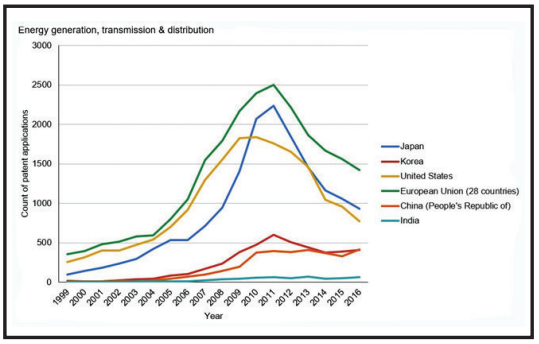
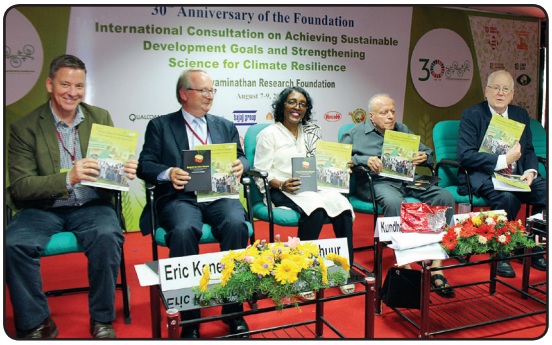
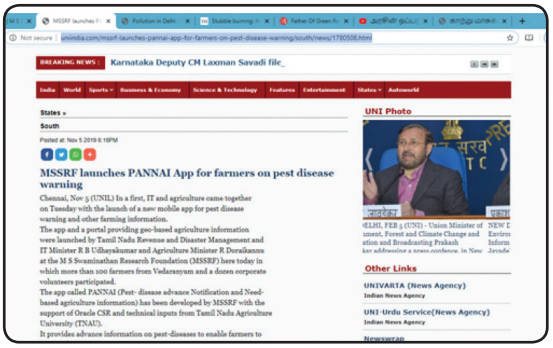


Figure 6: Energy generation, transmission and distribution patent applications.


30th Anniversary of the Foundation
International Consultation on Achieving Sustainable Development Goals and Strengthening Science for Climate Resilience
Swaminathan Research Foundation


The locust menace is causing serious damage to agriculture. Farmers are worried. The best way in controlling the locust invasion is to spray neem seed decoction over the plants. Neem is a strong repellent. Neem also serves as fertilizer. I hope our farmers will be able to manage the serious threat to crop security.


BREAKING NEWS
Karnataka Deputy CM Laxman Savadi file_
MSSRF launches PANNAI App for farmers on pest disease warning
Chennai, Nov 5 (UNI) In a first, IT and agriculture came together on Tuesday with the launch of a new mobile app for pest disease warning and other farming information.
The app and a portal providing geo-based agriculture information were launched by Tamil Nadu Revenue and Disaster Management and IT Minister R B Udhayakumar and Agriculture Minister R Doraikannu at the M S Swaminathan Research Foundation (MSSRF) here today in which more than 100 farmers from Vedaranyam and a dozen corporate volunteers participated.
The app called PANNAI (Pest- disease advance Notification and Need-based agriculture information) has been developed by MSSRF with the support of Oracle CSR and technical inputs from Tamil Nadu Agriculture University (TNAU).
It provides advance information on pest-diseases to enable farmers to
UNI Photo
Other Links
UNIVARTA (News Agency)
UNI-Urdu Service(News Agency)


COVID-19
MSSRF
RESPONSE
Series of assessments and support initiatives taken by the institution during and around the coronavirus crisis
MSSRF
Science for Sustainable Development


MSSRF @mssrf · May 29
#Lockdown, #COVID19 or otherwise - we need food. That's why we are continuously supporting farming communities especially in tribal areas. Our #Odisha team held #kharif planning meetings with farming communities & is helping with finger #millet seed procurement.


TN's flower growers wilt under lockdown impact
THE FLOWER MARKET
SEASON: March to June for most crops (except tuberose, which flowers in Aug-Sept and now that has two seasons)
Jayashree B & Rengalakshmi R
TN flowers make up around
Total production:
No. of farmers engaged in
Area under


Pests in a pandemic? India's plant doctors see you online now

Communication and Outreach

The communication and outreach activities of the Foundation are carried out through multiple efforts, including online interaction, physical events and seminars, besides facilitating visibility through news media and knowledge sharing through library services. During 2019–20, a new communication strategy was drawn up with a series of comprehensive initiatives. The objective was to connect research and scientific developments to society, besides engaging on key concerns related to the work of the Foundation. During 2019–20, the cumulative outreach was over three million reads, views and interactions through multiple media channels. In addition, support was provided for various projects to facilitate project objectives and enhance outreach and information dissemination. During the year, the writing of articles by scientists was facilitated and capacity built for popular writing. New internal and external sharing mechanisms were initiated and important days commemorated with special events and promotional activities.

Library and Information Services

The Bhoothalingam Library at MSSRF is well-organized and plays an important role in fulfilling the needs of scientists of the Foundation as well as researchers and students from other research and educational institutions. It has 18845 books, of which 60 were added during the year. It also holds a collection of CDs, journals, including 4585 bound journals, with 21 added during the year. Moreover, the library has a collection of technical reports and annual reports from various institutions. Current Awareness Services (CAS), Selective Dissemination of Information (SDI), Document Delivery, Publication and Distribution Services and Reprographic Services are offered by the library. It continued assistance through the Centre for Agriculture and Bioscience International (CABI) for full-text research articles to students; around 90 students from national and international universities benefited from this. Access to electronic databases of India Stat, JSTOR and SAGE has been made available. The lifetime work of Prof. M. S. Swaminathan has been digitized, and efforts are on to create an updated archival system.

Online Outreach

The website had an average of about 22000 page-views serving as a contact point for enquiries from media, students, development practitioners, farmers, academicians, international agencies and members of the public. In addition to news clippings, social media updates and publications, a total of 52 new articles were posted on the website during the year. MSSRF's monthly e-newsletter, *e-Synergy*, went out to over 2000 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 2020 was around 4900. Total impressions were about

548100 or an average of around 45675 reads every month on Twitter, with new followers. Prof. M. S. Swaminathan's Twitter handle (@ msswaminathan) had 2361000 impressions. Over 5515 new followers were added during the year, taking the number of his followers to 39315 as of March 31. On Facebook, the Foundation had a reach of over 164562 people, with regular posts, campaigns and event updates shared throughout the year. A total of 6421 people 'liked' the MSSRF Facebook page regularly. During the year, a page was also created on LinkedIn and regular posting initiated. The YouTube channel of the Foundation has been sharing live videos of events as well as event-based videos. An internal sharing mechanism 'Facebook workplace' was initiated for the staff and two orientation programmes provided on its use. MSSRF staff members are now using this for internal information sharing about ongoing activities. An Instagram profile has also been added, and it shares regular photographs from the work of the Foundation from various field sites.

The Hindu Media Resource Centre

The Hindu Media Resource Centre (THMRC) shares information and facilitates regular interaction with media through press releases, stories and media capacity building and also helps address queries to provide inputs on scientific and research/development stories. During the year, more than 288 new stories in newspapers, web editions and television channels featured MSSRF. These stories were covered in many languages, including English, Tamil, Telugu, Odia, Hindi 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, besides e-mailers, invites and logistics for organizing the events. Regular media tracking and documenting is being done with special compilations for major initiatives. Popular media writing by scientists was also facilitated during the year with over 10 articles authored by staff being published. Global media outreach was also made possible with high-impact mainstream popular media articles An active visitor outreach for students and practitioners from educational and research institutions was encouraged with an average of 500 visitors every month to the Chennai headquarters.

MSSRF 30th Foundation Day

The year marked the completion of 30 years of the Foundation, and an international conference was organized coinciding with the Foundation Day in August. A special website for MSSRF-30 was created with specially curated content. Also, support was provided for a series of publications brought out to commemorate the 30th Foundation Day of MSSRF besides an updated brochure. Co-ordination and support were provided for an MSSRF-30-year video film that was created for the occasion. Prof. Swaminathan's interaction with world leaders was documented as an interactive web tool. Media interaction and outreach were facilitated as well. A special event documentation of the MSSRF-30 conference

was completed in print, audio/video and presentations compiled and circulated to key stakeholders. A new organization profile document was also created for external outreach.

Lectures and Seminars

Public outreach support was provided through seminars and events across thematic areas. Seminars organized included subjects ranging from seed and biodiversity to nutrition and traditional agriculture. Over 15 seminars were organized during the year with researchers, students and stakeholders from different institutions participating. These seminars were also live streamed for the benefit of a wider audience. As part of special events, the first Gopalan Memorial Lecture, featuring Dr Soumya Swaminathan, tool place in January 2020, while a special series of agenda-setting talks with *Nature* Research publishing was held in March 2020. A day-long event on 'Every Child a Scientist' commemorating International Children's Day was held in November 2019 to build scientific temper among children from schools of the Chennai city corporation. Another special event was held on World Food Day on the theme of 'Healthy Diets for a #ZeroHunger World'.

Project Support

Communication support was provided to various projects to enhance the impact for reaching out to communities and other stakeholders. The designing and development of strategic communication approaches helped support projects. A series of promotional activities was held to support uptake of community usage for the Charities Aid Foundation – Geographical Information System (CAF-GIS) project. The Fish for All Centre completed 10 years, for which communication and outreach support was provided. Eight programs for two community radio stations were created as part of the Bay of Bengal project and trainings facilitated for media persons through two workshops. Communication support for the 'Nutrition-Secure Puducherry' initiative was provided as also communication planning and support for Resilience, Transforming India's Green Revolution by Research and Empowerment for Sustainable Food Supplies (TIGR2ESS) and Water Security and Climate Adaptation in Rural India (WASCA) projects for a series of emerging upcoming activities. The design and development of a series of policy briefs related to Covid-19 and the subsequent lockdown were facilitated. These were also promoted among key external stakeholders.

Seminars and Key Events

Through the year, MSSRF organized various seminars and events providing a platform for vibrant engagement on science, research, development among scientists, relevant stakeholders as well as members of the public. Some of the key events that were organized included the August Annual Conference and Foundation Day celebrations. Also, important days such as the 'World Food Day' and 'International Children's Day', besides the first Gopalan Memorial Lecture, were marked with events at the headquarters, and days such

as Soil Day and 'Coastal Cleanup Day' were commemorated by regional centres. Other highlights were the launch of the 'Nutrition-Secure Puducherry' initiative and an event on 150 years of science with 'Nature' research. A brief report on some of the key events follows:

• MSSRF Annual Conference 2019 – From 30 Years to 2030: The Annual Conference 2019 – marked the 30th Foundation Day celebration of MSSRF. Held from 7 to 9 August, it brought together a range of high-profile speakers and various stakeholders in science, development and policy. A major objective of this event was to take stock of changes in sustainable agriculture and rural development over the past three decades, in particular in food, nutrition and livelihoods, as a result of multisectoral interventions. The event helped plan future strategic research, development and deployment of scientifically credible knowledge and evidence in the challenging areas of sustainable development. The discussions focused on three thematic areas: climate change and coastal India; sustainable livelihood, nutrition and health security; and biodiversity mainstreaming for sustainable agriculture and climate resilience.

Primary outputs from this meeting included:

a. Consolidated results of evidence-based studies and interventions to achieve sustainable agricultural and rural development goals in different locations of India, particularly the coastal, semi-arid and dryland ecosystems and the biodiversity and cultural diversity hotspots of the country; gaps to be addressed were identified.

b. Development of partnerships and networks between policymakers, community institutions, media, NGOs, private-sector institutions, scientists and donors, working in the areas of sustainable livelihoods, natural resource management, and food, nutrition and health security, to upscale the achievements and take the results to desirable new heights.

c. Discussion of resource mobilization mechanisms and strategies for strengthening initiatives at the community-scientist-policymaker level to promote conservation, enhancement and sustainable and equitable use of agrobiodiversity and other natural resources for achieving the SDGs. The conference proceedings, video and presentations can be accessed here: https://www.mssrf.org/mssrfthirtyyearsnew/.

• The 'Nutrition-Secure Puducherry' initiative was launched by Mr V. Narayanasamy, Chief Minister of Puducherry, at the Pillayarkuppam 'Biovillage' amid a gathering of over 300 women from various collectives, to commemorate the 150th Gandhi Jayanti. In his video message, Prof. M. S. Swaminathan emphasized the five aspects of nutrition: calorie deficiency, protein malnutrition, micronutrient deficiency, water and sanitation and nutrition awareness to achieve 'nutrition security'. Dr Anil Kumar, Executive Director, MSSRF; Ms Kathanayagi, InnuyirGramaSangam; Dr Balagandhi, Director, Department of Agriculture and Animal Welfare; Dr N. Vijayakumar from KVK, Puducherry; and Dr G. N. Hariharan, MSSRF, spoke on the occasion. Women's group members, farming communities, government

department officials and scientists from MSSRF attended the event, which was well covered by the media.

• Universal Children's Day was celebrated at Chennai in November 2019. Children from Chennai's corporation schools (one zone) gathered to express their thoughts on climate change and share expectations from science and scientists. Foldscopes, donated to the institution by Prof. Bruce Alberts, former Editor-in-Chief of 'Science' and President of the National Academy of Sciences, United States, were distributed to the students through the 'Every Child a Scientist' initiative of MSSRF. Prof. Swaminathan emphasized the need for children to contextualize and know about climate change. The demonstration in Chennai was conducted by Mr Mo Pandiarajan, an expert who has been training children in the use of this equipment. Children gave suggestions on using solar energy, protecting trees and growing flowering plants, and pollinator bees and also shared interesting artworks, expressing thoughts on climate change.

• The launch of the Bharatiya Poshan Krishi Kosh (BPKK; the India Agriculture Nutrition Fund) highlighting the importance of agriculture for nutrition was held in the presence of Ms Smriti Irani, Minister for Women and Child Development, government of India, and Mr Bill Gates, Microsoft founder. In his keynote message on video, Prof. M. S. Swaminathan spoke of the importance of ending malnutrition, especially among mothers and children. He suggested that the government set up a band of 'community hunger fighters' to address malnutrition at the community level besides his five-point plan to address malnutrition.

• PANNAI app., launch: Mr R. B. Udhayakumar and Mr R. Doraikannu, Ministers of Tamil Nadu, launched the PANNAI (Pest-disease Advance Notification and Need-Based Agriculture Information) app and geo-agri portal developed by MSSRF with the support of Oracle CSR and technical inputs from Tamil Nadu Agriculture University (TNAU) on 5 November. This provides advance information on pest-diseases so farmers can protect their crops, also using integrated information from the Uzhavan app of Tamil Nadu. Mr Udhayakumar, Minister for Revenue and Disaster Management and Information Technology; Mr Doraikannu, Minister for Agriculture; Prof. M. S. Swaminathan; Dr Anil Kumar; Mr Ramesh Venkatachari, representative from Oracle; Mr R. Nagarajan, MSSRF Head of Project; and Mr Balasubramanian, a farmer, also spoke on the occasion.

• Gopalan Memorial Lecture: As a mark of honour to the memory of the 'Father of Nutrition Research in India', the Dr C. Gopalan Memorial Lecture was announced by Prof. M. S. Swaminathan at the condolence meeting for Dr Gopalan at MSSRF in October 2019. The first Dr C. Gopalan Memorial Lecture was held in January 2020 at MSSRF, Chennai, and featured Dr Soumya Swaminathan, Chief Scientist, WHO, and former DG, ICMR. In her talk, she focused on the 'double burden of malnutrition' or 'the new nutrition reality', namely, the co-existence of obesity along with stunting, that had to be addressed urgently.

• 150 years of Science through 'Nature': *Nature*, the international journal of science, turned 150 in November 2019. As part of the global celebrations, the Nature Research Group, along with MSSRF, marked the historic occasion with an event themed '150 Years of Science through the Pages of *Nature*'. The half-day event on 6 March 2020 at MSSRF, Chennai, featured six short, agenda-setting talks by leading scientists, innovators and science policy experts of India.

• Padma Awardees event: Two inspirational personalities, with several achievements despite disabilities, were felicitated at a special event in March 2020. Mr Manohar Devadoss and Mr S Ramakrishnan, both Padma Shri awardees, were felicitated by Mr N. Ram, Chairman, Kasturi and Sons, speaking at MSSRF, Chennai. Prof. Swaminathan spoke of the importance of celebrating humanity. 'The value system that you stand for is the value system we need in the country; where people will put the country above themselves and look at values applied to human well-being.'

• A webinar on locusts: MSSRF hosted a webinar on locusts in partnership with CABI titled 'Locust Attacks: What India's Farming Community Needs to Know'. The discussion was organized because of concerns due to unexpected locust swarms across western and northern parts of India. To provide scientific information, the online discussion took place with Dr Belinda Luke, Senior Insect Pathologist and Team Leader Biopesticides, CAB International; Dr Jaba Jagdish, Scientist and Head Entomology, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT); and Dr J. S. Kennedy, Dean, School of Post-Graduate Studies, Tamil Nadu Agricultural University. The event had video presentations that were disseminated widely to the public.

• Webinar in partnership with Monash University: The dangers of increasing inequalities, poverty and food insecurity and the need for urgent and enhanced relief packages were highlighted by Dr Madhura Swaminathan, Chairperson, MSSRF, at a webinar in June. Titled 'COVID19: Addressing Food Security and Nutrition', jointly hosted by Monash Business School's Centre for Development Economics and Sustainability (CDES), the School of International and Public Affairs at Columbia University and MSSRF, the panel included eminent speakers Dr David Dawe, Senior Economist with the Food and Agriculture Organisation (FAO), United Nations; and Dr Marie T. Ruel, Director of the Poverty, Health and Nutrition Division, International Food Policy Research Institute (IFPRI).

• Reboot Tamil Nadu webinar presence on Times of India platform: In an online event organized by the Times of India media house, Mr Gagandeep Singh Bedi, Principal Secretary Agriculture, Tamil Nadu; Mr Ravichandran Purushothaman; and Dr R. V. Bhavani, MSSRF Director for Agriculture-Nutrition-Health, participated along with Mr Jayaraj Sivan, Times of India. Dr Bhavani emphasized the agriculture-nutrition link and building better nutrition and immunity and how the community could better cope with pandemics.

The event was well received online with a high viewership.

- Seminar on Auroville: A seminar was delivered by Mr Joss Brooks on Auroville, on the transition from dust and drylands to forests. A restoration ecologist, Mr Brooks highlighted success stories of helping rejuvenate land and how it could solve the problems of Chennai. Prof. M. S. Swaminathan, Founder, MSSRF, applauded the unique approach of Auroville, saying it should be declared a 'University for Peace with Nature'.

- Seminar on Transforming Food Systems: Prof. Prabhu Pingali, an eminent economist, delivered a seminar at MSSRF in December 2019 on the book *Transforming Food Systems for a Rising India* written by him and co-authored by Drs Anaka Aiyar, Mathew Abraham and Andaleeb Rahman. The book explores challenges and opportunities to achieve a nutrition-secure future through production systems, improved health and hygiene environment and greater capability to access a balanced diet. Co-author Dr Anaka Aiyar, health economist, spoke on the need to refocus public policy to increase system and nutrition diversity and tackle the triple burden of malnutrition.

Publications

Books / Monographs /Manuals /Electronic Material

Balasubramanian. T.N., M. Devaraj and R. Rengalakshmi. 2020. *Training manual for climate risk managers.* Manual No. 87. Chennai: MSSRF. 57pp.

Bhavani, R.V., Israel Oliver King, R. Rengalakshmi, R. Ramasubramanian, S. Velvizhi, V. R. Prabavathy and B. Jayashree. 2019. *From 30 years to 2030: Achieving sustainable development goals and strengthening science for climate resilience*. Proceedings No.80. Chennai: MSSRF. 54 pp.

King E. D. Israel Oliver., Girigan Gopi, Prashant K Parida, N. Kumar, Kartik Charan Lenka and N. Anil Kumar. 2019. *Community agro biodiversity conservation for food security and sustainable livelihoods*. Working Paper No. 13. Chennai: MSSRF. 20 pp.

Kumar, N., King I. Oliver E. D., V. V. Sivan, Prashant K. Parida, Kartik Charan Lenka, V. Shakeela, J. Joseph, R. V. Bhavani and B. Jayashree. 2020. *Local health traditions and health foods for conservation and sustainable use of biodiversity.* Working Paper No. 14. Chennai: MSSRF. 25pp.

M. S. Swaminathan Research Foundation. 2020. *Good nutrition: A handbook for trainers.* Manual No. 85. Chennai: MSSRF. 58 pp.

M. S. Swaminathan Research Foundation. 2020. *The first Dr. C Gopalan memorial lecture delivered by Dr Soumya Swaminathan, Chief Scientist, WHO.* Chennai: MSSRF. 20 pp.

M. S. Swaminathan Research Foundation. 2019. *Towards a nutrition-secure Puducherry.* Monograph No. 48. Chennai: MSSRF. 16 pp.

M. S. Swaminathan Research Foundation. 2019. *Journey of MSSRF: Innovations and impacts*. Occasional Publication No. 9. Chennai: MSSRF. 48 pp.

M. S. Swaminathan Research Foundation. 2019. *30 years of MSSRF: Influencing policy change.* Occasional Publication No.8. Chennai: MSSRF. 48 pp.

M. S. Swaminathan Research Foundation. 2020. *Livelihoods of smallholder farmers engaged in floriculture in Tamil Nadu*. Policy Brief No. 2. Chennai: MSSRF. 4 pp.

M. S. Swaminathan Research Foundation. 2020. *Livelihoods of marine fishing communities along India's coast*. Policy Brief No. 3. Chennai: MSSRF. 4 pp.

M. S. Swaminathan Research Foundation. 2020. *On Farmers and farming in Tamil Nadu, Puducherry, Kerala and Odisha*. Policy Brief No.4. Chennai: MSSRF.11 pp.

M. S. Swaminathan Research Foundation. 2020. *Aquaculture in Tamil Nadu, Andhra Pradesh and Odisha*. Policy Brief No. 5. Chennai: MSSRF. 6 pp.

M. S. Swaminathan Research Foundation. 2020. *COVID-19 MSSRF response: Series of assessments and support initiatives taken by the institution during and around the Coronavirus crisis*. Policy Brief No.6. Chennai: MSSRF. 6 pp.

Panda, A. K., S. Raju, and D. J. Nithya. 2019. *Housing listing survey report*: *Strengthening livelihoods and enhancing food and nutrition security of small and marginal farmers in Koraput District of Odisha through a farming system model*. Research Report No. 53. Chennai: MSSRF. 14 pp.

Pichan, M. Salim and Jose Mathew. 2019. *Biodiversity of Kurichiyarmala forest of Western Ghats: Diversity and rarity of a fragile forest system of India.* Latvia: Scholars Press. 125 pp.

Raju, S., D. J. Nithya and Akshaya Kumar Panda. 2019. *Baseline survey report: Strengthening livelihoods and enhancing food and nutrition security of small and marginal farmers in Koraput District of Odisha through a farming system model*. Research Report No. 54. Chennai: MSSRF. 64 pp.

Ramasubramanian, R., T. Ravishankar, Shanti Priya Pandey and D. Nalini Mohan. 2020. *Manual on preparing mangrove nursery and mangrove genetic resources conservation centre*. Manual No. 84. Chennai: MSSRF. 56 pp.

Selvamukilan B., S. Malarvannan and R. Rengalakshmi. 2019. *Key outcomes of the project on promotion of plant clinics for safe vegetable production in Oddanchatram Region of Dindigul District, Tamil Nadu*. Research Report No.55. Chennai: MSSRF. 18 pp.

Velvizhi, S. and B. Jayashree. 2019. *Science, service and the seas: Ten years of fish for all research and training centre*. Chennai: MSSRF. 38pp.

Velvizhi, S. and L. Vedavalli. 2020. *Ocean state forecast information for safe and informed fishing MSSRF- INCOIS interventions in southern states of India.* Research Report No.56. Chennai: MSSRF. 18 pp.

Thesis

Jithin, M. M. 2019. Biosystematic study of selected rare, endemic and threatened tree species of high Gum, Resin, Oil (GRO) value in the Kerala part of Western Ghats, India. Thesis submitted to the University of Madras, Chennai, in partial fulfilment of requirement for the degree of Doctor of Philosophy.

Maganti Sowjanya. 2019. Collection, evaluation and molecular analysis for micronutrient variation in rice (*Oryza sativa* L.). Thesis submitted to the University of Madras, Chennai, in partial fulfilment of requirement for the degree of Doctor of Philosophy.

Saranya, J. 2019. Identification of salt responsive genes from c4 halophyte *Suaeda nudiflora* (wild). moq through suppression subtractive hybridization and expression analysis under salt and elevated carbon dioxide conditions. Thesis submitted to the University of Madras, Chennai, in partial fulfilment of requirement for the degree of Doctor of Philosophy.

Suma, T. R. 2019. Reorganization of Kurichya joint families and community natural resource management. Thesis submitted to the Kannur University, Kannur, in partial fulfilment of requirement for the degree of Doctor of Philosophy.

Articles in Journals / Books

Anil Kumar, N. and Suma Vishnudas. 2019. "Empowering local self governments for mainstream biodiversity in sustainable development of Kerala". *Social Science in Perspective*. 11(1): 637-651.

Asiya, P. P. R. Sreeraj, Joseph John and P. B. Ramya. 2019. "In-Vitro Antagonistic Activity of Plant Extract on Fusarium Species". *Mapana Journal of Sciences.* Vol. 18, No. 4, 53-62 ISSN 0975-3303|https://doi.org/10.12723/mjs.51.5. pp.53-62.

Asiya, P. and Girigan Gopi. 2019. "Socio-economic Profile and Adoption of Recommended Milking Practices among Small Dairy Farmers of Meenangadi Gram Panchayat of Wayanad District of Kerala". *Mapana Journal of Sciences.* Vol. 18, No. 4, 41-51 ISSN 0975-3303|https://doi.org/10.12723/mjs.51.4. pp.41-51.

Asiya, P., Manjula Menon, Girigan Gopi and Vipin Das. 2019. "Impact of Cropping Systems on Soil Microbial Load: Evidence from Wetland Ecosystems of Wayanad District, Kerala". *Mapana Journal of Sciences.* Vol.18, No.4, 1-8ISSN 0975-33033|https://doi.org/10.12723/mjs.51.1. pp.1-8.

Bhavani, R. V. and N. Anil Kumar. 2020. "Redesigning our farming systems". *Seminar*. 730(6): 2-4.

Devesh Singh, N. Mathimaran, T. Boller and A. Kahmen. 2020. "Deep-rooted pigeon pea promotes the water relations and survival of shallow-rooted finger millet during drought despite strong competitive interactions at ambient water availability". *PLOS One. 2: 1-22.* https://doi.org/10.1371/journal.pone.0228993

Gopinath, R. and Anuradha, G. 2019. "Need and scope for farming system for nutrition in Bihar". *Indian Journal of Social Research.* 60(5): 733-748.

Gothandapani Sellamuthu, Vidya Jegadeeson, Radha Sivarajan Sajeevan, Raja Rajakani, Pavithra Parthasarathy, Kalaimani Raju, Lana Shabala, Zhong-Hua Chen, Meixue Zhou, Ramanathan Sowdhamini, Sergey Shabala and Gayatri Venkataraman. 2020. "Distinct evolutionary origins of intron retention splicing events in NHX1 antiporter transcripts relate to sequence specific distinctions in *Oryza* species". *Frontiers in Plant Science*. 11: 267.

Gnanamoorthy, P., V. Selvam, P. K. Deb Burman, S. Chakraborty, A. Karipot, R. Nagarajan, R. Ramasubramanian, Qinghai Song, Yiping Zhang and John Grace. 2020. "Seasonal variations of net ecosystem (CO2) exchange in the Indian tropical mangrove forest of Pichavaram. *Estuarine Coastal and Shelf Science.*243 https://doi.org/10.1016/j.ecss.202

Jayashree, B and I. A. Aram. 2020."Conservation of millets: The role of community leaders in Kolli Hills, South India". *Indian Journal of Traditional Knowledge* 19(1): 101-110.

Jayesh P. Joseph, Manjula Menon and Girigan Gopi. 2019. "Conservation of medicinal plant resources: Potential for medicinal plants intensification in agroforestry systems". In Amruth M., A. V. Raghu, V. P. Raveendran,

K. V. Muhammed Kunhi and S. Viswanath (eds). *Medicinal plants cultivation and conservation.* Thirissur: Kerala Forest Research Institute. 45-55 pp.

Joseph John, P. R. Sreeraj, P. Asiya, P. Kathireswari, Rini Joseph and Jijo George. 2019. "Earthworm Population in Relation to Different Agro Climatic Regions of Wayanad District of Kerala". *Mapana Journal of Sciences*. Vol. 18, No. 4, 63-73 ISSN 0975-3303|https://doi.org/10.12723/mjs.51.6. pp. 63-73.

Sekar, J., Saharan, K., Raju, K., Singh, U. and Vaiyapuri, P.R. 2019. Consequences of bioinoculants and intercropping approach to alleviate plant drought and salinity stress for sustainable agriculture. In Akhtar, M.S. (ed). *Salt Stress, Microbes, and Plant Interactions: Mechanisms and Molecular Approaches.* Springer Singapore: Singapore. pp. 161-182.

Jothiramshekar, S., J. J. Benjamin, R. Krishnasamy, Suja George, R. Swaminathan and Ajay Parida. 2020. "Identification of salt-responsive genes from C4 halophyte *Suaeda nudiflora* through suppression subtractive hybridization and expression analysis under individual and combined treatment of salt and elevated carbon dioxide conditions". *Physiol Mol Biol Plants.*26: 163-172.

Juan Liu, Sergey Shabala, Jing Zhang, Guohui Ma, Dandan Chen, Lana Shabala, Fanrong Zeng, ZhongHua Chen, Meixue Zhou, Gayatri Venkataraman and Quanzhi Zhao. 2020. "Melatonin improves rice salinity stress tolerance by NADPH oxidase-dependent control of the plasma membrane K^+ transporters and K^+ homeostasis". *Plant, Cell and Environment*. https://doi.org/10.1111/pce.13759

Maske, Mahesh, S. Landage, M. Sayre and R. V. Bhavani. 2019. "Nutritional and livelihood security through backyard poultry model in tribal regions of Maharashtra, India". *Indian Journal of Poultry Science*. 54(2): 175−179.

Maske, Mahesh, M. Sayre, M. Sadatpure and R.V. Bhavani. 2020. "Drudgery reduction among farm women through innovative cotton harvesting bag: a study in Maharashtra, India". *International Journal of Farm Sciences*. 10(1): 85-89.

Mathimaran, N., M. N.Thimmegowda, V. R. Prabavathy, P. Yuvaraj, R. Kathiravan, M. N. Sivakumar et al. 2020. "Intercropping transplanted pigeon pea with finger millet: Arbuscular Mycorrhizal fungi and plant growth promoting Rhizobacteriaboost yield while reducing fertilizer input" *Frontiers in Sustainable Food System.*https://doi.org/10.3389/fsufs.2020.00088

Mathew Jose, P. M., P. M. Salim, R. Radhamany and K. Varghese George. 2020. "Araceae of Agasthyamala biosphere reserve, South Western Ghats, India". In Jayanta Kumar Patra, Gitishree Das Sanjeet Kumar, Hrudayanath Thatoi (eds). *Ethnopharmacology and Biodiversity of Medicinal Plants*. Florida: Apple Academic Press. 137-167 pp.

MiingTiem Yong., Celymar Angela Solis, Barkat Rabbi, Samsul Huda, Rong Liu, Meixue Zhou, Lana Shabala, Gayatri Venkataraman,

Sergey Shabala and Zhong Hua Chen. 2020. "Leaf mesophyll K^+ and Cl- fluxes and reactive oxygen species production predict rice salt tolerance at reproductive stage in greenhouse and field conditions" *Plant Growth Regulation*. https://doi.org/10.1007/s10725-020-00619-y

Nitya Rao and S. Raju. 2019. "Gendered time, seasonality, and nutrition: Insights from two Indian Districts" *Feminist Economics.* 26(2):95-125.

Panda, D., N. Hema Sailaja, Prafulla K. Behera, Kartik Lenka, Shyam S. Sharma and Sangram K. Lenka, 2020. "Genetic diversity of under-utilized indigenous finger millet genotypes from Koraput, India for crop improvement". *Journal of Plant Biochemistry and Biotechnology*, https://doi.org/10.1007/s13562-020-00557-w

Parida, Prashant K., Neeranjan Gauda, Jeva, R and Kartik Charan Lenka, 2020. "Magical Hands of a Tribal Farmer Set a Milestone in Finger Millet Cultivation-A Case from Koraput, Odisha India". *Scholarly Journal of Food and Nutrition.* https://dx.doi.org/10.32474/SJFN.2020.02.000144

Pichan M. Salim., Jose Mathew and T. K. Hrideek. 2020. "Sonerila sulpheyi (*Melastomataceae, Sonerileae*): A new species from the Southern Western Ghats, India". *Phytotaxa*. 435 (1): 76-80.

Prabha., S. Sini, T. S. Priyadarshini, P. Sasikumar, Greeshma Gopalan, Jayesh P. Joseph, M. M. Jithin, V. V. Sivan, P. Jayamurthy and K. V. Radhakrishnan. 2019. "Anti-inflammatory effect and mechanism of action of ellagic acid-3,3′,4-trimethoxy-4′-O-α-*Lrhamnopyranosid*e isolated from *Hopea parviflora* in *lipopolysaccharide*-stimulated RAW 264.7 macrophages". *Natural Product Research*. https://doi.org/10.1080/14786419.2019.1690486

Raneri, E. Jessica., Stefano Padulosi, Gennifer Meldrum, Oliver I. King. 2019. "Supply-side measures improving food environments: Promoting neglected and underutilized species to boost Nutrition in LMICs". *UNSCN Nutrition*. 44:10-25.

Rengalakshmi, R., M. Devaraj, B. Selvamukilan, R. Seenivasan and C. A. S. Britto. 2020. "Improving women's access to climate information services and enhancing their capability to manage climate risks". *APN Science Bulletin.*10(1): 3-10.

Rohit Parasar., R.V. Bhavani and S. Raju. 2020. "Access to milk and milk products and child undernutrition". In Swarna Sadasivam Vepa and Brinda Viswanathan (eds). *Undernutrition, Agriculture and Public Provisioning: The Impact on Women and Children in India*. London: Routledge and Taylor & Francis Group. pp 201-229.

Sarah H. K., Varsha Dhurde, Shilpa Bhaise, Rashmi Kale, Kalyanaraman Kumaran, Aulo Gelli and R. Rengalakshmi et al. 2019. "Barriers and facilitators to fruit and vegetable consumption among rural Indian women of reproductive age". *Food and Nutrition Bulletin*. 40: 87-98.

Sarah H. K., Varsha Dhurde, Shilpa Bhaise, Rashmi Kale, Kalyanaraman Kumaran, Aulo

Gelli, R. Rengalakshmi et al. 2019. "How do fruit and vegetable markets operate in rural India? A qualitative study of the impact of supply and demand on nutrition security". *Food and Nutrition Bulletin*. 20: 1-15.

Shilpha Jayabalan., Shalini Pulipati, Karthikeyan Ramasamy, Deepa Jaganathan, Sowmiya Devi Venkatesan, Gopikaa Vijay, Kumkum Kumari, Kalaimani Raju, Gopalasamudram Neelakantan Hariharan and Gayatri Venkataraman. 2019. "Analysis of genetic diversity and population structure using SSR markers and validation of a cleavage amplified polymorphic sequences (CAPS) marker involving the sodium transporter OsHKT1;5 in saline tolerant rice (*Oryza sativa L.*) landraces". *Gene* .https://doi.org/10.1016/j.gene.2019.143976

Suji Somasundaram., Anne-AliénorVéry, Rithvik S Vinekar, Tetsuya Ishikawa, Kumkum Kumari, Shalini Pulipati, Kavitha Kumaresan, Claire Corratgé-Faillie, R. Sowdhamini, Ajay Parida, Lana Shabala, Sergey Shabala and Gayatri Venkataraman. 2020. "Homology modelling identifies crucial amino-acid residues that confer higher Na+ transport capacity of OcHKT1;5 from *Oryza coarctata* Roxb". *Plant and Cell Physiology*. https://doi.org/10.1093/pcp/pcaa061

Suma, T. R. and S. Gregory. 2019. "Gandhiji's vision of Grama Swaraj and the Kurichya joint farming system: The development experience and the way forward". *Rajagiri Journal of Social Development*. 11(2): 87-110.

Swaminathan. M. S. 2020. "From food security to nutrition security". *Seminar*. 730(6): 1-2.

Tianxiao Chen., Yajun Zhu, Kai Chen, Congcong Shen, Xiuqin Zhao, Sergey Shabala, Lana Shabala, Holger Meinke, Gayatri Venkataraman et al. 2020. "Identification of new QTL for salt tolerance from rice variety Pokkali". *Journal of Agronomy and Crop Science*. https://doi.org/10.1111/jac.12387

Zhao Q.J. Liu, S. Shabala, L. Shabala,M. Zhou, H. Meinke, Gayatri Venkataraman, Z. Chen and F. Zeng. 2019. "Tissue-specific regulation of Na^+ and K^+ transporters explains genotypic differences in salinity stress tolerance in rice". *Frontiers in Plant Science*. https://doi.org/10.3389/fpls.2019.01361

Popular Articles

Balakrishnan, V., T. Raveendran and Salim Pichan. 2019. "Kavu: Viswasathinte Avasagahangal". (in Malayalam). *Aranyam.* 40(2): 40-43.

Gopinath, R. 2019. "Food security situation in India".*Thittam.* 6: 37-42.

Mohan, N. 2019. "Chenkurinji". (in Malayalam). *Aranyam.* 40(3): 40-40.

Mohan, N. 2019. "Vana Ashokangal". (in Malayalam), *Aranyam.* 40(4): 44-45.

Pavithran, M. K. 2019. "Ella veettilum kurumulake valartham". (in Malayalam), *Karshakanatham*. pp 31-33

Pavithran, M. K. 2019. "Jaivakrishiyil pinnakke valangal koodi ulpeduthanam". (in Malayalam). *Karshakanatham*. pp 48-49.

Conference Proceedings

Bikram Baliarsingh K., S. Malarvannan, Balaji Mohanty and M. A. Gill. 2019. "Integrated fish farming by tribal poor of Boipariguda Block, Koraput district, Odisha - A profitable model". In *Proceedings of the World Brackish water Aquaculture Conference,* Central Institute of Brackishwater Aquaculture, Chennai. pp 21-25.

Bikram Baliarsingh K., S. Malarvannan, C. Naresh Patra, K. Ajit Sahu and E. D. Oliver King. 2019. "Livelihood enhancement of tribal poor through fish culture in seasonal ponds of Kundra Block, Koraput, Odisha". In *Proceedings of the National Seminar on Industrialization, Environment and Local Sustainability*, Vikram Deb Autonomous College, Jeypore. pp145.

Gopinath, R. 2020. "Food security status after economic reforms in India: An analysis". In *Proceedings of International Conference on Liberalisation, Privatisation and Globalisation: Three Decades of Experience in India,* The Gandhigram Rural Institute. Dindigul. pp 134.

Gopinath, R and R. V. Bhavani. 2020. "Leveraging agriculture for nutrition". In *Proceedings of the 9th National Seminar on Doubling Farmers Income by 2022: Challenges, Opportunities and Way Forward*. MOBILISATION Society and Career Point University, Hamirpur. pp. 55-62

Nagarajan, R. 2019 "Application of GIS and Remote Sensing in Agriculture" in *Proceedings of National Seminar on Innovations in Plant Science, Soil Health and Agriculture*. Lady Doak College, Madurai. pp 04

Rengalakshmi, R., R. Rajkumar, G. Girija, K. Sudhakar and R. Seenivasan. 2019. "The Role of modern information communication and technologies in building the 'move up' the strategy of livelihoods among small producers". In *Proceedings of the National Seminar on Engineers Conclave,* Bharath Electronics Ltd, Bengaluru, pp 60.

Selvamukilan, B., R. Rengalakshmi and V. R. Prabavathy. 2019. "Building smallholder farming climate resilient in pest management: The role of eco-friendly technologies". In *Proceedings of the International conference on Effect of Climate Change on Plant Pests and Biodiversity in Desert Environment*, Arab Centre for the Studies of Arid Zones and Dry Lands, Egypt. pp 68.

Web Published Articles/ Videos

Bhavani, R. V. 2020. "Impact of COVID-19 on rural lives and livelihoods in India". Observer Research Foundation. https://www.orfonline.org/expert-speak/impact-covid19-rural-lives-livelihoods-india-64889/

Bhavani, R. V and Priya Rampal. 2020." The lockdown and its aftermath". Observer Research Foundation. https://www.orfonline.org/expert-speak/the-lockdown-and-its-aftermath-67550/l

Chandrika, C. S. 2019. "Keralathilumvenam Kaalavasthaadiyantharaavastha" https://www.madhyamam.com/opinion/articles/kerala-need-weather-emargency-opinion/641329

Chandrika, C. S. 2019. “Nava kerala chinthakal”. https://m.madhyamam.com/opinion/articles/neo-kerala-thinkers-malayalam-article/644027

Chandrika, C. S. 2019. “Keralathesthree souhrudamaak kaanaavumo?”. https://m.madhyamam.com/opinion/articles/kerala-women-friendly-state-opinion/647270

Gopinath, R. 2020. “Include agricultural activities under hundred days employment scheme”. *Hindu Tamil Thisai*. https://www.hindutamil.in/news/opinion/columns/554382-100-days-work-plan.html

Gopinath, R and B. Jayashree. 2020*, “*Beyond food rations: Six ways India can ensure nutrition security for its most vulnerable people”. https://scroll.in/article/961967/beyond-food-rations-six-ways-india-can-ensure-nutrition-security-for-its-most-vulnerable-people

Jayashree, B. 2019. “Smart tech makes for smarter fishing in India*”.*https://news.trust.org/item/20191231124158-y042r

Jayashree, B. and R. Rengalakshmi. 2020. “TN’s flower growers wilt under lockdown impact”. *The Times of India*. https://timesofindia.indiatimes.com/city/chennai/tns-flower-growers-wilt-under-lockdown-impact/articleshow/75197355.cms

Jayashree, B and R. Gopinath.2020. “Nutrition and the Budget’s fine print*”.* https://www.thehindu.com/opinion/lead/nutrition-and-the-budgets-fine-print/article30803731.ece

Jayashree, B. 2020. ”Lockdown unlocking technology for India’s farmers”.https://blogs.nature.com/indigenus/2020/05/lockdown-unlocking-technology-for-indias-farmers.html

Pratheepa, C. M. 2019. “A journey towards Sirkazhi block-Experience from the field”. https://tigr2ess.globalfood.cam.ac.uk/news/journey-towards-sirkazhi-block-experiences-field

Varshney, R. K. and B. Jayashree. 2020. “Union Budget 2020-21: Examining the agri-research agenda”. https://www.downtoearth.org.in/blog/agriculture/union-budget-2020-21-examining-the-agri-research-agenda-69171

Awards and Recognition

Janakiraman, A. 2020. IFLA - Wall of Fame. International Federation of Library Association, The Netherlands.

Lenka, Kartik Charan. 2020. Best extension worker, awarded by Indian Council of Agriculture Research-Indian Institute of Soil and Water Conservation Research Centre, Sunabeda, Koraput

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Mr. Navjot Singh, *SRF*
Mr. Jagannath Khillo, *Project Fellow*
Mr. M.N. Sivakumar, *Project Fellow**
Mr. Pratap Chandra Jena, *Devp. Assistant*
Mr. Max Aurthor Gill, *Devp. Assistant*
Mr. Balaji Mohanty, *Devp. Assistant*
Mr. Ghasi Takri, *Devp. Assistant*
Mr. Santhosh Raj Benia, *Devp. Assistant*
Ms. Surajita Kumari Turuk, *Devp. Assistant*
Mr. Lambodar Jena, *Devp. Assistant*
Mr. Ranjit Kumar Dalai, *Devp. Assistant*
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Mr. Rajdeep Behera, *Devp. Assistant*
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Mr. Naresh Chandra Patro, *Devp. Assistant*
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Ms. Rama Khara, *Cleaning Assistant*

Ganjam

Mr. Krutibash Rauta, *Devp. Assistant*

Community Biodiversity Programme, Kolli Hills, Namakkal

Dr. E.D. Israel Oliver King, *Principal Scientist*
Dr. N. Kumar, *Scientist (Social Science) **
Mr. P. Yuvaraj, *SRF*
Mr. S. Chinnathambi, *Devp. Assistant*
Mr. A. Annadurai, *Devp. Assistant*
Mr. K. Sivakumar, *Devp. Assistant**
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Mr. P. Thangavel, Office *Assistant*

BIOTECHNOLOGY

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Chennai

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Dr. Gayatri Venkataraman, Principal Scientist
Dr. Suja George, Principal Scientist*
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Dr. V. Vasanthabharathi, Scientist
Dr. S. Gothandapani, Research Associate
Dr. R.G. Hemalatha,Research Associate
Dr. K. Anusha Priyadarsini, *Research Associate*

**left during the year*

Mr. S. Muthukumar, SRF
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Mr. E. Siva, *Lab Assistant**
Mr. M. Kannan, *Lab Assistant*
Ms. N. Nagalakshmi, *Lab Assistant*

Kalpakkam

Mr. R. Kalaimani, *Scientist*

Karnataka

Mr. Veeresh S.Akki, *SRF**
Mr. Manikantha V. Gunaga, *Field Assistant*
Mr. Basappa Karadigudda, *SRF*

ECOTECHNOLOGY

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Assam

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Ms. Roshmi Handique, *Devp. Associate**
Ms. Gargee Baruah, *Devp. Associate*

Chennai

Dr. S. Malarvannan, *Sr. Scientist*
Dr. K. Bhuvaneswari, *Research Associate**
Dr. C.M. Pratheepa, *Research Fellow*
Mr. Vivek Babu, *Project Fellow*
Ms. J. Rojarani, *Devp. Associate*
Ms. K. Siranjothi, *Devp.Associate*
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Mr. K. Sunder Vadivelu, *Executive Secretary*
Ms. R. Jayashree
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Mr. S. Mohan, *Attendant*

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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. J. Sesurayappan, *Devp. Assistant*

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Dr. Mathimaran Natarajan, *Principal Scientist*
Ms. D.S. Girija, *Devp. Coordinator*
Mr. M. Senthil Kumaran
Sr. Technical Assistant
Ms. K. Soundary, *Devp. Assistant*

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Mr. Rabindra Behera, *Devp. Associate*
Mr. Sunil Kumar Sethi, *Devp. Assistant*

Thiruvaiyaru

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

Thiruvannamalai

Mr. V. Samu Jebaraj, *GIS Analyst*

Poompuhar

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

Ramanathapuram

Mr. M. Karunamoorthi, *GIS Analyst*

Villupuram

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

Myanmar

Dr. Hameeda Banu N. Itagi, *Principal Scientist**

AGRICULTURE, NUTRITION AND HEALTH

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Chennai

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Dr. D.J. Nithya, *Scientist*
Mr. S. Raju, *Scientist (Social Science)*
Mr. A. Sakthivelan, *Sr. Secretary*

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

Cross Cutting Theme: Climate Change

Dr. T. Jayaraman, *Sr. Fellow*

Ms. Sreeja Jaiswal, *Project Supervisor*
Mr. Gaurav Gharde**,** *Research Associate*
Mr. L. Isaac, *Research Associate*

COMMUNICATION & LIBRARY AND INFORMATION SERVICES

Ms. B. Jayashree, *Director*

Mr. A. Janakiraman, *Librarian*
Mr. G. Suresh Kumar, *Library Assistant*
Dr. N. Parasuraman, *Principal Archivist & Knowledge, Manager*
Ms. E. Christy Leema Rose Mary, *Jr. Manager**

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Chief Financial and Administrative 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

**left during the year*

Ms. Y. Dilhara Begam, *Sr. Secretary*
Ms. J.D. Sharmila, *Secretary**
Ms. T.Sheeba Rajkumar, *Front Office Exec.**
Mr. K. Suresh, *Office Assistant*

ACCOUNTS

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. Sasikumar
Mr. Dildarkhan Pathan
Mr. M. K. Pavithran
Dr. V. Selvam
Dr. J. D. Sophia
Dr. N. Mohanan
Mr. E. Charles Newton Thambidurai

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Institutional Donors – National

ASPEE Foundation, Mumbai

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Individual Donors – National

Prof. P.C. Kesavan, Chennai

Mrs. Amiya Kesavan, Chennai

Mr. Saradindu Chowdhury, Kolkata

Dr. D. Murugaselvam, Chennai

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	Qualcomm, USA
Indian Institute of Tropical Meteorology (Ministry of Earth Sciences, Govt. of India, Pune)	Adaptation Fund, USA
Indian National Centre for Ocean Information Services (INCOIS), Hyderabad (Ministry of Earth Sciences, Govt. of India)	Bluesensus, Germany
Department of Fisheries, Govt. of Puducherry	ORACLE, USA
NTPC Tamil Nadu Energy Company Limited (NTECL), Chennai	Internews,USA
HDFC Bank, Mumbai	
Space Applications Centre, ISRO, Ahmadabad	
National Bank for Agriculture and Rural Development (NABARD), Mumbai and Chennai	
EGREE Foundation, Kakinada	
National Centre for Sustainable Coastal Management (NCSCM), Chennai	

Programme Area 200: Biodiversity

National	*International*
Rashtriya Krishi Vikas Yojana (RKVY), Govt. of India, New Delhi	Bioversity International, Italy
Directorate of Agriculture and Food Production, Govt. of Odisha, Bhubaneswar	Frauen Power e.V, Germany
Department of Science and Technology (DST),Govt. of India, New Delhi	Conservation International Foundation, USA
The National Academy of Sciences (NASI), Prayagraj (Allahabad)	Botanic Garden Conservation International, UK
Indian Institute of Rice Research (IIRR), Hyderabad	The University of British Columbia, Canada
Kerala Council for Science, Technology and Environment, Govt. of Kerala, Thiruvananthapuram	
NABARD, Chennai, Kalpetta and Trivandrum	
Foundation for Rural Entrepreneurship Development, Pune	
Directorate of Environment & Climate Change, Govt. of Kerala, Thiruvananthapuram	
ICAR-Indian Institute of Millet Research, Hyderabad	
Kerala State Biodiversity Board, Thiruvananthapuram	
State Medicinal Plants Board, Kerala, Thiruvananthapuram	
National Biodiversity Authority, Chennai	
Cochin Shipyard Limited, Ernakulam	
HDFC PARIVARTAN, Mumbai	

National	*International*
Bajaj Allianz General Insurance Co. Ltd., Pune	
Office of Divisional Forest Officer, Jeypore Division, Jeypore	
ICAR-National Agricultural Science Fund (NASF), New Delhi	

Programme Area 300: Biotechnology

Department of Biotechnology, Govt. of India, New Delhi	
DST, Govt. of India, New Delhi	
Biotechnology Industrial Research Assistance Council (BIRAC), Govt. of India, New Delhi	
Department of Agriculture, Govt. of Karnataka, Bengaluru	
Council of Scientific and Industrial Research (CSIR), Govt. of India, New Delhi	
University Grants Commission, Govt. of India, New Delhi	

Programme Area 400: Ecotechnology

VA Tech Wabag Ltd., Chennai	Global Challenges Research Fund, University of Cambridge, UK
Indian Meteorological Department, Ministry of Earth Sciences, Govt. of India, New Delhi	Global Challenges Research Fund, University of Reading, UK
GIZ, New Delhi	Access Agriculture, Kenya
NABARD, Chennai	Asia Initiatives, USA
InsPIRE Network for Environment,	SAARC Development Fund, Bhutan
UNDP-Ministry of Environment and Forests and Climate Change, Govt. of India, New Delhi	Norwegian Institute of Bioeconomy Research, Norway
CABI, New Delhi	Bill & Melinda Gates Foundation, USA

Programme Area 500: Agriculture Nutrition and Health

National	*International*
Tata Trusts, Mumbai	International Centre for Living Aquatic Resource Management (ICLARM), Malaysia
Directorate of Agriculture and Food Production, Govt. of Odisha, Bhubaneswar	Department for International Development (DFID), UK
State Development Policy Council, Govt. of Tamil Nadu, Chennai	
RKVY, Govt. of India, New Delhi	
Maharashtra Council of Agriculture Education and Research, Pune	
Ministry of Consumer Affairs, Food and Public Distribution, Govt. of India, New Delhi	

Others

Ministry of Environment, Forest and Climate Change, Govt. of India, New Delhi	World Food Prize Foundation, USA
All India Poultry Development and Services Pvt.Ltd, Pune	Food and Agriculture Organization of the United Nations, New Delhi
Ministry of Consumer Affairs, Dept. of Food and Public Distribution, Govt. of India, New Delhi	UN World Food Programme, New Delhi

FINANCIAL STATEMENT 2019-20

M.S.SWAMINATHAN RESEARCH FOUNDATION

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

BALANCE SHEET AS AT 31st MARCH 2020

FOUNDATION — **Figs in Rs. Lakhs**

LIABILITIES	Sch. No.	2019-2020 Rs.	2018-2019 Rs.	ASSETS	Sch. No.	2019-2020 Rs.	2018-2019 Rs.
OWN FUNDS				**OWN ASSETS**			
CORPUS FUNDS	1	166.96	166.41	FIXED ASSETS	4	449.66	490.70
GENERAL FUND & OTHER FUNDS	2	3383.39	3336.84	INVESTMENTS	5	6328.02	5952.81
ENDOWMENT FUNDS	3	4854.42	4803.57	CURRENT ASSETS			
CURRENT LIABILITIES	10	1335.55	1230.00	CASH & BANK BALANCES	7	1095.71	1164.09
				ADVANCES	8	1866.93	1929.22
TOTAL [A]		**9740.32**	**9536.82**	**TOTAL [A]**		**9740.32**	**9536.82**

PROJECTS

LIABILITIES	Sch. No.	2019-2020 Rs.	2018-2019 Rs.	ASSETS	Sch. No.	2019-2020 Rs.	2018-2019 Rs.
PROJECT FUNDS & OBLIGATIONS	4	1608.73	1899.88	PROJECTS RECEIVABLES	9	641.72	600.37
CURRENT LIABILITIES	10	713.23	712.67	ADVANCES	8	402.14	358.73
				BANK BALANCES	7	1278.10	1653.45
TOTAL [B]		**2321.96**	**2612.55**	**TOTAL [B]**		**2321.96**	**2612.55**
GRAND TOTAL [A]+[B]		**12062.28**	**12149.37**	**GRAND TOTAL [A]+[B]**		**12062.28**	**12149.37**

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 2020

FOUNDATION **Figs in Rs. Lakhs**

EXPENDITURE	Sch. No.	2019-2020 Rs.	2018-2019 Rs.	INCOME	Sch. No.	2019-2020 Rs.	2018-2019 Rs.
SALARIES	14	448.54	503.41	INTEREST INCOME	11	602.41	495.22
ENDOWMENT EXPENSES	15	46.72	88.25	DONATION	12	274.83	343.08
MEETINGS & OTHER RELATED EXPENSES	16	17.82	55.92				
OTHER ADMINISTRATIVE EXPENSES	17	230.46	111.95	OTHER RECEIPTS	13		
DEPRECIATION ON FIXED ASSETS	5	43.74	36.84	RENTAL RECEIPTS		7.45	11.21
10% OF ENDOWMENT INTEREST INCOME TRANSFERRED TO ENDOWMENT FUNDS		50.85	44.43	CREDIT BALANCE WRITTEN BACK			
				MISCELLANEOUS		0.00	37.78
EXCESS OF INCOME OVER EXPENDITURE FOR THE YEAR TRANSFERRED TO THE GENERAL FUND		46.56	46.49				
TOTAL		**884.69**	**887.29**	**TOTAL**		**884.69**	**887.29**

Provisional (Unaudited)

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