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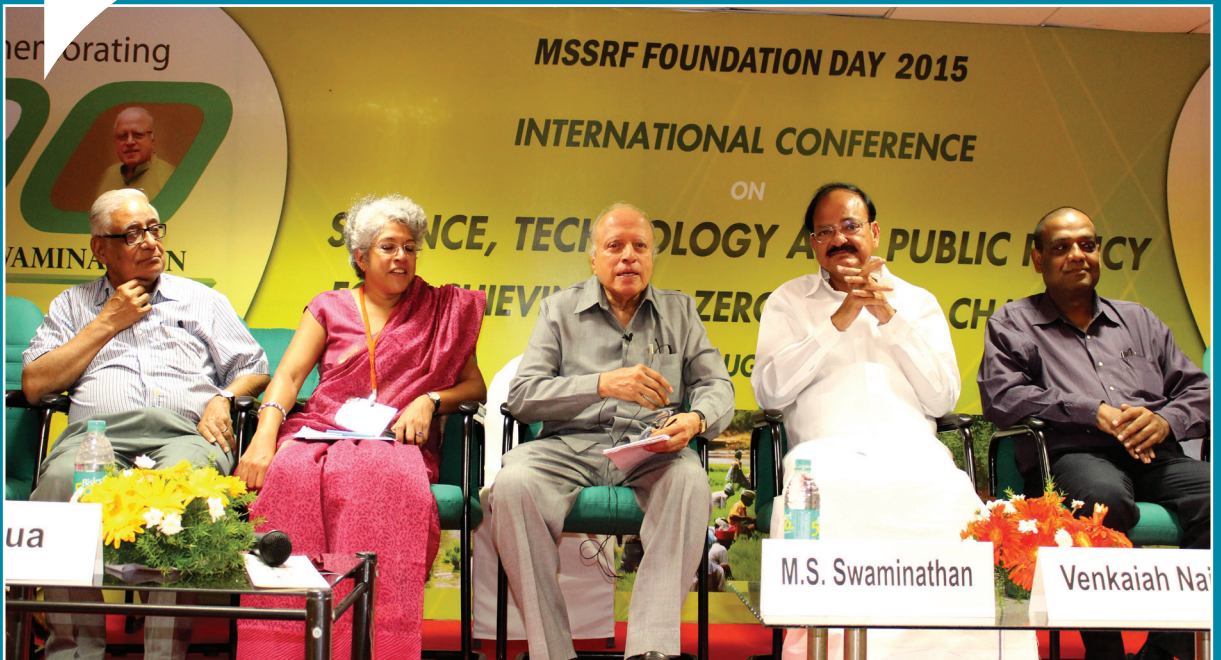
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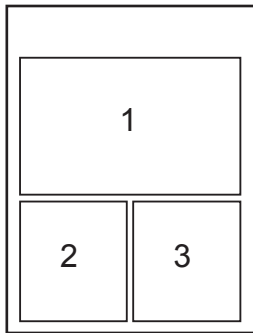
TWENTY-SIXTH

ANNUAL REPORT

CENTRE FOR RESEARCH ON
SUSTAINABLE AGRICULTURAL
AND RURAL DEVELOPMENT,
CHENNAI

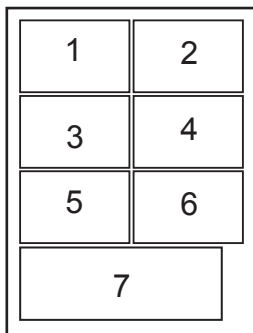
M. S. SWAMINATHAN RESEARCH FOUNDATION





Front Cover

1. Hon'ble Shri. M. Venkaiah Naidu, Minister for Information & Broadcasting, Government of India participating in the "International Conference on Science, Technology, and Public Policy to Achieve the Zero Hunger Challenge" at the Foundation.
2. Hon'ble Shri. N. Chandrababu Naidu, Chief Minister of Andhra Pradesh and Prof. M.S. Swaminathan interacting during the launch of Smart Villages in Vijayawada.
3. Hon'ble Smt. Nirmala Sitharaman, Minister of State (Independent Charge) for the Ministry of Commerce & Industry and Hon'ble Shri. Jairam Ramesh, Member of Parliament, Rajya Sabha at the "International Conference on Science, Technology, and Public Policy to Achieve the Zero Hunger Challenge".



Back Cover

1. Additional income generation for salt workers through floriculture at Vedaranyam
2. Audio conference on weather based agro advisories for vegetable cultivation at Kannivadi
3. Farmers interacting with experts through audio conference at Mambapathai village
4. Integrated crop management – On-Farm Trials at Kolli Hills
5. Annadata model – Kitchen garden for improving dietary diversity at Koraput
6. GRI members active in packing tamarind cakes as an additional source of income at Jeypore
7. Reintroducing wild edibles to tribal food basket through grassroot institutions at Wayanad.

Twenty-Sixth Annual Report

2015 - 2016



M. S. Swaminathan Research Foundation

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and Rural Development
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Chairperson's Introduction

In line with the new priority areas identified following the 25 year review, last year the Foundation continued with its flagship programmes, while at the same time attempting to identify new Pan-MSSRF projects in emerging socially relevant areas. There was also a change of leadership during the year, with Dr. Ajay Parida leaving us after a long and productive stint, and Dr. V. Selvam taking charge as the Executive Director in January 2016. I look forward to the consolidation of our research and development under the leadership of Dr. Selvam.

The activities of different programme areas are too many to summarise here. A few highlights.

The work of the Coastal Systems Research programme was recognized through the Earth Care Award instituted by JSW Foundation and the Times of India. A Biosaline agriculture project was initiated with the support of Government of Karnataka to demonstrate halophyte cultivation in saline affected areas.

The Community Agro-biodiversity Centre in Wayanad multiplied and distributed more than 52,000 seedlings of 320 rare, endangered, and threatened (RET) species, medicinal plants, and ornamental plants. A Trainers' Training Centre for Practical Learning in Achieving the UN Sustainable Development Goals was dedicated to the people of Kerala on June 11, 2016 in the presence of several trustees. Eleven new value added food products were generated and by the Kolli Hill Agro Biodiversity Conservers' Federation, a confederation of farmers' groups producing and marketing millets and millet

based products. The Biju Patnaik Medicinal Plants Garden and Research Centre, Odisha, under new leadership, gave prime attention to conservation and supply of seed material of landraces of rice in the Jeypore tract.

The Biotechnology group has over the years developed a number of transgenic lines of rice for abiotic stress tolerance and nutritional enhancement, and these are now being prepared for biosafety assessment and limited field trails. The lichen research programme has isolated a molecule that has shown potential against TB pathogen.

The Ecotechnology programme focused on a pulse production – a key national requirement. Pulse production was taken up on 6,000 acres with the participation of 4300 farmers. The innovative site specific Watershed programme was recognized by the Ministry of Rural Development, Government of India, under the Sansad Adarsh Gram Yojana as one of the 31 good practices from projects across the country.

The Food Security programme continues to work with women farmers as part of the Mahila Kisan Sashaktikaran Pariyojana -- covering more than 2,500 women farmers in 46 hamlets of Odisha and 3265 women farmers across 60 villages in the districts of Wardha and Yavatmal in Maharashtra to strengthen food and nutritional security at the household level.

The Information, Education and Communication programme began implementing an online learning programme for public library professionals through the International Network

of Emerging Library Innovators. Twenty one Village Knowledge Centres provided location specific information to 1,30,000 rural people (one-fifth of whom were women). The Fisher Friend Mobile Application developed by MSSRF was launched in Malayalam and Oriya.

The Gender and Grassroots institutions group worked to mainstream gender in all activities of the Foundation. Research studies focused on gender gaps in technology adoption. A new study was taken up on the role of women's agency in the use of energy. MSSRF now works with 16 grassroots institutions.

The Leveraging Agriculture for Nutrition in South Asia project or LANSAs has begun trials in Wardha and Koraput to demonstrate the concept of Farming System for Nutrition. As part of LANSAs's research uptake, a total of 926 agriculture-nutrition stakeholders (447 in India, 176 in Pakistan, 275 in Bangladesh, 28 in Afghanistan) have been involved.

MSSRF organised several seminars, workshops and conferences during the year. A three

day International Conference on Science, Technology, and Public Policy to Achieve the Zero Hunger Challenge was held last August and attended by 500 delegates. It was inaugurated by the Governor of Tamil Nadu, HE Dr. K. Rosaiah. Union Ministers Nirmala Sitharaman and Venkaiah Naidu, and Members of Parliament Jairam Ramesh and H.K.Dua participated in the concluding session.

The achievements of the Foundation stem from the dedicated work of its staff and scholars, and I congratulate them and wish them further success. The Foundation is doubly lucky in having trustees of great eminence who have guided and shaped the activities of the Foundation. I am deeply grateful to them.

Dr. V. Selvam, Dr. G.N. Hariharan and Ms. R.V. Bhavani coordinated the work, Ms. Suni Sebastian edited the contents and the printing of the Annual Report was done by AMM Prints. . I record my appreciation and gratitude to them.

Madhura Swaminathan
Chairperson

COASTAL SYSTEMS RESEARCH

The Coastal System Research programme and its field activities on enhancing the adaptive capacity of the local community to sea level rise through Integrated Mangrove Fishery Farming System (IMFFS) and mangrove restoration received recognition through the “Earth Care Award” instituted by JSW Foundation and the Times of India. The landuse/landcover analysis of the Gulf of Mannar showed an increase in mangrove cover from 1.21 sq km in 1990 to 4.22 sq km in 2010. The research on halophytes to domesticate them for biosaline agriculture in salt-affected areas is now receiving wider attention. Community-based mangrove restoration was taken up in 25 ha in the intertidal areas in Ramanathapuram district of Tamil Nadu, and the Panchayat Raj Institutions replicated models of restoration of tropical dry evergreen forests in 25 acres in three locations near Vedaranyam, Nagapattinam district, Tamil Nadu. A women salt workers’ federation was formed with 707 members belonging to 23 villages in Vedaranyam for strengthening their livelihoods during the rainy season. The Fish for All Research and Training Centre organized 29 training programmes for 1,335 male and 842 female fisherfolk of Nagapattinam and Karaikal coasts on fish processing technologies and on marine biodiversity conservation. The carbon flux studies in Pichavaram mangroves indicate that water in the mangrove ecosystem acts as a major carbon source due to the presence of large amounts of organic matter and its microbial degradation leading to the release of carbon dioxide into the atmosphere.

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Sub Programme Area 101

Mangrove and Non-mangrove Coastal Bioshields

Mangrove Bioshield

Navi Mumbai

During this reporting period, restoration of the degraded area along the Thane Creek in Navi Mumbai, Maharashtra, was initiated with a tripartite agreement between M.S. Swaminathan Research Foundation, Maharashtra Forest Department, and the TATA Power Company Ltd., Mumbai. The primary stakeholder depending on mangrove wetlands for fishing was involved, along with a local NGO named Vanashakti, in implementing the project. A successful joint mangrove management model experimented in the mangrove wetlands of Tamil Nadu, Andhra Pradesh, and Odisha was adopted for restoring the mangroves.

The causes of mangrove degradation were assessed jointly with the local community and the Forest Department. Conversion of mangroves for shrimp farms and salt pans and the felling of trees for domestic use were identified as the major cause. In the degraded areas, it was found that 20- to 35-cm high earthen bunds of abandoned shrimp farms obstruct the free flow of tidal water leading to the stagnation of saline water. The topography of the degraded area is slightly elevated when compared with the creek, and the maximum

elevation was found to be between 15 and 20 cm. The tidal amplitude in the main creek near the degraded area was about 4 m. The degraded area receives tidal flushing during new moon and full moon days.

Permission for canal digging to avoid tidal water stagnation was obtained from the Divisional Forest Officer, Mangrove Cell, Government of Maharashtra, during December 2015. The field staff of Vanashakti, the local NGO, and community members were oriented on the canal design and layout of the canals. The Vanashakti staff mobilized the local community and canal digging in an area of 5 ha was carried out during February–March 2016 using 600 labours days. The main canal was dug with a depth of 60 cm and the side canals with a depth of 30 cm. The existing trees were left undisturbed while digging the canals. Tidal flushing to reduce soil salinity is allowed in the area, and nursery-raised mangrove saplings will be planted along the canals in August 2016.

Karankadu

Planting of mangroves in the intertidal mudflats along the shore was done in 25 ha near Karankadu village, Ramanathapuram district, Tamil Nadu. About 55,000 nursery-raised saplings of *Rhizophora apiculata* and *R. mucronata* were planted, and the survival rate is about 90%. The saplings attained a height of 120 cm during March 2016 with six leaves. Barnacle infestation has been noticed in the saplings.

Godavari

In the Godavari mangrove wetlands, during August 2015, about 5,000 nursery-raised mangrove saplings were planted in an area of 2 ha. The work was carried out by the Sri Murali Krishna Eco-Development Committee (the recognized village-level institution (VLI) of the Andhra Pradesh Forest Department), Chollangipeta. In September 2015 the canals were desilted for proper tidal flushing. The survival rate of the saplings was above 90% during February 2016.

Krishna

In the Krishna mangrove wetlands, during the year 2015, restoration of mangroves was carried out in Sorlagondi and Basavanipalem villages under the United Nations Framework Convention on Climate Change (UNFCCC). About 1 lakh *Avicennia marina* saplings were raised in the nursery. Under this program, MSSRF is working in collaboration with the Krishna district administration and Andhra Pradesh Forest Department to restore 200 ha of land. The plantation work will begin soon.

Sub Programme Area 102

Integrated Mangrove Fishery Farming System

Tamil Nadu

In Tamil Nadu, Integrated Mangrove Fishery Farming System (IMFFS) ponds established between 2011 and 2014 were given to the communities of the respective villages of Naluvethapathy (2 ha), Velankanni (3 ha), Veerankoil (3 ha in Eripurakkurai), MGR Nagar (5 ha), and Kalaingar Nagar (5 ha) for fishery farming. The mangrove saplings in the Naluvethapathy IMFFS ponds were under water for more than a week and rotted during the floods in December 2015. The performance of mangrove plants in the IMFFS ponds at Velankanni and Eripurakkurai was found good as of March 2016 (Table 1.1).

Fish culture

In Naluvethapathy, the IMFFS committee has stocked fish fingerlings and juvenile shrimp collected from the wild. However, in

Table 1.1 *Performance of mangrove plantations in IMFFS farms in Velankanni and Eripurakkurai*

Sites	<i>Rhizophora apiculata</i>		<i>Rhizophora mucronata</i>		<i>Bruguiera gymnorhiza</i>	
	No. of saplings	Height of saplings (cm)	No. of saplings	Height of saplings (cm)	No. of saplings	Height of saplings (cm)
Velankanni (planted November 2013)	1023	160	2960	174	1475	120
Eripurakkurai (planted May 2014)	708	71	2387	78	—	—
Total	1731	231	5347	252	1475	120

other IMFFS locations, shrimp juveniles were purchased from the hatcheries and stocked. The stocking density was maintained at 3–4 fingerlings/m². Stocking was done in April 2015 and harvest was made in July 2015 and the profit was shared among the IMFFS members. Each member received an additional income ranging from Rs. 10,000 to 12,000. Now, the group has decided to stock crabs as the profit is more when compared with fish and prawn culture.

Andhra Pradesh

Fish culture

In Andhra Pradesh, IMFFS ponds were established in 8 ha and were managed by the village communities of Bhairavalanka (4 ha) in East Godavari district and Sorlagondi (4 ha) in Krishna district. In Sorlagondi, 10 Yanadi (tribal) families have stocked crabs collected from the wild and also water crabs given by Central Institute of Brackishwater Aquaculture (CIBA). About 150 crabs were stocked in 1 ha, including the 15–20 water crabs given by CIBA for fattening. Each farmer earned a profit ranging from Rs. 25,000 to 30,000 as the market price of the crabs has increased significantly (a crab weighing 700 g or more is sold at Rs. 1,000–1,200/kg). The major issue faced by the farmers this year has been the limited availability of the wild juvenile crabs in mangroves. In Bhairavalanka sea bass fingerlings (2,000) were stocked in each of the two ponds in February 2016.

During January 2016, IMFFS pond preparation was initiated in 25 ha in Nali in Krishna district

with the support of the UNFCCC. Shrimp farmers in Nali are marginal farmers with a farm size ranging from 1 to 2 ha. These farmers were not able to earn profits because of high input costs. Hence, the interested farmers were taken to the IMFFS ponds in Sorlagondi for an exposure visit. This resulted in farmers adopting the IMFFS model. As of April 2016, 13 IMFFS ponds have been constructed in 15 ha. Each pond was dug to a depth of 1 m below the mean sea level to hold water during low tide. The tidal flow was ensured and sluice gates were constructed. The pond preparation work was monitored by the individual farmer, by the executive committee members of the VLI, and by the MSSRF project staff. Planting of mangrove saplings and aqua farming activities will be initiated in July 2016.

Mangrove plantation

The *R. apiculata* planted in 4 ha of IMFFS ponds in Bhairavalanka has reached a height of 193 cm, and the survival percentage is approximately 95%. About 1,900 saplings were planted in June 2013.

Sub Programme Area 103

Biosaline Agriculture

A genetic garden for halophytes was established at Agasthiyampalli village near Vedaranyam with 29 species and maintained under shade nets. Saline water is used for irrigation and plant growth is monitored. During this year, the Department of Agriculture, Government of Karnataka has sanctioned a project mainly to a) assess the vulnerability of

Karnataka coast to sea level rise and b) identify suitable areas and develop and demonstrate different biosaline agriculture methods for the cultivation of selected commercially important halophytes and saline tolerant crops.

Sub Programme Area 104

Integrated Coastal Zone Management of the Vedaranyam Coast

During this year project interventions were taken up in 49 villages near Vedaranyam. The village community was mobilized and organized for conservation and management of coastal resources in 12 villages. In 23 villages, programs on health and livelihood activities for the salt workers were implemented. The Village Resource Centres and Village Knowledge Centres are operational in another 14 villages, and they provided need-based information to the community. Monthly village level meetings were conducted in all 49 villages to monitor the programmes and activities. During this year, tropical dry evergreen forests (TDEFs) were established in 61 acres. Twenty six biology students from the nearby schools and colleges visited the TDEF site for their study. One of the significant impacts during this year has been the establishment of TDEFs in 25 acres in villages by panchayat raj institutions and other institutions for which MSSRF provided technical guidance, and the details are given in Table 1.2.

MSSRF has built the capacity of the Village Development Committees VDC to manage

Table 1.2 *Replication of TDEF plantation*

Name of the Village	Location	Area (acres)
Pannal	Panchayat land	16
Karuppampulam	Ayyanar temple	4
Muthupet	Rahmath Matriculation School	5

the revolving funds given for various income-generation activities. During this year, 707 women members in 23 project villages were mobilized to form 101 self-help groups, and Rs. 14 lakhs was given as revolving fund which was utilized by 217 members for various income-generation activities during the lean season (rainy season). The federation is monitoring the revolving fund utilization jointly with MSSRF, and it has earned an interest amount of Rs. 70,820.

As the health status of salt workers has been found to be very poor by the survey taken by MSSRF joint with the Jawaharlal Institute of Postgraduate Medical Education & Research (JIPMER), it was decided that their overall health conditions need to be improved. Nearly 9,000 salt workers in 12 villages and students of 9 schools in Vedaranyam block were covered under the health programme. About 2,426 children were treated for vitamin A, D and calcium deficiency and also provided medicines for deworming. A total of 4,731 salt workers were treated for various diseases including vitamin, calcium and iron deficiency and for occupational hazards such as dermatitis, low back pain, arthritis and other ailments.

Sub Programme Area 105

Fish for All Research and Training Centre

The Fish for All Research and Training Centre is continuing its efforts to improve the socioeconomic condition of coastal communities through a holistic approach to resource management, capacity building, and disaster preparedness. It acts as a training-cum-demonstration centre to strengthen the livelihood of fisherfolk by value addition to the process chain involving women, artisans, non-traditional fisherfolk, women fish vendors, and fishing labourers.

Fish Processing Unit

A series of steps were initiated to improve the income of poor women fish vendors and also to increase the production capacity of fish processing units. Initially, fish vendors in and around Poompuhar in Nagapattinam district, Tamil Nadu, were mobilized and their socioeconomic data was collected. Meetings and focus group discussions were organized with them and with the traditional leaders of the respective villages to make them understand the importance of quality fish production and its benefits.

A district-level consultative meeting was organized in October 2015 with the interested women fish vendors to assess the needs and issues related to fish processing and marketing. The facilities available at the fish processing units were explained and

their doubts on maintenance, technology, marketing, and benefits were clarified. The Winmeen Mahalir Fish and Fish Product Producers' Association was formed with 85 poor women fish vendors from 6 villages in and around Poompuhar during November 2015. Under this, four livelihood-based sub-groups were formed for promoting fish processing, dry fish production, value-added fish products, and fish culture. The general body is the decision-making body in which women involved in fish vending, fish processing, prawn peeling, and fish handling and loading are the members. Executive committee members were selected from the general body in which MSSRF has an *ex officio* representation. The association has evolved bylaws and a joint bank account has been opened.

Simple processing technologies for low-value fishes such as silver bellies, sardines, ribbon fishes, and clams were initiated. Training sessions were conducted for quality production of fresh, dry, and value-added products. Training on cost-benefit analysis was organized for 43 women fish vendors with the help of an external marketing consultant. MSSRF provided Rs. 2 lakhs as a revolving fund for the procurement of fishes for processing. Traders were identified in Puducherry and in Coimbatore and Kanchipuram, Tamil Nadu, for selling the processed materials. A solar fish dryer was commissioned in the Fish for All Centre for drying large quantities (up to 1,000 kg) of fishes. The association has received a certificate from the Food Safety and Standards Authority of India (FSSAI) under Food Safety and Standards Act, 2006, for marketing the fish

Table 1.3 *Fish processing and profits earned*

Processed Items	Fish (kg)	Expenditure (Rs.)	End Product (kg)	Gross Income (Rs.)	Net Income (Rs.)
Dry fish	3339	142220	870	197026	54806
Fresh fish	19	850	19	950	100
Value-added products	24	10800	35	17075	6275
Total	3382	153870	924	215051	61181

products. The association earned a profit of about Rs. 61,181 in four months of which 1% was given to the federation and the remaining amount was shared equally among the members. Details of the processed products are given in Table 1.3.

Fish waste from the processing unit was used for compost and bio-manure preparation. Two compost pits were established and the technique of compost preparation was standardized. The compost was field tested in the kitchen garden of the Fish for All Centre and given to farmers and fisher communities to assess its performance. About 49 kg of fish compost was distributed to 15 farmers for the field trial. Results showed that the compost led to an increase in the yield of vegetable crops.

Responsible Fisheries

In order to address issues such as overexploitation of fish resources and reduction in fish catch, the centre adopted a two-pronged approach targeting fisherfolk as well as the youth. They were educated on the Food and Agriculture Organization (FAO) code of conduct for responsible fisheries, including mesh size regulations, the importance of brooders, maintenance of cleanliness and hygiene in coastal areas,

and conservation of endangered species, coral reefs, and mangroves. An awareness programme on hygienic handling and sea safety was conducted in the coastal villages of Nagapattinam and Karaikal districts in Tamil Nadu and Puducherry, respectively, with the support of Network for Fish Quality Management and Sustainable Fisheries (NETFISH) of the Marine Product Export and Development Authority (MPEDA), Ministry of Commerce and Industry, Government of India; 225 fisherfolk participated in this programme. Awareness programmes and competitions on marine conservation were organized and 1,943 students (1,028 girls; 915 boys) from five colleges and seven schools from Nagapattinam, Cuddalore, and Karaikal districts participated.

Inland Aquaculture

Fish culture in the community pond (1.1 ha) at Thenpathi was initiated during this year. A microplan was prepared consisting the roles and responsibilities of MSSRF, of the traditional leaders, and of the SHG women and for sharing the profit. According to this, 60% of the profits will go to the SHG women (12 Dalits), 20% will go to the community fund, and the remaining 20% will be kept aside as

seed money for the next culture. About 1,500 fingerlings of six fast-growing Indian and Chinese carps such as catla, rohu, mircal, silver carp, grass carp, common carp, and sea bass were stocked in November 2015. The Fish for All Training Centre provided technical support in pond preparation, water filling, species selection for culture, and feed and water analysis. The SHG women were trained in feed management, water analysis, farm management practices, and stocking of quality seeds.

Integrated Fish Farming

The Centre continues to provide technical guidance to Kaveri Inland Fish Farmers' Association, Sirkazhi. Twenty fish farmers from the association have been registered under the Fish Farmers Development Agency (FFDA) with the facilitation of the Fish for All Centre. All registered farmers are eligible to get Rs. 85,000 as subsidy from the department for farm pond digging and for procuring fingerlings and feed. The farmers (4 women, 16 men) earned Rs. 7,58,834 as profit, and the details are given in Table 1.4. Each individual has earned a profit ranging from Rs. 30,000 to 70,000.

Training and Capacity Building

Needs assessment was done for fishermen, women, labourers, women fish vendors, fish farmers, and the youth. The needs were then prioritized and 13 key topics were selected for training. So far five training materials (syllabus and curriculum) have been developed and the remaining topics are under preparation. A training calendar was prepared for the Fish for All Centre, and it was circulated among the stakeholders at the block and district levels. Agencies such as IOB- RSETE, ATMA, NETFISH, MPEDA, Nehru Yuva Kendra, and the Fisheries Department at the district and state levels came forward to utilize the facilities and expertise of the Fish for All Centre.

During the reporting period, 29 systematic training programmes on quality dry fish production, fish processing technology, pisciculture, and marine biodiversity conservation were conducted for the fishermen, women and fish farmers in and around Nagapattinam and Karaikal districts. About 2,177 (1,335, male; 842, female) participated in the aforementioned training programmes, and the details are given in Table 1.5.

Table 1.4 *Economics of fish harvesting using the integrated fish farming method*

Geographic Area Covered (Blocks)	No. of Fish Farmers	No. of Fish Ponds	Total Area of Ponds (cents)	Total Fish Stock (No.)	Total Fish Harvest (kg)	Total Expenditure (Rs.)	Gross Income (Rs.)	Net Income (Rs.)
Sirkazhi	12	12	540.0	23100	6920	324086	830400	506314
Mayiladuthurai	5	5	142.5	5350	1985	74798	238200	163402
Senbanarkovil	3	3	67.0	2200	1100	42913	132000	89118
Total	20	20	749.5	30650	10005	441797	1200600	758834

Table 1.5 *Training and capacity-building programmes*

Training Topics	No. of Training Programmes	Total Participants		Total No. of Villages Covered
		M	F	
Quality dry fish production	8	0	232	10
Fish processing techniques	1	0	14	5
Cost–benefit analysis for fish products	1	0	23	5
Marine biodiversity conservation	12	635	902	12
Fish culture	1	22	2	1
New fishing technology	1	67	21	2
Integrated fish farming	3	98	85	6
Others	2	20	56	12
Total	29	842	1335	53

Certificate Course

Elderly fisherfolk are not keen on their children taking up the fishing profession as there is a noticeable decrease in fish catch. However, it has been observed that the youth show enthusiasm in fishing especially if they have access to new knowledge and skills to enhance the efficiency of their fishing activities. The Centre has designed training courses (20 hours of theory and 40 hours of practical sessions) for the youth. So far 103 students from three colleges have completed the training and received their certificates. As there is a demand for such courses, the Centre is working on providing more such training modules.

Sub Programme Area 106

Remote Sensing and Geographical Information Systems

Great Nicobar Biosphere

Intensive ground-truthing was done in an area of 800 sq km of the Great Nicobar Biosphere,

and the data was used to digitally reclassify the landuse/landcover for 2005 and 2010. The Champion and Seth classification method was adopted for classifying Level II forest types such as tropical evergreen forests, tropical moist deciduous forests, littoral forests, and tidal forests. Since the images were of coarse resolution, it was difficult for detailed Level III forest-type classification.

Sunderbans

Landuse and landcover maps for the years 1990 and 2010 were completed using LANDSAT and LISS III satellite images. The hybrid classification technique was adopted, and the class was validated using ground-truthing data. In Sunderbans, mangrove forests covered an area of 2,126 sq km in 2010 while the mudflats covered 74 sq km, aquaculture 65 sq km, and fallow land/ agriculture 3,528 sq km. The change detection and the vegetative maps were prepared based on the Normalized Difference Vegetation Index (NDVI) method for the years 1990 and 2010 for the Sunderbans Biosphere Reserve.

Gulf of Mannar

The landuse and landcover maps for the years 1990 and 2010 were completed, and the change detection was calculated. In the Gulf of Mannar, the mangrove forest cover has increased from 1.21 sq km in 1990 to 4.22 sq km in 2010, while the mudflat area has decreased from 95.4 sq km in 1990 to 24.53 sq km in 2010. The littoral forest has increased from 18.37 sq km in 1990 to 35.11 sq km in 2010. The built-up land area has increased from 25.14 sq km in 1990 to 169.83 sq km in 2010. All other landuse and landcover details are given in Table 1.6.

Sub Programme Area 107

Greenhouse Gas Fluxes in the Mangrove Ecosystem

In the Pichavaram mangroves, the fluxes of carbon dioxide (CO₂) and methane (CH₄)

between mangrove canopy and atmosphere, between soil and atmosphere, between water and atmosphere, and between soil and water were measured to assess the annual net ecosystem exchange of carbon into the atmosphere. The data will be used to develop models to predict the impact of climate change.

Eddy Covariance Flux Tower and Sensor Setup

A 10-m high Eddy covariance (EC) flux tower was established in the Pichavaram mangrove to measure CO₂, CH₄, and energy fluxes. In addition, net radiation, incoming photosynthetically active radiation (PAR) are being measured at 6 m height from ground level. Air temperature, relative humidity, wind speed, wind direction, and precipitation are being continuously recorded at 2 m, 6 m, and 10 m, respectively. Similarly, soil heat flux, soil temperature, and electrical conductivity are also being measured. An automated soil

Table 1.6 *Change detection of landuse/landcover for Gulf of Mannar between 1990 and 2010*

Landuse/Landcover	Area in the Year 1990 (sq km)	Area in the Year 2010 (sq km)	Change in area between 1990 and 2010 (sq km)
Agriculture	1586.48	1696.09	109.61
Barren land	59.01	51.26	-7.75
Built-up area	25.14	169.83	144.69
Carnatic umbrella thorn Forest	20.31	20.69	0.38
Littoral forest	18.37	35.11	16.74
Mangrove forest	1.21	4.22	3.01
Marsh land	22.25	18.18	-4.07
Mudflat	95.4	24.53	-70.87
Salt pan	31.29	103.7	72.41
Sand	437.11	402.44	-34.67
Thorn forest (Prosopis)	105.9	63.36	-42.54

CO₂ flux system has been installed to monitor the soil CO₂ flux. All the parameters are being monitored from May 2016, and the outcome will be reported next year. These experiments are expected to provide scientific evidence whether mangrove forests act as a sink or source of atmospheric CO₂ and CH₄.

Air–water CO₂ fluxes

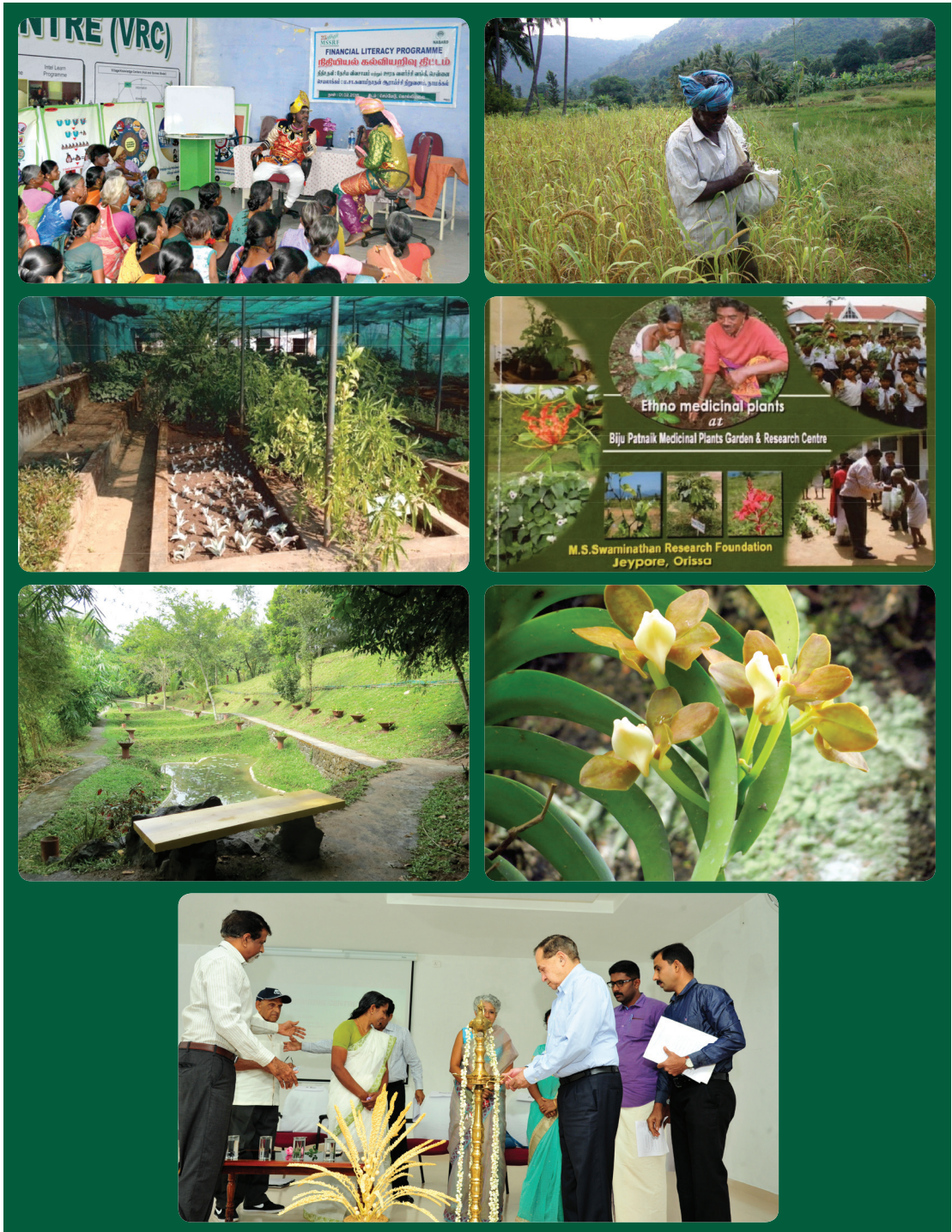
Seasonal variation of the partial pressure of CO₂ (pCO₂) was measured in Pichavaram mangroves at eight locations where the pressure ranged from 1,106.49 to 2,963.05 µatm during the post-monsoon season, from 2,702.58 to 4,421.89 µatm in summer, and from 2,841.46 to 10,952.91 µatm in the monsoon season. Higher values were recorded in the waters with moderate salinity and low pCO₂ values were recorded during high salinity regime. Air–water CO₂ flux varied

from 4.12 to 96.99 mmol/m²/d with a mean value of 37.37 ± 30.47 mmol/m²/d. The highest CO₂ degassing flux was recorded in the monsoon season (70.19–96.99 mmol/m²/d), while low flux (4.55–22.79 mmol/m²/d) was recorded during the post-monsoon season. In summer, it was found to be between 4.12 and 21.19 mmol/m²/d. In the present study, CO₂ fluxes in Pichavaram mangroves were confined only to aquatic component and the results indicated that they act as a source of CO₂ to the atmosphere. High values of pCO₂ in the mangrove waters are due to the presence of high organic matter such as leaf and litter from mangrove trees as well as the organic load from nearby shrimp farms discharging effluents into the mangroves. The study is being continued to monitor the fluxes to get a clear answer to the research question.

BIODIVERSITY

The Biodiversity Programme addresses the issues associated with conservation and sustainable use of agrobiodiversity. In Kolli Hills, Tamil Nadu, the livelihood diversification of a total of 805 tribal farm families in 40 settlements was taken up through the Integrated Tribal Development Programme (ITDP). Millet intercropping in 47 acres of WADI (small orchard) fields increased the availability of the grain among participating families. The Kolli Hills Agro Biodiversity Conservers' Federation is involved in the production and marketing of 11 value-added natural food products under the guidance of MSSRF. In Wayanad, Kerala, the Community Agrobiodiversity Centre (CAbC) multiplied more than 52,000 seedlings of 320 rare and endangered tree (RET) species and medicinal and ornamental plants and distributed them to other gardens as a conservation measure. In total, 916 women and 712 men have undergone various training and capacity-building programmes for enhancing livelihoods. Furthermore, the Centre has established five farmer conservation plots in various locations in Wayanad, thereby conserving 22 traditional varieties of leguminous crops. The Biju Patnaik Medicinal Plants Garden and Research Centre, Jeypore, Odisha, facilitated the supply of seed materials of 75 old rice landraces and 27 popular rice landraces to central and state government institutions. The Panchabati Gramya Unnayan Samiti in Jeypore received the "Pranam Matrubhumi" award from the Samaj (the oldest print media of Odisha) for its work and initiatives in community development and conservation of local landraces. Five hundred accessions of different rice varieties from the Community Gene Bank at Chennai were multiplied in association with the Regional Rice Research Station, Tamil Nadu Agricultural University (TNAU), Tirur.

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Sub Programme Area 201

Community Conservation Programme Kolli Hills

201.1 Integrated tribal development programme

The Integrated Tribal Development Programme (ITDP) focused on a total of 805 tribal farm families in 40 settlements at Thiruppuli Nadu, Alathur Nadu, Gundur Nadu, and Gundani Nadu (TAGG) panchayats of Kolli Hills. The key objective of the programme was to curtail migration of tribal farm families and to provide them with options for on farm livelihood diversification by creating WADI (*siruthottam* or orchard) farms and by promoting measures for soil conservation, water resource development, women empowerment, community health development, training, and capacity building.

Intercropping in WADI Farms

During the reporting period, about 159 farmers in TAGG panchayats adopted millet intercropping in the WADI fields using little millet (*samai*), finger millet (*kelvaragu*), and foxtail millet (*thinai*). Intercropping of millet has been done in 45.79 acres, and about 12,532 kg of millet have been harvested. Of the total harvest, tribal farmers retained 8,942 kg for their consumption and sold the remaining 3,590 kg.

Orchard and kitchen garden development

As a part of the drive to create nutritional awareness among the participating farm families, several village-level awareness

campes were organized. In addition, to ensure that the nutritional requirements of 805 WADI farmers are met, seeds of high-yielding varieties of common vegetables were provided as kitchen garden kits; these included tomato, brinjal, chilly, green leafy varieties, lady's finger, ribbed gourd, bitter gourd, bottle gourd, and pumpkin (see Table 2.1). During this year, these tribal families harvested about 14,295 kg of vegetables.

Table 2.1 **Details of kitchen garden and yield during Kharif 2015**

Panchayat	No. of Farmers	Total Yield (kg)	Consumed (kg)	Sold (kg)
Thiruppuli	213	5700	5200	500
Gundur	212	5000	5000	0
Alathur	190	2035	2035	0
Gundani	190	1560	1560	0
Total	805	14295	13795	500

Soil and water conservation measures

Soil conservation measures such as compartmental bunds and V bunds were completed in 64 acres of land, and trenching work was done in 10 acres. The remaining activities are ongoing in all four panchayats. So far 209 ponds have been dug in TAGG panchayats, and work in 10 more locations is under way. .

Farm and nonfarm enterprises

As part of the project activities, 150 participants received loans amounting to a total of Rs. 30,05,000 and individual loan amounts ranging from Rs. 15,000 to Rs. 30,000 to start various enterprises such as dairy, goatery, piggery, poultry, small shops, grocery shops, restaurants, vegetable cultivation,

and electrical and oil engine repairing and plumbing and mechanical work.

Training and capacity building

During this year, about 291 training programmes were organized for 805 WADI farm families of TAGG panchayats covering aspects such as application of biofertilizers, insecticides, and fungicides; basin weeding and formation; shading, staking, and formation; V bunding, trenching, and mulching; and creation of percolation ponds. Awareness programmes on kitchen gardens and nutrition, community health, and income-generation activities were also carried out.

Production of microbial inputs for agriculture

Adaptation of Technology Training on handling biofertilizers, biofungicides, and bioinsecticides and on commercial production of *Vesicular Arbuscular Mycorrhizae* (VAM biofertilizer) was organized at two locations, namely, Nathukkulipatti of Gundur Nadu panchayat and Keeraikkadu of Gundani Nadu panchayat. The training focused on the importance of application of biofertilizers and was aimed at imparting knowledge and skills to women members on the production technology of *bio-inputs through necessary practical sessions*. As a part of the exposure visits, trainees visited production units for biofertilizers (Azospirillum, VAM, potash-mobilizing bacteria, and phosphobacteria), biofungicides (*Trichoderma viride*, *Pseudomonas*, *Bacillus subtilis*, and *Paecilomyces*), biopesticides (*Bacillus subtilis*, *Pseudomonas*, *Beauveria*, *Metarhizium*, and *Verticillium*), and *Panchakavia* at Kannivadi region of Dindigul district.

201.2 Resilience of poor rural communities in agrobiodiversity hotspot areas

During this year, this project was implemented in 13 villages of Thiruppuli Nadu panchayat, Kolli Hills, covering 403 tribal households. A total of 774 men and 726 women participated in different project activities such as seed fair, traditional food festival, information and communication systems, automatic weather station, and training and capacity building.

Millet seed distribution through community seed banks

The self-help groups (SHGs) and farmers groups of Kolli Hills collected about 1 tonne of millet seeds for community seed banks established by MSSRF in 16 locations. The seed banks distributed about 504.95 kg of millet seeds to 245 farmers on a loan basis during the Kharif season.

Millet yield enhancement Trial

Yield enhancement trial is an important activity to help farmers adopt suitable agronomic practices to obtain higher yield from millet cultivation in small areas. During this year, two methods of cultivation for yield enhancement trials were carried out: in the mono-cropping trial, finger millet/little millets were planted in 20 cm × 10 cm rows using a furrow maker. In the intercropping trial, finger millet/little millets were planted in six lines with maize, Italian millet, and mustard crops. During the Kharif season of 2015, a total of 245 farmers cultivated millets in 80.81 acres in eight panchayats of Kolli Hills using the aforementioned methods of yield enhancement (Table 2.2).

Table 2.2 *Details of millet cultivation during Kharif 2015*

Panchayat	No. of Farmers	Finger Millet (Acre)	Little Millet (Acre)	Foxtail Millet (Acre)	Proso Millet (Acre)	Kodo Millet (Acre)	Total (Acre)
Thiruppuli Nadu	69	8.8	4.35	2.85	0.5	0	16.9
Alathur Nadu	42	6	0.55	5	0	0.3	11.85
Gundani Nadu	24	4.4	8.95	3.25	0	0	14.79
Gundur Nadu	34	11.05	0	4.4	0	0.2	15.65
Selur Nadu	57	16.02	0.15	0.15	0.1	0.1	16.52
Devanur Nadu	9	2.1	0.5	0.3	0	0	2.9
Bail Nadu	9	1.7	0	0	0	0	1.7
Valavanthi Nadu	1	0.5					0.5
Total	245	50.57	14.5	15.95	0.6	0.6	80.81

Vermicompost production and use

During this reporting period, 87 tribal farmers in Thiruppuli Nadu panchayat produced about 16,131 kg of vermicompost. Farmers were provided with adequate training on compost production processes such as application of farm waste, spraying of water, checking the quality of worms, and collection of vermish and -compost as a part of production management and handling of vermicompost. Vermicompost was used in their own farms for production of millets, paddy, coffee, and other fruit crops.

Millet processing

The millet processing mills were established during the past five years, and currently these mills are managed by concerned SHGs and farmers' clubs in Thuvareppallam, Semputhuvalavu, Padasolai, Thiruppuli Orpuram, Puliyampatti, Navakkadu, Sundakkadu, Periyakovilur, and Vendalappadi. These millet-processing mills have helped

local farmers reduce the drudgery involved in millet processing and created opportunities for additional income. During the year, 4,956 kg of finger millet, rice, and wheat flour were processed by these mills and about Rs. 30,535 was earned as additional income.

Production and Marketing of the Natural Foods from Kolli Hills

The Kolli Hills Agro Biodiversity Conservers' Federation, a confederation of SHGs for both women and men, produced and marketed 11 value-added products such as ragi (finger millet) malt, ragi flour, ragi *murukku*, Italian millet rice, Italian millet flour, Italian millet payasam mix, Italian millet laddu, little millet rice, little millet flour, little millet *upma* mix, and little millet *bajji* mix under the brand name "Kolli Hill Natural Foods." From April 2015 to March 2016, 26 tonnes of millet value-added products were sold, and it earned an overall gross income about Rs. 13,12,855.

Farmer producer organization

During this year, MSSRF organized a Farmer Producer Organization (FPO) at Kolli Hills. It brought together 355 progressive farmers as members from six panchayats, namely, Thiruppuli Nadu, Gundur Nadu, Alathur Nadu, Gundani Nadu, Ariyur Nadu, and Valavandhi Nadu. This FPO is divided into 28 farmers' interest groups (FIGs), and it has a tie-up with Indian Bank, Semmedu. In a participatory mode, MSSRF organized awareness and orientation training programmes on the roles, responsibilities, and functions of the FPO towards its members. The Board of Directors of the FPO consists of 10 farmers selected by the members of FIGs; the registration and incorporation of the FPO is in progress.

Financial inclusion programme

MSSRF has organized a financial literacy awareness programme with the support of the National Bank for Agriculture and Rural Development (NABARD) in 16 locations in Kolli Hills. The main objective of the programme was to accelerate the pace of financial inclusion as it enables the public to understand the needs and benefits of the products and services offered by the banks. About 1,453 tribal farmers (506, male; 947, female) participated in this programme. Of the total farmers, about 1,337 have a tie-up with Indian Bank, Semmedu, for central government sponsored insurance schemes such as Pradhan Mantri Suraksha Bima Yojana and Pradhan Mantri Jeevan Jyoti Bima Yojana.

Sub Programme Area 202

Community Agrobiodiversity Centre, Wayanad

202.1 Food and livelihood security of tribal communities in Wayanad

During this year Community Agrobiodiversity Centre (CAbC) implemented activities for livelihood development and food and nutrition security of the tribal households. In order to ensure income and to increase the availability of various food groups, the following activities were carried out: orchard development, promotion of good agricultural practices, integrated natural resource management, provision of safe drinking water, establishment of nutrition gardens, and enhancement of human resource capacities to diversify livelihood options. The Centre initiated orchard development activities in 251 tribal households. As part of this, saplings of coffee, pepper, nutmeg, coconut, mango, areca nut, garcinia, and gooseberry with organic inputs were distributed. In Mukkilpeedika village about 80 tribal households got access to safe drinking water and 28 tribal households initiated livestock rearing for their livelihood. As part of ensuring nutrition and access to diverse food groups, 470 nutrition gardens were established and availability of leafy greens, other vegetables, pulses (legumes), tubers, and fruits was ensured. In total, 916 women and 712 men have undergone various training and capacity-building programmes organized by CAbC for enhancing livelihood options.

A nutrition survey was conducted among 107 households to assess the nutritional status of the Paniya tribal community in Mukkilpeedika, Pannikkal, and Puthoorvayal. The survey revealed that the tribal population, in general, face acute deficiency of calorie, protein, carbohydrates, and fat intake.

Promotion of pepper and ginger crops

This intervention was implemented in 280 tribal households in five selected gram panchayats, namely, Pozhuthana, Kaniyamabata, Kottathara, Nenemeni, and Noolpuzha, of Wayanad district in Kerala. The major communities included in the projects were Kuruma (65%), Kurichiya (17.14%), Paniya (6.78%), Pathiya (6.7%), and Kaattunaikka (4.28%). A baseline survey on socioeconomic status and agronomic practices of targeted beneficiaries was carried out. Three decentralized, disease-free, quality pepper planting material production units with a capacity to generate a total of 50,000 plants/year has been established; these are now being managed and monitored by trained local women's groups. These production units multiplied traditional pepper varieties as a priority. Besides Panniyoor-1 (18,000 plants) traditional varieties such as Kallumukku (3,586 plants), Karimunda (218 plants), Cherumani (87 plants), Wayanadan (1,232 plants), Jeerakamundi (48 plants), Valiakaniyakkadan (432 plants), Arkkalamundi (54 plants), Manjamundi (45 plants), and Chomala Namban (36 plants) were also raised in the nurseries. Nursery raising and management techniques were imparted to the

selected women's groups through training and capacity-building programmes.

With the technical support of Indian Institute of Spices Research (IISR), ginger cultivation through mini rhizome techniques is being promoted. Theoretical and hands-on sessions on this subject were conducted with interested ginger farmers. After providing training in bio-inputs such as *Trichoderma* and *Pseudomonas*, its production was assigned to selected women's groups and farmers. Initial steps were taken to establish value addition units of ginger in two gram panchayats. Agro-clinic services with expert services from the Department of Agriculture were extended to a total of 190 farmers (78, male; 112, female), who benefited from it.

Bio-input production

About 2.5 tonnes of biopesticides such as *Trichoderma* spp. (*T. viride* and *T. harzianum*) and *Pseudomonas fluorescence* were produced with the involvement of women's groups. The SHGs involved in biopesticide production earned a sum of Rs. 65,000 during the year.

Micro-propagation

Micro-propagation of commercially important banana varieties along with traditional varieties such as *Poovan*, *Monthan*, and *Njali Poovan* were started. Regional Agriculture Research Station (RARS), Ambalavayal, and IISR, Calicut, extended their technical support.

Nutritional analysis

Nutritional analysis of select crop varieties was carried out. Parameters tested included crude

protein, fat, fibre content, moisture, dry matter, and energy value. Crops selected for the analysis were *Dioscorea* (six varieties), cow pea (eight cultivars), leafy green vegetables (three varieties), and rice (eight varieties). The crops that showed the highest nutritional potential were *machakotta* variety of cow pea, *injikachil* of *Dioscorea*, *mullenkayama* of rice, and *Diplocyclose palmatus* of green leafy vegetables; These varieties are preferred by communities based on their familiarity with the varieties were recommended for promotion through the nutrition garden initiative.

Value chain development of mushroom

In order to develop alternate livelihoods for the poor and tribes in Wayanad, during this year MSSRF initiated promotion of mushroom cultivation and its marketing in four villages. Selected women and men underwent intensive training on mushroom cultivation. A market survey was carried out to explore the potential for mushroom cultivation in Wayanad.

202.2 Education, Communication, and Training

Every Child A Scientist at Hub Centre

A total of 30 students belonging to socially and economically weaker sections enrolled for the Every Child A Scientist (ECAS) programme during the reporting period. As part of providing orientation in the areas of conservation and promoting science education, 35 classes were organized during the year. The classes covered a wide range of topics including biodiversity, environment, plants, animals, climate change, natural resources, agriculture,

technologies, and so on. Information and Communication Technology (ICT) is used as a tool for knowledge transfer.

Under the name 'VENALKOODU', a 30-day science orientation class was organized for ECAS students from April 4 to May 11. The focus was on various aspects of biodiversity, climate change, and sustainable development. A total of 35 students attended this programme. A 5-day-long residential camp was organized in support of SPACE, Thiruvananthapuram, for ICT orientation for ECAS students. They also got the opportunity to familiarize themselves with film-making techniques.

ECAS at schools

This year, the ECAS programme has been initiated in two more schools, thus covering four schools in Wayanad. A total of 160 students attended ECAS activities and 16 classes each were organized in all four schools on topics related to biodiversity conservation and environmental protection. Activities such as audio workshops for content development by students and web radio were carried out. A medicinal plant garden at Yethi School, Kambalakkad, and a fruit garden at Government Model Residential School, Kaniyambatta, were established for creating awareness among students.

ECAS at tribal hamlets

During this year, the Centre, in collaboration with Meenangadi gram panchayat, initiated ECAS activities in three tribal hamlets to achieve "zero school drop-out." The Centre conducted a 2-day workshop at the premises

of MSSRF for community volunteers who are willing to join the “zero school drop-out” mission. A total of 24 tribal youths attended this workshop and developed an action plan for addressing the problems associated with school drop-outs.

Training and capacity building programme for farmers, youths and women

During the past year, 34 training programmes were organized to impart advanced farming methods and techniques to 1,730 farmers. The Centre organized 10 training programmes for transferring innovative farming methods such as precision farming and organic farming, while 18 training programmes were organized for attracting and retaining tribal youths in agriculture. The Centre also organized 10 training programmes in the areas of mushroom cultivation, bee keeping, and dairy farming for those interested in self-employment opportunities (Table 2.3).

Skills development programme for tribal youth

The Centre organized capacity-building training programmes for tribal youth to

continue their higher education and to enhance access to career opportunities. A total of 130 Adivasi youths, including 73 girls, registered for the training programme. This year, 96 training sessions have been conducted. These activities were supported by SBI Life.

Strengthening grass-roots institutions

The Centre is partnering with two grass-roots institutions, namely, Wayanad District Tribal Development Action Council for tribal development initiatives and other community-based livelihood and food security programmes and with SEED CARE, the organization of traditional seed conservers of Malabar for the conservation and commerce of traditional crops, especially rice.

Community Agrobiodiversity Conservation Awards

During this year, the Centre instituted the “Community Agrobiodiversity Conservation Award” for recognizing and encouraging those who conserve diverse traditional crop varieties, with the interest earned from the “Genome Savior Award” by Wayanad Tribal Development Council (WTDC from 2015

Table 2.3 *Details of participants and areas of training*

Target Group	Area and Number of Training Programmes (in brackets)	Participants		
		Men	Women	Total
Farmers	Precision farming (10)	156	529	685
General youths	Mushroom cultivation (6)	53	179	232
	Innovative farming techniques related to precision farming (3), mushroom cultivation (4), cattle farming (4), value addition of vegetables and fruits (4), bee keeping (3)	292	521	813
Total		501	1229	1730

onwards. Mr. Palliyara Raman, a Kurichya farmer, and his joint family, who are conserving eight traditional rice varieties, bagged the award for the work they are doing. Ms. Vadachira Janaki, a Kuruma farmer, and her family bagged the CABc Award for total agrobiodiversity conservation in their farm land.

Community website

A website on the tribal life and culture of Wayanad is being developed for creating a virtual space for tribal communities to showcase their rich traditions to the outside world. The content is generated by the trainees who are members of tribal communities in Wayanad. The website is to be managed by Adivasi youth of the district and will be a dynamic virtual space for discussing tribal developmental issues under the Wayanad District Tribal Development Action Council.

202.3 Biodiversity Conservation

M. S. Swaminathan Botanical Garden

The master plan for the M. S. Swaminathan Botanical Garden (MSSBG), prepared by the Denver Botanic Gardens, United States, has suggested phase-by-phase development of three zones: (1) the community zone, (2) the agrobiodiversity zone, and (3) the conservation zone. The community zone was designed with

14 components. Components such as sensory garden, children’s garden, and butterfly garden were designed meticulously. In the meantime the existing garden was enriched with 34 endemic and threatened plant species. Around 9,700 people visited the garden during the reporting period.

RET Plant conservation programme

During this year, more than 52,000 seedlings of 320 rare and endangered tree (RET) species, medicinal plants, and ornamental plants were multiplied in the nursery, and the saplings were distributed to various gardens as part of their conservation activities. *At the Western Ghats Endemic Plants Information Centre (WEPIC) at CABc 2,300 herbarium specimens of 740 species were processed and organized.*

Sacred grove augmentation programme

This programme was started in 2015 with the aim of augmenting sacred places in Wayanad with medicinal and culturally important plants. During this year the Centre planted 2,000 saplings of 120 species of medicinally and culturally important plants at Pazhassi Tomb in Mananthavadi and at Sree Manikavu Shiva Temple in Meenangadi. *The survival status of the saplings was monitored at both the sites, and 74–79% survival was observed with very good growth rate both in terms of girth and height (Table 2.4).*

Table 2.4 **Survival rates of saplings shown by select RET tree species in ex-situ condition**

Sl No.	Site	No. of Species Planted	No. of Saplings Planted	No. of Saplings Survived	Percentage of Survival
1	Sree Manikavu Shiva Temple, Meenangadi	120	1500	1182	78.8
2	Pazhassi Tomb, Mananthavadi	120	500	372	74.4

Medicinal plant programme

During the reporting period, over 50,000 seedlings of 105 species of medicinal plants were raised in the nursery for distribution among farmers, students, and other general public interested in conservation of plants. Home herbal gardens, numbering 250, were established in various places in Wayanad district. Thirteen training programmes for 112 persons on nine herb-based primary healthcare products for home remedies were conducted in the district. The products include *adalodaka lehyam*, *murivenna*, *lepam* for cracked heels, *sahadevi thailam*, oils for skin diseases, toothache, and earache, *uragulika sathavari lehyam*, and *nellikka lehyam*. A local expert who has vast experience in producing herbal products provided extended training.

Linkages were established with Council for Scientific and Industrial Research–National Institute for Interdisciplinary Science and Technology (CSIR–NIIST), Thiruvananthapuram, for phytochemical profiling of selected medicinal plants, and with Kerala Veterinary and Animal Sciences University, Pookode, Wayanad, for validation of a few ethno-veterinary claims. The phytochemical research on nine species of medicinal plants is under way. Research on *Bridelia scandens*, *Hopea parviflora*, *Celastrus paniculatus*, *Pterocarpus marsupium*, and *Cayratea pedata* var. *glabra* is progressing.

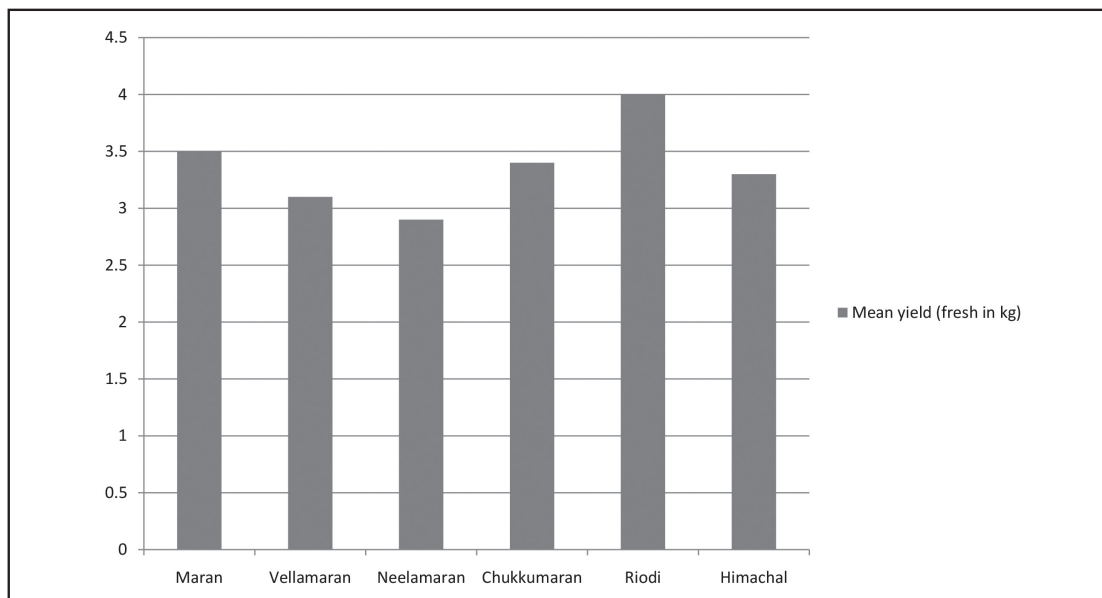
Validation of three ethno-veterinary claims was carried out at the Department of Veterinary Pharmacology and Toxicology, College of

Veterinary and Animal Sciences (CVAS), Pookode, Wayanad. Four poly-herbal formulations for animal diseases such as pyrexia, mastitis, diarrhea, and bovine foot lesion were developed during this year which were found effective under lab conditions. Validation of these formulations is in progress. The findings were presented in the XV Annual Convention of Indian Society of Veterinary Pharmacology & Toxicology (ISVPT), ICAR–National Dairy Research Institute, Karnal, Haryana, during January 14–16, 2016.

Conservation of crop diversity

Five farmer conservation plots were established in various locations in Wayanad for conserving 22 traditional varieties of leguminous crops, especially cow pea, during the reporting period. Black pepper and ginger germplasm have been maintained with 23 traditional varieties and 12 improved varieties of pepper and 9 traditional varieties of ginger. The food crop germplasm of CABc was further strengthened by adding 13 varieties of vegetable crops (6 brinjal and 7 cucurbits). A field-level evaluation of yield of traditional ginger varieties was carried out at three farmer plots using sack cultivation method. Among the 6 varieties experimented, *Riodi* was found to be the best yielder, suitable for the district (Figure 2.1). Demonstration of soilless ginger cultivation using nutrient-rich coir pith was also attempted as a measure for addressing soil-borne diseases of ginger and was able to generate disease-free propagules for supplementing germplasm.

Figure 2.1 *Evaluation of traditional varieties of ginger for yield (sack cultivation).*



Sub Programme Area 203

Biju Patnaik Medicinal Plants Garden and Research Centre

203.1 Conservation of landraces

Farmers of the intervention area under Jeypore tract were facilitated to conserve landraces of paddy through *ex-situ* and *in-situ* processes. Some promising landraces such as *Machhakanta*, *Kalajeera*, *Haladichudi*, *Bodikaburi*, and *Gothia* were cultivated across 50 acres by farmers from 12 villages under two blocks. Farmers in 2 villages are conserving landraces through the community-level field Gene Bank. In Nuaguda and Kashiguda field Gene Banks, 61 and 97 varieties, respectively, are being conserved. Exposure visits for the

farming communities to the conservation plots were organized, and they were facilitated to identify landraces suitable to their land. Based on this exercise, 41 traditional rice varieties were distributed among 37 farmers belonging to six gram panchayats of three blocks of Koraput. Seed materials of 75 old rice landraces were provided to the Department of Botany, Government College, Koraput, for exhibition and study by students. Old seed materials of 27 popular rice landraces were also provided to the Botanical Survey of India (BSI), Kolkata, for their museum. Moreover, seed materials of 74 rice landraces were provided to research scholars of the Central University, Koraput, for undertaking studies. Triple-layer polythene pulse storage technology was introduced in the community seed banks for ensuring the safe storage of seeds and grains of pulses. Monitoring the

material stored indicated that there was a 10–20% reduction in storage loss. In addition to the aforementioned community-based efforts, 140 rice landraces, 20 finger millet landraces, and 2 little millet landraces has been conserved at Biju Patnaik Medicinal Plants Garden.

203.2 Outreach and Capacity Development Interventions

Panchabati Gramya Unnayan Samiti

The Panchabati Gramya Unnayan Samiti received the “Pranam Matrubhumi” award from the *Samaj* (the oldest print media of Odisha) for their noble work and initiatives in community development and conservation of local landraces. The villages under the Samiti received 6,000 saplings of different forest species from the Odisha Forest Department for planting in their avenues and backyards. In addition, communities also received 20,000 fish fingerlings from Fishery Department for promotion of fish farming. Cooking utensils were provided to 11 villages from the Samiti funds and utilized by the community during festivals and ceremonies.

People's Biodiversity Register

The Odisha Biodiversity Board has supported MSSRF for the preparation of People's Biodiversity Registers in 16 gram panchayats in Boipariguda, Jeypore, and Kundra blocks of Koraput district. During the current year, a total of 12 Biodiversity Management Committees (BMCs) were formed as per the requirements of the Biological Diversity Act, 2002. This was

followed up with documentation of indigenous knowledge and preparation of database. Documentation of indigenous knowledge across 80 villages was completed through personal interview, group discussion, and focus group discussion. The key respondents were traditional health practitioners (THPs), foresters, teachers, PRI members, and other traditional knowledge holders. Documentation of 37 local rice varieties, 8 millet landraces, 16 tubers, 22 wild flowers, 27 wild fruits, 26 wild animals, 16 bird species, 17 fishes, and 21 insects have been completed.

Sub Programme Area 204

Community Gene Bank

The collection, cataloguing, and maintenance of the germplasm materials of the accessions in the Gene Bank were continued during the year. The annual rejuvenation process of Gene Bank accessions was attempted with multiplication of nearly 500 varieties of rice at the Tamil Nadu Agricultural University (TNAU) Regional Rice Research Station, Tirur. Unfortunately, the unprecedented floods in Chennai during November–December 2015 devastated the germplasm plots maintained there but seeds of nearly 80% of the crop could be reused due to timely effort. The millet rejuvenation process was completed for a targeted 100 accessions with the help of the Kolli Hills team. The seeds of both rice and millets are being processed for the storage.

Efforts were undertaken to submit a few suitable project proposals in the area of

capacity development and on- and off-farm seed management methods. The proposals on *Grand Anicut* of Tamil Nadu for the FAO-GIAHS recognition in partnership with TNAU and on promoting community management of on-farm conservation and commercialization

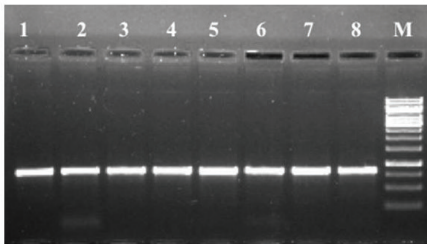
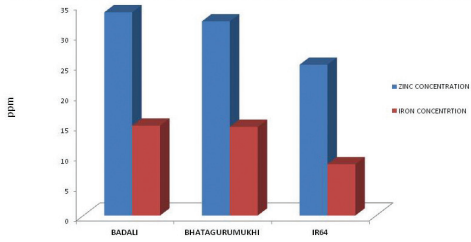
of local paddy varieties in the tribal area of Eastern Ghats submitted to DST, Government of India, were the major ones. Several rounds of discussions were held with the concerned TNAU team and farmers of Koraput region for preparing the proposals.

BIOTECHNOLOGY

Over the years the focus of the Biotechnology group has been on developing rice varieties for abiotic stress tolerance and nutritional enhancement. A number of genes have been used for transformation of local rice varieties (IR 20, White Ponni, and ADT 43) for salinity tolerance. Several genetic combinations that are currently being studied include iron-deficiency-responsive element binding factors (IDEF) to assess the enhancement of iron transport into rice grains; a heavy metal transporter from *Prosopis juliflora* (PjHMT) for phytoremediation; and a RING zinc finger protein 1 (AmRZFP1) from *Avicennia marina* and a triple construct of phospho-ethanolamine N-methyl transferase (PEAMT) from *Suaeda maritima* for salinity tolerance. The mycobiont and whole thallus cultures of five new species of lichens were established for the biosynthesis of compounds. A molecule isolated from lichen *Trypethelium eluteriae* showed a minimum inhibitory concentration of 12.5 µg/ml against TB pathogen. The field trial to prove the concept of “biofertilization” and “bioirrigation” using consortia of biofertilizers (arbuscular mycorrhizal fungi (AMF) and *Pseudomonas* sp. MSSRFD41, plant growth promoting rhizobacteria (PGPR)) was conducted in a mixed cropping system of pigeon pea and finger millet, and the results indicated that the biofertilizers increased crop yields comparable to chemical fertilizers. The “water 4 crops” program demonstrated the reuse potential of bio-treated sugar effluent in agriculture through integrated aqua-agro farming systems (fish culture and then for irrigating crops).

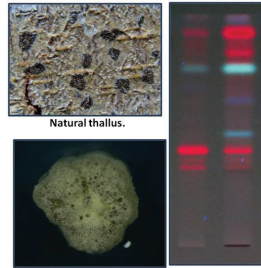
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Zinc and Iron concentration in traditional rice varieties compared with a popular variety (IR 64)



Screening of Cas9 gene for identification of rice transformants

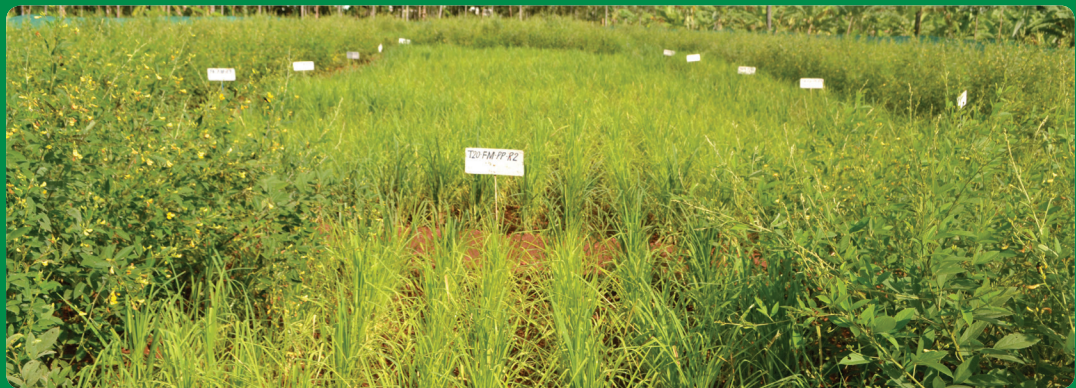
Glyphis cicatricosa Ach.



Mycobiont culture HPTLC chromatogram



Halophilic Bacterial diversity from Mangrove rhizosphere



Sub Programme Area 301

Genetic Enhancement

301.1 Rice Biofortification with Enhanced Iron and Zinc

A total of 160 landraces of rice were collected from the states of Andhra Pradesh, Odisha, Kerala, and Tamil Nadu. These landraces and varieties were raised at the experimental plots at Indira Gandhi Centre for Atomic Research (IGCAR), Kalpakkam. The seeds were harvested from these lines and dehused with non-ferrous dehusker at the Tamil Nadu Agriculture University (TNAU). The dehused seeds were screened for their iron and zinc contents to identify the promising lines using energy dispersive X-ray fluorescence (ED-XRF) technique. Substantial variations among 160 accessions existed for both iron and zinc content. Iron concentration in unpolished rice varied from 8.1 ppm to 21.0 ppm and zinc concentration from 14.4 ppm to 35.3 ppm. The mean value of iron is 13.16 ppm and of zinc 23.46 ppm. The trend remained the same over two seasons for both the micronutrients. Stability of the genotypes in terms of the accumulation of micronutrients in the grain should be studied over a period of time. The effect of polishing in the loss of iron and zinc was evaluated. Brown rice was polished for 45 seconds and the XRF analysis revealed large variation in iron and zinc levels among the varieties. The rice variety Patadhan recorded highest loss of iron (96.7%) and the minimum (25.4%) was

observed in the landrace Jeerakasamba. The Bhudei variety recorded lowest loss of zinc (5.93%). Compared with zinc (~5.93–40%), loss of iron (~25.4–96.7%) is nearly twice after 45 seconds of polishing across the grain shapes. Although concentrations of both iron and zinc were reduced, the effect of polishing on zinc was much milder than on iron. The effect of genotype as a source of variation appears to be highly significant.

Iron concentration in brown rice varied from 0.4 ppm (Patadhan) to 13.6 ppm (Zamukoli) and zinc from 11.3 ppm (Bondalu) to 30.1 ppm (Bhudei). The genotypes, however, do not show a positive correlation (except Gangabali) upon polishing. Principal coordinate analysis of some important agro-morphological traits is being carried out. A total of 30 SSR markers (panel of 30), as suggested in Gramene database, are being used for this study.

301.2 Studies on Genetic Diversity in *Moringa oleifera* Using SSR Markers

Moringa oleifera is a multipurpose tree with immense nutritional value and is used to combat malnutrition in several parts of the world. In this study, a total of 97 accessions collected from different districts of Tamil Nadu, Andhra Pradesh, and Odisha were genotyped using 20 SSR markers to assess the genetic diversity and population structure. A total of 140 alleles were detected with the PIC value of 0.6832; gene diversity 0.7292. Population structure analysis using a model-based approach revealed that the accessions were divided into two subgroups. Molecular variance

analysis using Principal Coordinates Analysis (PCoA) explained an 18.32% variation in the first three axes, and Analysis of Molecular Variance (AMOVA) indicated a 2% variance due to differences among the population with the remaining 98% variance attributed to variation within the individuals. Cluster analysis based on unweighed neighbour joining showed a clear separation of samples into two subgroups. Further comparison of the cluster subgroup was highly consistent with the structure pattern and PCoA plot. The findings from this study reveal a high diversity in the sample set studied. From this a few distinct accessions can be selected for further exploration for their nutritional content, and the nutritionally superior germplasm can be popularized.

301.3 Characterization of *NHX1* Antiporter Gene from *Oryza coarctata*

Functional Characterization of PcNHX1 Gene in Yeast and Tobacco: Oryza coarctata (=Porteresia coarctata) is a halophytic wild rice that grows in coastal areas of India and Bangladesh. Sodium proton exchanger (NHX) antiporters are membrane proteins that are involved in intracellular ion and pH regulation in plants and hence play a role when the plant is subjected to salinity stress. The *OcNHX1* open reading frame (ORF) was cloned in pYES2 and transformed into three mutant yeast strains. *OsNHX1* ORFs from IR64 indica and japonica rice cloned in pYES2 were included as controls. Growth in arginine phosphate (AP) medium containing 50mM NaCl was assessed on plates. The

OcNHX1 transformed mutant strains showed significantly better growth in plates relative to the mutant alone. Growth was also examined in liquid AP medium. *OcNHX1* transformed mutant strains grew significantly better than *OsNHX1* (IR64/japonica) transformed strains or mutant alone in AP medium containing 25 mM NaCl.

Homozygous T_2 *OcNHX1* transgenic tobacco lines (L2, L3, L7, and L8) were assessed for salinity tolerance. Control untransformed and *OcNHX1* T_2 transgenic tobacco seeds were plated on MS medium with varying NaCl concentrations (0, 100, or 150 mM NaCl) and grown for 25 days. On the 25th day, fresh weight, root length, leaf pair length, and first leaf pair widths of the seedlings were measured. With increasing salinity, fresh weight of *OcNHX1* transgenic seedlings was significantly higher at 150 mM NaCl, and the first leaf pair length and widths were also significantly higher at 100–150 mM NaCl in *OcNHX1* transgenic lines indicating that these lines are saline tolerant.

Isolation and Cloning of NHX1 Splice Variants from O. coarctata: In rice three different splice variants have been reported for *OsNHX1* (japonica; *Os07g47100*). Two transcripts, *Os07g47100.1* and *Os07g47100.2*, show opposite differential expression in response to light. A third variant, *Os07g47100.3*, retains part of the 13th intron, leading to a truncated ORF. The presence of *OcNHX1* splice variants was investigated in *O. coarctata* leaf samples. RT-PCR analysis confirmed that the intron retention event observed in *Os07g47100.3*

is also conserved in *O. coarctata* *OcNHX1*. A 1.2 kb fragment containing the exon 14–intron 13 splice junctions could be amplified by RT-PCR. This was cloned and sequenced, and the sequence was found to correspond with the *OcNHX1* exon14–intron13 junction in the *PcNHX1* genomic sequence (Genebank Accession no: JQ796375.1). The existence of this transcript variant of *OcNHX1* was further confirmed by RT-PCR amplification of fragments of varying sizes (~275 bp, 1.2 kb, 650 bp, and 250 bp).

301.4 Characterization of *OcHKT1;5* from *O. coarctata*

HKT1;5 genes encode plasma membrane-localized sodium transporters that retrieve Na^+ from the xylem into xylem parenchyma cells, reducing shoot Na^+ accumulation in wheat and rice. Transgenic tobacco plants overexpressing *OcHKT1;5* under the transcriptional control of the (*OcHKT1;5* (Nona Bokra) xylem parenchyma-specific promoter) were examined for salinity tolerance. In leaves, *OcHKT1;5* expression is induced by salinity while in roots, expression is unaltered. Seeds of *OcHKT1;5* lines show significantly higher germination, increased dry weight, enhanced root growth, lowered seedling Na^+ content, and decreased Na^+/K^+ ratio under salinity. In hydroponics and soil, *OcHKT1;5* lines show reduced leaf Na^+ accumulation and lowered Na^+/K^+ (leaf and root) ratios under salinity. *OcHKT1;5* tobacco lines show increased leaf-specific expression of tobacco *NtSOS1* and lowered root-specific *NtSOS1* expression. Shoot Na^+ exclusion observed in transgenic

OcHKT1;5 lines is primarily due to targeted *OcHKT1;5* expression, but may also depend on lowered root-specific *NtSOS1* expression, possibly reducing shoot–root xylem Na^+ loading.

301.5 Targeted Disruption of microRNA in Tobacco (*Nicotiana tabaccum*) Using a CRISPR/Cas9 System

Targeted genome modification of crop plants has great potential in trait improvement. Such targeted genetic manipulations can now be achieved using site-specific nucleases (SSNs) such as zinc finger nucleases (ZFNs), transcription activator like effector nucleases (TALENs), and clustered regularly interspaced short palindromic repeats (CRISPR)/CRISPR associated protein9 (CRISPR/Cas9) system. They have become powerful tools for generating targeted mutagenesis by non-homologous end joining (NHEJ) repair pathway or insertion of transgene at a specific locus (safe harbor locus) in the genome of crops interested by homology-directed repair (HDR). Among the aforementioned SSNs, the most recent CRISPR/Cas9 system is a simple, most efficient, and versatile system. During this year a CRISPR/Ca9 system was employed to knockout miRNA genes that are negative regulators during various environmental stress conditions including salinity and drought. miRNAs are a class of small, endogenous non-coding RNA molecules, playing regulatory roles in gene expression at the post-transcriptional level by mediating mRNA degradation or translational repression of their target genes

in a sequence-specific manner. These miRNAs can act as both positive and negative regulators in regulating stress responsive genes and thereby are involved in stress tolerance or susceptibility. We have designed a single guide RNA (sgRNAs) for targeting the miRNA169 gene in tobacco (*Nicotiana tabaccum*). These sgRNAs were cloned in plant expression vector (pCAMBIA1301) under U6 promoter and transformed into tobacco by *Agrobacterium*-mediated transformation. The transgenic tobacco plants are currently being screened for the CRISPR/Cas9 induced mutations in the miRNA169 gene.

301.6 Studies on Salinity Tolerance and Free Air Carbon Dioxide Enrichment in *Suaeda nudiflora* (Willd.) Moq. Using Genomics and Proteomics Approach

Suaeda nudiflora is a halophyte and grows in highly saline coastal areas. A suppression subtraction hybridization (SSH) library was constructed between control and 200mM NaCl treated plants to identify genes and proteins which are responsive to salt treatment. A total of 250 cDNA clones was isolated from this library and their sequences were submitted to NCBI (Accession no: JZ896709–JZ896958). A total of 20 genes was selected representing abiotic stress response, signaling, and metabolic and cellular processes from the SSH library. Primers for the 20 selected genes were designed with the sequence information of Expressed Sequence Tags using NCBI primer blast. Total RNA was extracted from the shoot and root of *S. nudiflora*. After DNase treatment, cDNAs were synthesized to

identify the differential expression of selected genes at different time points and different concentrations.

The physiological and biochemical changes of *S. nudiflora* under salinity (200mM) were studied by measuring chlorophyll content, electrolytic leakage, lipid peroxidation and total soluble sugars. In this study, we observed an increase in MDA content and electrolyte leakage in salt-stressed *S. nudiflora* compared to control plants. Salt stress significantly reduced the total chlorophyll content in *S. nudiflora* compared to control. The reduced chlorophyll content in salt-treated plants might be attributed to either a diminished chlorophyll biosynthesis or enhanced chlorophyllase activity.

301.7 Identification of NaCl-Responsive Transcripts from Halophyte *Salicornia brachiata* Roxb., through SSH

Salicornia brachiata (Amaranthaceae) is a leafless succulent annual halophyte and commonly grows in coastal areas in India in a wide range of salt concentrations (0.1–2.0 M) and can accumulate quantities of salt as high as 40% of its dry weight. The study aims to identify differentially expressed genes in *S. brachiata* in response to salt treatment through cDNA subtraction. Two SSH cDNA libraries between *S. brachiata* (*Sb*) x *Sesuvium portulacastrum* (*Sp*) (Aizoaceae) and *S. brachiata* x *Suaeda maritima* (*Sm*) (Amaranthaceae) was constructed to identify family-specific and genus-specific unique ESTs from 200mM NaCl-treated plants for 14 days. Two cDNA libraries had resulted in

following number of clones: *Sb x Sm*, 109 clones; and *Sb x Sp*, 62 clones. Dot-blot analysis was done to identify the differentially expressed transcripts. Blast2Go and contig analysis were performed for two libraries. *Sb x Sp* contained 8 contigs and 44 singlets. *Sb x Sm* contained 19 contigs and 68 singlets. A total of 166 ESTs was submitted from both libraries in NCBI (Accession No: JZ903575–JZ903710).

A total of 15 and 20 transcripts were selected from both the libraries *Sb x Sp* and *Sb x Sm*, respectively, representing abiotic stress response, signaling, and metabolic and cellular processes. Results from the shoot sample shows that most of the genes were upregulated at 14 days of treatments and few genes at 48 hours. The coming year will focus on studying the expression pattern of the select genes in root samples as well as at different concentration of NaCl (100,200,300,400,500 mM) using semi-quantitative PCR.

Identification of salt responsive genes and proteins in Sesuvium portulacastrum L. using molecular tools: *S. portulacastrum* is a halophyte grown in problematic soil in arid and semiarid regions, and it accumulates high concentrations of salts in its cells and tissues and overcomes salt toxicity by developing succulence. SSH was used to identify differential expression of genes related to salt stress tolerance. A total of 326 ESTs and 72 ESTs were found to be expressed in response to salt treatment in SSH library between *Salicornia* and *Suaeda*, respectively. The functional roles of these ESTs were predicted using BLASTX algorithm and are

mainly involved in plant metabolism, signaling, and stress response. Semi-quantitative PCR for select 26 ESTs from library between *Sesuvium* and *Salicornia* and 10 ESTs from library between *Sesuvium* and *Suaeda* was performed using RNA isolated from leaf of control plant and RNA isolated from plants treated with 200mM NaCl for 48 hours, and withdrawal of NaCl after 48 hours. So far, semi-quantitative PCR has been completed for 16 ESTs. The results suggests that expression of ESTs were more in plants treated for longer duration (14 days) than for control and plants treated for 48 hours. The expression declined after 48 hours when NaCl was withdrawn from the medium.

Isolation, identification, and characterization of salt responsive genes and proteins in halophyte *Suaeda maritima* using genomics and proteomics approach: The aim is to identify differentially expressed genes in the halophyte *S. maritima* compared with *S. portulacastrum* and *S. brachiata* in response to salt treatment through cDNA subtraction; identify differentially expressed proteins with response to salt exposure in these halophytes through 2-dimensional gel electrophoresis, mass spectrometry, and/or MALDI-TOF; and finally compare the two approaches to reveal unique differentially expressed genes and proteins. Comparative 2-dimensional gel electrophoresis (2DE) was performed in *S. maritima* between control and treated plants. Based on the quantity of protein, 2DE was performed using an 11 cm IPG strip (Biorad) according to the manufacturer's instructions. A total of 13 proteins spots (2 unique, 7

upregulated, 4 downregulated) under salt treatment and only 5 upregulated protein spots were analyzed using MALDI-TOF, and the remaining spots needs to be analyzed.

301.8 Monitoring the Expression Profile of Transgenes in Pusa Basmati Transgenic Line Grown under Elevated CO₂ and NaCl Integrated Treatment

Transgenic events were generated for salt stress response in rice and were screened for change in response in presence of elevated CO₂ (eCO₂). Here, we report the studies done at transcript level on Pusa Basmati transformed with *APX* and *MDAR* genes from a mangrove plant *Avicennia marina* for its response under eCO₂ and NaCl salinity integrated treatment by semi-quantitative reverse transcriptase PCR. Transgenic rice seedlings were grown hydroponically and exposed to eCO₂ (~520 ppm) using miniature free air CO₂ enrichment (mini-free air carbon dioxide enrichment (FACE)) method. NaCl salinity treatments were imposed at the reproductive stage for 15 days, and leaf samples were collected at the 15th day of this eCO₂ and NaCl salinity integrated treatment. Total RNA was extracted from leaves and semi-quantitative reverse transcriptase PCR was performed to monitor the expression profiles of *AmAPX* and *AmMDAR* transgenes, and elongation factor 1a (to ensure equal loading, a housekeeping gene is used as control) was used as internal control. The results were compared to transgenic rice plants grown under eCO₂ alone and one set grown at ambient (atmospheric CO₂) condition without NaCl salinity treatment.

The results showed the upregulation of *AmAPX* transgene in eCO₂ and NaCl combined treatment compared to both eCO₂ alone and at ambient condition. In eCO₂ alone condition, this gene was shown to express more transcripts compared to ambient condition but less transcripts than eCO₂ and NaCl integrated treatment conditions. *AmMDAR* transgene did not show any differential expression under these three experimental conditions.

301.9 Stress-Induced Transcriptome Profiling of Six Abiotic Stress-Tolerant Plants for Identification of Genes and Pathways Functioning in Abiotic Stress Tolerance

The project was designed to understand the molecular mechanisms of abiotic stress tolerance in stress-tolerant plant systems by carrying out whole transcriptome profiling under drought and salt stress. During this year mRNA and small RNA libraries were constructed from control and salt- and drought-stressed leaf and root tissues of all the six selected species (*A. marina*, *P. juliflora*, *Macrotyloma uniflorum*, *Chrysopogon zizanioides*, *Sorghum bicolor*, *Pennisetum typhoides*). The RNAseq libraries were pooled together and sequenced on IlluminaHiSeq 2500 platform to generate 30 million paired end reads per sample. Small RNA libraries were pooled together and ran on a single lane of SE 50. The entire sequence data generated were deposited in the National Instituted of Health (NIH) Short Read Archive database. *De novo* transcriptome for species without

a reference genome was generated using Trinity software, and differential expression profiling of genes (DEG) under salt and drought stress was carried out using EdgeR. GO (gene ontology) enrichment of different DEG profiles was performed with BiNGO, and statistical enrichment of DEGs was tested using KOBAS 2.0.

Detailed analysis of DEG profiles and other results were carried out for *P. typhoides* and *P. juliflora* this year, and the drought and salt up-/downregulated genes in leaf and root; small RNAs up-/down regulated under drought and salt stress; drought- and salt-specific DEGs in leaf/root; DEGs common to drought and salt in leaf and root; DEGs common to leaf and root under drought and under salt; transcription factors and transporter genes among the DEGs; and unique DEGs were identified.

301.10 Expression Profile of *AmNAC1* Transcription Factor under Multiple Stress Conditions in *A. marina*

NAC (NAM, ATAF1/2, and CUC2) proteins are plant-specific transcription factors reported to be involved in diverse physiological processes in *A. marina* plants, including growth, development, and stress responses. Transcript expression analysis revealed that the *AmNAC1* transcript was decreased compared to control after 24, 48, and 72 hours of NaCl treatment. Whereas an increase (more than twofold) in *AmNAC1* transcript expression was observed in the leaves and root tissues of seedlings treated with 250 mM NaCl for 7 days, the level of transcript was reduced

thereafter when the treatment was extended beyond this period. However, the expression pattern of *AmNAC1* remained very similar in both leaf and root tissues analyzed. Seedlings that were subjected to combined stresses (NaCl treatment and aphid infestation) revealed a tenfold higher expression of *AmNAC1* transcript when compared with seedlings treated with NaCl alone, suggesting the involvement of *AmNAC1* in the regulation of both abiotic and biotic stress pathways in *A. marina*.

Sub Programme Area 302

Bioprospecting

Bioprospecting is the systematic search for useful natural products from uncommon bioresources for potential applications. Lichens (fungus forming obligate symbiotic association with alga or cyanobacteria) are considered as a repository of a wide array of secondary compounds, including polyketide compounds with pharmaceutical, cosmetic, and agrochemical importance. Currently MSSRF is bioprospecting select lichen secondary compounds for their potential anti-cancer, anti-tuberculosis, and anti-microbial properties.

302.1 National Network Programme on Lichens: Bioprospecting Its Secondary Compounds and Establishing Cultures and Collections

In nature, lichens show slow growth rate, produce low biomass, and grow as crusts

over the substratum making it difficult for large-scale harvesting for compound extraction for bioprospecting screenings. MSSRF is collaborating with the National Botanical Research Institute (NBRI) and the Agharkar Research Institute (ARI) and has established the mycobiont and whole thallus cultures of 40 important lichen secondary compound rich species from Western Ghats and the Himalayas for the biosynthesis of compounds. The biosynthesized lichen compounds were isolated, purified using various chromatographic methods, and characterized at Indian Institute of Technology Madras (IITM), Chennai. These key active compounds were provided to collaborative laboratories at the Cancer Institute (CI) and the National Institute for Research in Tuberculosis (NIRT), Chennai, for relevant bioprospecting screening.

302.2 Establishing Lichen Cultures Repositories

During the year, the mycobiont and whole thallus cultures of *Buellia* sp1, *Diorygma* sp, *Graphis scripta*, *Platygrame caesiopruinosa*, and *Phaeographis* sp. were established and mass cultured for the production of desired quantity of secondary compounds. The mycobiont culture of *Trypethelium elutriae* and *Buellia subsororioides* were subcultured and the desired quantity of compounds were biosynthesized. The biosynthesized compounds were identified and quantified using high performance thin layer chromatography (HPTLC).

Molecular Identity and Confirmation of Lichen Cultures: DNA isolation protocol was standardized both for the natural thallus and for the established mycobiont cultures of *B. subsororioides*, *Diorygma* sp, *G. scripta*, *Glyphis cicatricosa*, *P. caesiopruinosa*, and *T. elutriae*. The molecular identity was confirmed using the conserved region of the fungal genome, the internal transcribed spacer (ITS), and mitochondrial small subunit (mrSSU) regions. The characterized sequence data of these species were submitted to National Center for Biotechnology Information (NCBI).

302.3 Bioprospecting of Secondary Compounds

During this year IITM characterized the earlier supplied six lichen secondary compounds. Additional three compounds were provided for characterization. The batch subcultures of three lichen species were harvested and organic solvent and hydro-alcoholic extracts were prepared. These extracts were supplied to the partnering bioprospecting laboratories for preliminary screening.

302.4 Screening Lichen Extracts against Cancer Lines

CI, Chennai, has screened a total of 46 lichen extracts against five cancer cell lines (MCF-7 (breast), NCI H460 (lung), U251 (human glioma cell line), and the control cell lines (Hek293 and HaCat)). Among them 13 extracts (MSSRF/L10/Ha1, MSSRF/L10/Se1, MSSRF/L11/Se1, NBRI/L1A/Ha1, NBRI/L1A/Se1, NBRI/L4/Ha1, NBRI/L4/Se1, ARI/L1A/Ha1, ARI/L7/Ha1, ARI/

L8/Ha1, ARI/L9/HHa1, ARI/L7/Se1, ARI/L8/Se1) showed non-specific activity against the cell lines tested.

302.5 Screening Compounds against Tuberculosis

NIRT, Chennai, screened a total of 46 extracts against Gram positive, Gram negative, and methicillin-resistant *Staphylococcus aureus* (MRSA) tuberculosis strains. Among these 4 extracts showed inhibitory activity against M.tb H37Rv with an MIC of less than 25µg/ml; TE derivative MSSRF/TE/03 showed an MIC of >50 µg/ml; and MSSRF/TE/04 showed an MIC of 12.5 µg/ml against TB strain H₃₇ Rv rapid-growing non-tuberculosis *Mycobacterium pheli*, *M. chitae*, *M. parafortuitum*, *M. szulgai*, *M. intracellulare*, *M. avium*, and *M. kansasii*.

Sub Programme Area 303

Microbial Diversity

The bioprospecting of microbial diversity from the mangrove and agriculture ecosystem resulted in the identification of potential plant growth promoting and phytoprotective bacterial and actinobacterial isolates capable of functioning under salinity stress. This sub program also focuses on crop growth enhancing microbe-mediated biofertilization and bioirrigation in mixed cropping system using pigeon pea (PP) and finger millet (FM) in semiarid regions to enhance productivity with reduced use of mineral fertilizers and also under drought conditions.

303.1 Microbial Community Profiling of the Mangrove Ecosystem

Culturable and Unculturable Diversity of Bacteria and Archaea

Denaturing gradient gel electrophoresis (DGGE) analysis showed a rich and more complex diversity of bacterial community compared with archaeal diversity. Most of the bacterial community belonged to unculturables with very few showing similarity to known culturable microbes such as *Bacillus*, *Halomonas*, *Pseudomonas Virgibacillus*, *Vibrio*, and so on. Based on RDP Classifier the predominant microbial community in this ecosystem is occupied by bacterial phyla, proteobacteria, bacteroidetes, firmicutes, chlorflexi, ignavibacteria, actinobacteria, and unclassified bacteria. Among proteobacteria, gamma proteobacteria was predominant, followed by alpha, beta, and epsilon group; no delta proteobacterial groups were observed in this study. Archaeal community also belonged to the unculturable group of two different phyla—Crenarchaeote and Euryarchaeote—with the former being the dominant group represented by three families, namely, Desulfococcaceae, Pyrodictaceae, and Sulfolobaceae, while the phylum Euryarchaeote comprised of two families, namely, Haloferaceae and Methanomassiliicoccaceae. The culturable bacterial diversity determined by restricted fragment length polymorphism (PCR-RFLP) showed the presence of four different phyla, Alphaproteobacteria, Actinobacteria, Firmicutes, and Gammaproteobacteria, representing nine different families comprising of seventeen different genera.

Culturable and Unculturable Diversity of the Nitrifiers and Denitrifiers

BOX-PCR finger printing profile of the 52 *nifH* positive isolates belonged to 23 different groups. The 16S rDNA sequence analysis of the representative BOX-PCR indicated that the majority of the nitrogen fixing bacterial community belonged to a wide range of genera such as *Azospirillum*, *Bacillus*, *Catenococcus*, *Klebsiella*, *Mangrovibacter*, *Rhodobacter*, *Vibrio*, *Serratia*, and *Staphylococcus* groups. DGGE analysis showed that majority of the sequences of *nifH* gene belonged to uncultured nitrogen fixing bacterium. DGGE analysis using denitrifying marker genes such as *nirS* and *nosZ* showed that the majority of the sequences belong to uncultured denitrifying bacterial group with a few groups represented in the culturable population. Within the culturable population 83 isolates harbored nitrite reductase gene, and 62 isolates harbored nitrous oxide reductase gene. The BOX-PCR fingerprinting analysis based on BOX repetitive elements found in the non-coding regions showed that these 83 strains formed 14 clusters at 60% confidence level. The 16S rDNA sequence analysis of the representative denitrifiers from BOX-PCR belonged to a wide range of genera such as *Halomonas*, *Labrenzia*, *Paracoccus*, *Pseudomonas*, and *Staphylococcus*, which harbored both *nirS* and *nosZ* gene, while *Bacillus*, *Nitratireductor*, *Shewanella*, and *Virgibacillus* harbored only *nirS* gene. Unculturable ammonia oxidizing bacteria belonged to *Nitrosomonas* and *Nitrosospira*. Nearly 17 different bacterial genera with nitrogen fixing and denitrification

ability contributing to nitrogen cycling were identified from this ecosystem.

The Obligate Halophilic Bacteria Community of Mangrove Rhizosphere

Among 225 halophilic bacterial strains isolated from Pichavaram mangrove, 19 were strictly obligate, and hence, they were grown in media supplemented with either 33 ppt or 25 ppt saline water. Based on 16S rRNA gene sequence analysis the genus *Arenibacter*, *Bacillus*, *Halobacillus*, *Microbulbifier*, *Maritaela*, *Paraliobacillus*, *Tanecibaculum*, *Salinicola*, and *Salinispora* were identified as obligate halophiles, which requires minimum 1% NaCl, but the exact nutritional requirement for growth needs to be explored. The genus *Salinispora* which is less reported with 5 type strains was found to be predominant in the mangrove ecosystem. A total of 21 *Salinicola* strains isolated from rhizosphere of mangrove ecosystems showed obligate requirement of NaCl (0.5–30%) for growth. Among these 13 isolates, >97% shared 16S rRNA gene sequence similarity with available *Salinicola* sp. and other genus in the NCBI database, while 8 isolates shared 98.4–98.7% with *S. salaries* M27T but formed an outward clade in phylogenetic tree clearly representing new groups in the genus *Salinicola*. One of these isolates, designated MSSRFH1T, occupying a phylogenetic position close to *S. peritrichatus*. JCM18795^T, was reported as a new species with the binomial *Salinicola rhizosphaerae* sp. nov. This is the first report on presence of this genus in mangrove rhizosphere. The presence of a large number of isolates of

this genus was observed in Pichavaram mangrove rhizosphere, which indicates that this ecosystem is the specific niche of this microbe.

303.2 Biofertilization and Bioirrigation for Sustainable Mixed Cropping of PigeonPea (PP) and Finger Millet (FM)

The second-year field trial to prove the concept of “biofertilization” and “bioirrigation” using consortia of biofertilizers (arbuscular mycorrhizal fungi (AMF) and *Pseudomonas* sp. MSSRFD41, plant growth promoting rhizobacteria (PGPR)) was conducted in mixed cropping system of PP and FM similar to the first-year trial (2014–2015) in Thovarapalam village, Kolli Hills.

The experiment was conducted in a randomized block design of 20 treatments (T1–T20) with four replications in a total area of 2,888 m², with individual plot sizes of 25.74 cm² having dimension 3.9 × 6.6 m, 0.3 m and 1.0 m between plots and replicates, respectively. Treatment T1–T5 was FM monocropping; T6–T10, PP monocropping; and T11–T20 mixed cropping of PP and FM planted in the ratio of 2:8 rows. Treatment T1, T6, and T11 received 100% recommended dose of fertilizers (RDF) NPK; treatment T2, T7, and T12 received 50% RDF with no biofertilizers; while the remaining treatment received 50% RDF with biofertilizers AMF and PGPR either alone or in combination; Treatment T18 was negative control with zero input, and T20 served as biofertilizer control with only AMF +PGPR and no inorganic fertilizer. Around

12,000 PP seedlings were raised in polybags with four different treatments: AMF, PGPR, AMF +PGPR, and control and maintained upto 45 days.

Plots were prepared as per the RBD and rows were created using row maker; recommended dose of chemical and biofertilizers were given as band application in the respective plots. About 45-day-old PP seedlings were transplanted to the respective plots by maintaining 52 plants in mixed cropping and 143 in monocropping pattern. Treated and untreated FM seeds were sown in respective treatment plots by maintaining 1,144 plants in monocropping and 834 in mixed cropping. Weeding was done once in 15 days, and harvest was done in the net plot area of 180 × 330 cm.

Performance of FM and PP was monitored using a number of biometric parameters. Remarkably, grain yields in the treatment 50% RDF with biofertilizer AMF+PGPR was on par with 100% RDF without biofertilizer, indicating that biofertilizers have a high potential to replace chemical fertilizers without jeopardizing yields. The dual inoculation of AMF and PGPR was more effective than single inoculation of either AMF or PGPR, underlining the fact that these two biofertilizers acted synergistically. The 50% RDF with biofertilizer application increased grain yield in monocropping FM and PP by 125% and 103%, respectively, when compared with no biofertilizer application and with 48% increase in grain yield in both the crops in mixed cropping. Yield parameters at 50% RDF

combined with biofertilizer application was on par with 100% RDF without biofertilizer (Figure 3.2). Thus the application of biofertilizers has a positive impact on all the growth and yield parameters with 50% reduction in chemical fertilizers.

Shade Effect in Mixed Cropping of PP and FM: The plant height of PP varieties Sa1 and Vamban3 used in the experimental trials was 250 and 180 cm, respectively, and the FM *Surutai arium* grew upto 90 cm; in the mixed cropping system the impact of shade effect of PP on FM was observed in a north–south orientation. Hence, the shade effect experiment was carried out to understand the impact of orientation of cropping pattern in mixed cropping system of PP and FM. A total of 12 plots were prepared in the dimension of 3.9 × 6.6 m with a border of 0.3 m between the plots and 1.0 m between the replicates. The treatment and design was identical to the main experiment except for the opposite orientation of the planting pattern in east–west direction compared with the main experiment in north–south orientation. The methodology for collection and analysis of data was the same as in the main experimental plot. Among the treatments the combined application of AMF+PGPR enhanced straw dry matter by 20–53%, seed dry weight by 65–128%, and a slight increase in 1,000 seed weight in FM was observed. Biometric analysis clearly reflects that the ideal orientation for the mixed cropping system is east–west. In this orientation photosynthesis rate may be high due to direct sunlight compared to north–south orientation.

Plant Density Bioirrigation in Mixed Cropping of PP and FM: The concept of bioirrigation in which a deep-rooted plant supports a shallow-rooted plant through the phenomenon of hydraulic lift is evaluated by plant density bioirrigation (PDB) experiment. PDB trial was conducted by altering the PP crop density pattern and its impacts in the yield of both FM and PP. A total of five different planting systems, namely, T1-2 PP: 8 FM rows; T2-1 PP: 4 FM rows; T3PP (mosaic 100% PP in NPA): FM line sowing (LS); T4PP (mosaic 50% PP in NPA): FM (LS); T5PP (mosaic 25% PP in NPA): FM (LS) were set up and the growth and yield parameters were recorded as in the main trial. The data is being analyzed.

303.3 Microbes for Biotic Stress Attenuation in Agricultural Crops

Fusarium spp. cause wilt disease in tomato plants. The infected plants were collected, and the pathogen was isolated from Kannivadi, Dindigul district. A total of 33 fungal pathogens were isolated from the infected plant parts of tomato, and 18 isolates were identified as *Fusarium* sp. using specific primers such as ITS FUf, ITS Fur, ITS-Fu1r, TEF-Fu3f, and TEF-Fu3r. Fusaric acid (FA) produced by certain *Fusarium* sp. counteracts the biocontrol efficiency of *Pseudomonas* sp. by altering the 2,4-diacetylphloroglucinol and phenazine antibiotic biosynthetic gene expression. Hence, it is necessary to identify pathogen-specific biocontrol agents for efficient control of the pathogen in the field condition. The production of FA by these isolates was determined by thin layer chromatography (TLC). The fungal

isolates were grown in Czepak dox broth and incubated for 7 days, and FA was extracted from the culture filtrate and run on the TLC plate. The production of FA in each isolate was confirmed by comparison of retention factor that co-migrated with the authentic standard. Out of 18 strains, 12 were found to produce FA. Identifying efficient biocontrol isolates for the control of FA positive strain is in progress.

303.4 Integrating Bio-treated Wastewater Reuse with Enhanced Water Use Efficiency to Support the Green Economy

This project attempts to treat the distillery waste water of KCP Sugar and Industries Corporation in their Lakshmipuram and Vuyyuru sites in the Krishna district of Seemandhra with microbes and plants in a constructed wetland (CWL)

model and to reuse the water for agriculture. The water quality of raw and treated water from the CWL was measured fortnightly for its physico-chemical parameters (refer Table 3.1). The improvement in water quality was due to the biological and chemical processes. The reduction of COD and BOD in different beds is due to degradation of organic pollutants by the algal biomass on substrate surfaces and enhanced supply of oxygen by the diatoms and emergent macrophytes. This process helped to increase the dissolved oxygen concentration in water which is essential for fish culture. The consortium in CWL contains green alga *Amphora* sp. (diatom), *Chlorococcum* sp., *Cladospora* sp., *Spirogyra* sp., and cyanobacteria *Anabaena* sp., *Chroococcus* sp, *Gomphospaeria* sp., and *Phormidium* sp.

Table 3.1 **Physico-chemical parameters of raw and treated water at Lakshmipuram distillery site**

Parameters	Raw Water	Treated Water	% Reduction
pH	8.7	7.1	—
Ec (mS)	1.8	1.4	—
Temp	30.4	30.1	—
TDS (mg/L)	594.1	510.5	14
Total hardness (mg/L)	373.1	271.3	27
Chloride (mg/L)	275.7	217.6	21
Phosphate (mg/L)	5.1	1.8	65
Sulfate (mg/L)	2	1.4	30
Total alkalinity (mg/L)	527.3	396.6	25
COD (mg/L)	3969.3	409.5	90
Nitrate (me/L)	1.6	0.7	56
Magnesium (me/L)	2.9	1.7	41
Calcium (me/L)	2.3	1.4	39
DO (mg/L)	2.5	4.5	-80
TSS (mg/L)	124.5	59.4	52
BOD (mg/L)	272.9	59.8	78

A modeling with Sub Wet 2.0, a software to support the decision-making process by assisting experts and water managers in the design of CWL to improve water quality, was used to assess the performance and efficiency of CWL at Lakshmipuram. The results show that both observed and simulated values are very close which indicated that overall treatment efficiency of the CWL is very much appreciable

Reuse of Bio-treated Sugar Effluent

The reuse potential of bio-treated sugar effluent was demonstrated in agriculture through integrated aqua-agro farming systems (fish culture and then for irrigating crops).

Fish Culture: In the first cycle, fish culture was carried out mainly to observe the survival, growth, and health of fishes growing in treated sugar effluent. The fishes were grown for 274 days with a survival rate of 92% and 76% for *Catla* sp. and *Rohu* sp., respectively. The overall net production for both species was 76.88 kg. Culturing fish before using the bio-treated sugar effluent for irrigation infuses 37.6% of nitrogen and 100% potassium into the water; this contributes toward fertilizer savings. The second cycle was initiated by stocking better performing *Rohu* sp. with a density of 1.7/m².

Sugarcane Cultivation: Based on the request by industry, sugarcane crop was chosen for demonstrating reuse. Furrow irrigation was done with the frequency of 15 and 10 days for clayey and sandy soil, respectively. The average sugarcane yield from irrigating

bio-treated water is 64.9 t/ha while in plots irrigated with fresh water it is 65.25 t/ha, which is equivalent to the average productivity in subtropical regions. Quality characteristics of sugarcane done at Vuyyuru Sugarcane Research Institute determined that the percentage of Brix (18), purity (93), and commercial cane sugar (14) was higher than the industrial requirement, which is appreciated by the industry as being of better quality than the canes brought from farmers' fields.

SALTMED Model: SALTMED modeling is mainly carried out to study the impact of irrigating bio-treated sugar effluent on soil, and it helps in prediction of yield, measurement of soil salinity, irrigation scheduling, and estimation of crop water requirements. Based on the model, sunhemp was grown and the fields ploughed for further cultivation of crops.

Vuyyuru Site

Water Quality Changes: Analysis of variations in water quality was done by comparing pre-monsoon, south-west monsoon (SW), north-east monsoon (NE), and post-monsoon seasons, and it was observed that temperature plays an important role in the formation of Milliard's product, melanoidin. A consortium consisting of *Phacus* sp., and *Merismopedia* sp. (cyanobacteria) is used in the current treatment process. The interaction of distillery effluent with the algal consortium was investigated by Fourier transform infrared spectroscopy (FT-IR), which reveals that the algal cell wall and exopolysaccharides have

different functional groups which on interaction with cations present in distillery effluent are able to remove the contaminants.

Observations from the field trials on irrigating with bio-treated distillery effluent and anaerobic treated distillery effluent for halophytes showed a luxuriant growth of *Sesuvium portulacastrum*, and hence it was planted inside CWL. Systematic observations are being done to study the phytoremediation potential of halophytes.

A common corn variety (F1 Hybrid Sweet Gold 95) was cultivated to study the reuse potential of bio-treated distillery effluent. The experiment was designed to compare the impact of bio-treated distillery effluent (T1) with anaerobic treated distillery effluent (T2) keeping fresh water (T3) as control. Yield comparison within treatments of all the cycles revealed that the sweet corn irrigated with T1 had better yield of 16.5 t/ha than T2 and T3, which yielded 7.2 t/ha and 14.4 t/ha, respectively. The crop

analysis to study the accumulation of macro and micro nutrients as an effect of irrigating sweet corn with T1, T2, and T3 were carried out at ICRISAT, Hyderabad. The samples were analyzed for macro (N, P, K, Ca, Mg, and S) and micro nutrients (Fe, Mn, Zn, Cu, and B) on dry weight basis. The crop analysis of sweet corn kernels showed that the uptake of elements was near to sufficiency range and not harmful or toxic to the plant itself and for animals or human consumption.

An attempt to grow halophytes *Sesuvium portulacastrum*, *Suaeda maritime*, and *Suaeda nudiflora*, halophytic grass species of *Aerulopus lagopoides*, and *Paspalum vaginatum* was done. These plants were irrigated with 4 litres of bio-treated distillery effluent (T1) and anaerobic treated distillery effluent (T2) on every alternate day by localized irrigation method. Periodical monitoring and recording of growth and survival was done. Mortality and stunted growth was observed in T2 while plants in T1 grew luxuriantly.

ECOTECHNOLOGY

The Ecotechnology programme operates with the “biovillage” model as a central theme for job-led economic growth with concurrent attention to natural resource management in various agro-ecological regions. During this year various on-farm, off-farm, and non-farm activities from different regions benefitted over 6,000 families. The Bio-Industrial Watershed Programme was recognized by the Ministry of Rural Development, Government of India, under the Saansad Adarsh Gram Yojana (SAGY) as one of the 31 Good Practices projects across the country. In Puducherry, 80% of the farmers adopted integrated crop management (ICM) practices, and 70% adopted integrated pest management (IPM) practices to improve the yield in pulses cultivation under the India Morocco Food Legumes Initiative (IMFLI). The mini dhal mill in Pudukkottai was able to process more than 15 tonnes of pulses, which was sold under the brand name “Pattikaadu.” The integrated dairy project at Pudukkottai produced and marketed about 3 lakh litres of milk annually. Two Farmer Producer Organizations in Tamil Nadu and one in Puducherry were registered and linked with Tamil Nadu State Small Farmers Agribusiness Consortium (SFAC) and National Bank of Agriculture and Rural Development (NABARD).

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Sub Programme Area 401

Coastal Regions

401.1 Puducherry State

Biovillages

Innuyir Grama Sangam: The Innuyir Grama Sangam (IGS), based at Biocenter, Pillayarkuppam, is functioning with 264 groups and 2,626 members from 55 villages. Of the total members, 22% belong to the “single women” category. The annual total savings of the members was Rs. 90 lakh with an average savings of Rs. 236 per month per member and a cumulative saving is Rs. 1.95 crore. An amount of Rs. 1.70 crore was mobilized from banks, and 79 groups availed the credit support for economic development activities (78%), for higher education of children (12%), and for medical emergencies and purchase of immovable assets. In order to strengthen their existing livelihoods (backyard dairy, goat rearing, poultry farming, and vermicomposting), they were organized into livelihood clusters, and the annual business turnover of the cluster is Rs. 28.24 lakh. In this connection, technical skills building and business plan development for the selected livelihood activities were carried out, and 367 members have taken up the livelihood activity. As a result three milk collection centres were established, which accounted for 82% of the total turnover with an operational cost of Rs. 3 lakh and net profit of Rs. 1.10 lakh. Federation has become a nodal agency for insurance schemes, and during the past year, 2,624 members were linked to the social security

scheme of LIC of India and paid the premium of Rs. 1.75 lakh and were insured for Rs. 5.40 crore. Training and capacity-building programmes were focused on themes such as institution building, livelihoods, social security and governance, and software use, and 1,515 members participated. With reference to financial sustainability, the federation has now reached a stage where it can meet its entire administrative cost (including all local staff, except the coordinator’s salary), and it has established good governance at group, cluster, and federation levels, which ensures organizational sustainability. The accounts procedures are computerized which supports close monitoring of the group’s performance and ensures transparency at all levels. Guidance was provided for following the legal compliances with the Income Tax Department, and application was made for 12A & 80G exemption.

Sustainable farming systems

The India Morocco Food Legumes Initiative (IMFLI) is currently being implemented in three villages in two communes (Villiyarur and Mannadipet) of Puducherry. The region experienced 30% deficit rainfall during 2015–16. Various agricultural interventions were implemented with the support of Pasumai Farmer Producer Organization (PFPO). The production and productivity of black gram, moth bean, and minor millet increased (40%) through critical inputs and better farm management practices.

Pulse varietal selection trials were conducted during two seasons in 2015—Kharif (June–August) and Rabi (November 2015–March

2016)—in Vinayagampet and Sorapet villages of Mannadipet commune. Six varieties of black gram namely, Vamban-4, Vamban-6, ADT-5, CO-6, T 9, and WBU 108—were tested. Vamban-4, Vamban-6, and WBU 108 showed better yield and were moderately resistant to pest and disease, especially yellow mosaic virus.

The PFPO advised farmers to adopt the Vamban-4 black gram variety for both seasons, based on the results of the varietal trials. In the Kharif season of 2015, PFPO supported inputs on a revolving fund basis for 148 acres (148 farmers) for millet cultivation. The average yield in this season was 800 kg/acre. During the Rabi season of 2015, PFPO supported 275 farmers across 148 acres in three villages for black gram, 115 acres for moth bean, and 11 acres for groundnut cultivation. A total input support of Rs. 1,370,000 was provided to the farmers through the Asia Initiatives supported Social Capital Credit Scheme (SoCCS). The yield data collection process is in progress for the Rabi season. A total of 105 farmers regularly received advice on climate-smart agricultural practices and on various government schemes through voice advisories. Technical pamphlets were prepared and distributed on pulse package of practices. Four plant clinics programme were conducted, and a total of 422 farmers benefited. Three telemedicine programmes were conducted, and these benefited 105 farmers.

Grass-roots institutions

The PFPO is successfully functioning with 410 shareholders (330, women; 80, men) from 25

groups in four villages in Puducherry. During the reporting period, 4 new farmer producer groups at the village level were formed in two villages consisting of 72 members. To enhance their skills and to play an effective role in the apex producer organization, exposure trips were arranged to Nallavur Farmer Producer Organization, Villupuram, which helped to promote cross-learning and to adopt innovative methods. Training on accounting procedures and on the importance of updating books of accounts was provided to 78 representatives from 25 farmer producer groups.

PFPO was recognized by NABARD under Producer Organisation Development Fund (PODF) programme to implement various activities for 3 years. The first quarterly project advisory committee meeting of the PFPO supported by NABARD was held, and all the stakeholders from the banking sector and 35 PFPO shareholders participated. It was decided to appoint staff to strengthen and scale up the project. The lead bank promised to provide additional credit for crop production with nominal rates of interest. Formally registering PFPO and increasing its membership has also been proposed.

Sub Programme Area 402

Semi-Arid Regions

402.1 Kannivadi

Two grass-roots institutions have been functioning at the site and role change process has been initiated; MSSRF has changed its

role from that of “promoting organization” to “partner organization” in 2016.

Kulumai Producers Federation

The membership in Kulumai Producers Federation has increased from 200 groups to 228 (300 new members have joined the groups). The current strength of the federation is 3,250 members. During the past year, 37 groups (455 members) were linked with NABFINS Ltd, Dindigul, and received a credit support of Rs. 1.28 crore; and 32 groups (186 members) were linked with nationalized banks and received Rs. 38.50 lakh for various livelihood activities. In addition, Kulumai extended credit support through its community banking for Rs. 5.25 lakh to 38 members for low-cost toilet construction. In collaboration with LIC of India, Kulumai is facilitating the social security insurance scheme. This year they extended the policy to 378 new members, covering a total of 1,685 members. The older women members who may not access the aforementioned scheme are covered by Kulumai insurance services and currently 110 members are enrolled. As part of the role change strategy, from April 2016 onwards they are functioning independently, and the process of hand holding in role change is under way. Financial and organizational sustainability of the institutions were ensured in this process.

To support the business activities of the different enterprises, federation established two subsidiary structures, namely, Kulumai Rural Livelihood Foundation (KLRF) and Kulumai Milk Producer Company Ltd (KMPCL). The objectives of KLRF are to fine-tune the

technologies for decentralized production and extend market services to products. During the past year, 30 tonnes of solid-based bioinputs and 100 litres of liquid-based bioinputs (*Azospirillum*, Phosphobacteria, Potash mobilizing bacteria, Arbuscular mycorrhizae, *Trichoderma viride*, *Pseudomonas fluorescens*, *Beauveria bassiana*, *Paecilomyces lilacinus*, and *Bacillus subtilis*) worth Rs. 20 lakh were produced and marketed, which is 31% higher than that of the previous year. Through this initiative 1,200 employment days were created and 3,200 farmers adopted the biofertilizer and biopesticides application. Of the total farmers, 90% were small and marginal farmers and 30% of women farmers applied in their fields. Training programmes were organized for NGOs, institutions working with farmers, and government departments handling the marketing of bioproducts and organic inputs; moreover, 1,200 farmers (560 men and 640 women) were trained on its use and benefits. Ten low-cost vermicompost production units are regularly producing and marketing 5.0 tonnes. Based on the market feasibility study and availability of resources, eight new enterprises were identified and proposals were prepared. A total of 300 trainee days were conducted for women members regarding hi-tech nursery production with financial support of NABARD.

Kulumai federation promoted Kulumai Milk Producer Company Ltd with the technical support of ESAF, Kerala, and NABARD. Currently, the company has a membership of 628 shareholders/milk producers with the share capital of Rs. 6.28 lakh. All the

milk producers were organized into 57 Joint Liability Groups (JLGs) for management purposes. They established 12 milk collection centres in partnership with ABT Foods Pvt Ltd, handling 2,800 litres per day with a worth of Rs. 70,000 per day. The unique features of the collection centres are: women manage using milk analyzers to give differential pricing based on milk quality, and solar energy is used for daily power requirements. Inputs in feed management and animal care helped the members to produce quality milk which fetches Rs. 4–5/litre higher than market value.

Reddiyarchathram Sustainable Agriculture Producers' Company Ltd

During this year, 72 farmers from six groups have joined the Reddiyarchathram Sustainable Agriculture Producers' Company Ltd (RESAPCOL), and the current shareholder strength is 1,064 (52% men and 48% women). RESAPCOL has established an agri-input shop in their premises. The total turnover of the inputs business was Rs. 13.77 lakh, of which 74% is for cotton and maize seeds. With reference to output market, the company established a direct farmer-to-consumer linkage for vegetables which supported women's participation in market services; otherwise it is the complete domain of men farmers. RESAPCOL, in association with Waycool Food Products, Chennai, made a plan to procure vegetables directly from farmers, store it in cold storage facility established with the support of Bayer based on demand, and sell it directly to the gated community consumers in Chennai. Trial runs were conducted for 5 days during August

and September of the year 2015 to fine-tune the supply process. Fifteen different types of vegetables, such as tomato, lady's finger, small onion (shallot), Bellary onion, drumstick, snake gourd, bitter gourd, bottle gourd, radish, cauliflower, lemon, cluster beans, ridge gourd, brinjal green and brinjal violet, were procured from farmers and the average turnover is Rs. 27,440 per week. Based on these experiences, an MOU was signed with the company to supply the vegetables on a daily basis. In relation to access to financial services, 264 farmers (93, men; 171, women) were linked with the commercial bank for availing dairy loans. Twelve JLGs were formed with 48 women farmers, and they were linked with Punjab National Bank to avail Rs. 80,000 each to buy dairy animals to support farming. During the year 2015–16, a total sum of Rs. 1.32 crore was mobilized. The company has a good relationship with the local agricultural department and negotiated to have access for women farmers to different government schemes and entitlements.

Reddiyarchatram Seed Grower Association (RSGA) is conducting participatory need-based capacity-building programmes on the issues in pest, disease, water, soil management, seed quality, post-harvest practices, and market linkages. It is being done in partnership with the Commonwealth of Learning. Methods adopted for training are print-based learning, web-based learning, voice mail-based learning, cross-farm and exposure visits, farmers' field and business school, linking with experts through phone/video, demonstrations, exposure visits, lectures, and so on. During the past year, 374 agriculture- and veterinary-

based contents were developed and shared with IFFCO Kishan Sanchar Limited for delivering the messages to IFFCO-Airtel farmers. Agriculture- and veterinary-based voice mails were heard by 664 farmers (533, men; 131, women) and corporate literacy by 325 farmers (155, men; 170, women). With reference to web based learning, a website www.L3FTN.COM is developed and managed by RSGA for the Life Long Learning Farmers in Tamil Nadu to provide locale specific weather and market information and technical details of crop cultivation. Around 9313 visitors visited the website out of that 7025 were the first time visitors and 2288 were returning visitors. Totally the pages have been viewed 27901 times during this year. Also, 18 video clips on agricultural practices were uploaded to YouTube, which were liked by 2,369 viewers. Moreover, 173 postings on modern agri-techniques and success stories of the farmers were uploaded to Facebook and liked by 23,356 users, and around 17,740 friends mutually shared these information. In case of print-based learning, the farmers' association publishes the monthly magazine *Seithisolai*. As part of the role change process, the community informatics activities were institutionalized through RESAPCOL, and they are facilitating the process of information and knowledge transfer and extending entitlement linkage support services.

402.2 Pudukkottai District

Land and water management

Prior to crop season, 215 soil samples of pulse and groundnut fields were taken during Kharif

and Rabi seasons and tested in the Agricultural Research Station of Kudimiyanmalai. The soil is low in available nitrogen and phosphorus, and potassium availability is at a medium level. The levels of micro-nutrients such as manganese, zinc and copper, and iron are low, but the manganese levels are enough for plant metabolic activity. Based on these results the farmers are advised to use enriched farmyard manure, NPK fertilizers, green manures, green leaf manures, biofertilizers, and soil and foliar application of micro-nutrient mixtures. Biofertilizers and products such as rhizobium and panchakavya application were promoted for increase in productivity. Through the SoCCS programme, nine open wells (Rs. 6 lakh) were rejuvenated, which enabled conversion of 17.5 acres of fallow land into productive use.

Sustainable farming systems

Nineteen farmer participatory varietal selection trials were conducted in the reporting period covering black gram, green gram, red gram, and groundnut crop. Vamban-4 and -6 and MDU 1 performed well in black gram trials. Vamban-4 black gram was scaled up in 738 acres. CO-8, Vamban-3, and VRM-1 performed well in green gram. Vamban-3 green gram was scaled up in 52 acres. VRI-2, CO-7, and Pollachi 1 performed well in groundnut. VRI-2 was scaled up in 643 acres adopting improved practices. Illupur Agriculture Farmer Producer Company (IAPCL) provided Rs. 7.5 lakh as pulses crop loan and Rs. 4.2 lakh as groundnut crop loan.

Field-level research studies were conducted on seed treatment, weedicide application,

different foliar sprays, and integrated pest management (IPM) methods. The results were shared during the Farmer Field Schools (FFS) and Farmer Field Day (FFD). Seed production was carried out in 28 acres (22 farmers) of black gram. Five tonnes of black gram seeds were procured from farmers and redistributed during the Rabi season. IAPCL initiated “Agriculture Service Centres” in six villages, using panchayat buildings. These centres aid in technology transfer, custom hire of farm implements such as seed drills, solar power sprayers, and bioinputs; they also provide market information leading to fair price realization for farm produces. During the reporting year 8,439 farm advisories were disseminated through voice and text messages to farmers on various topics. The results of yield analysis show that the average yield of black gram at the panchayat level was 286 kg/acre (26% increase over the control plots). The average yield of green gram was 178 kg/acre against the control plot average yield of 114 kg/acre, which is a 24% increase through the adoption of improved practices. Similarly the yield of groundnut was 564 kg/acre as compared to 364 kg from the control plot which shows 21% increase by the improved practices.

Sustainable livelihoods

IAPCL is currently promoting four enterprises— Patikaadu Pulses, Patikaadu Organic Vegetable, Patikaadu Integrated Dairy, and Eco Poultry under the brand name of “Patikaadu.” A building for processing and marketing of pulses was leveraged from the regulated market committee, Illuppur, in which a pulse processing and vegetable grading unit was established. A mini dhal mill was also leveraged from the Department of Agriculture Engineering, and the mill is successfully processing the pulses into dhal (Table 4.1). Apart from IAPCL, the local villagers are also using this facility to process their pulses into dhal. In total, 9.7 tonnes of black gram, 4.6 tonnes of green gram, and 1.4 tonnes of red gram were procured from the farmers with 5–10% premium compared with the market price. The processed dhal is cleaned and graded and packed to be sold in the market under the IAPCL brand name. Apart from processing, value addition of black gram into products such as papads is also being tried out on a pilot scale.

A total of 258 farmers have registered under the Patikaadu Organic Vegetable Enterprise,

Table 4.1 **Black gram (BG) processing and output from mini dhal mills**

Input	Qty in Kg (Rs./kg)	Value (Rs.)	Output	Kg (Rs.)	Value (Rs.)
BG grain	100 (90)	9000	BG full	28 (160)	4480
Purchase exp	100 (13)	1300	BG split	46 (150)	6900
Processing	100 (8)	800	BG broken	12 (80)	960
Packing and marketing	74 (2)	148	BG husk	14 (20)	280
Total		11248			12620

Note: 13% incremental value realization over the investment through the BG value addition activity.

of which 142 are involved in organic vegetable production. Every alternate day about 200 kg of organic vegetables are marketed to urban buyers in Chennai, Coimbatore, Pudukkottai, Trichy, and Madurai. During the reporting period, organic vegetables worth Rs. 3 lakh were procured from farmers with 20% and above premium price. Sustainable Agriculture Alliance continued their technical and financial support.

The Patikaadu Integrated Dairy Enterprise consisting of 349 shareholders is aimed at helping its members become entrepreneurs by establishing integrated home dairies and collectively marketing the milk at fair prices. In total, Rs. 36.5 lakh worth of milk was procured from the farmers at a price range of Rs. 22–34/litre based on the quality of the milk. It also conducted 17 animal healthcare camps and supplied 22,000 cuttings. The use of Co-4 grass for fodder is picking up among the farmers. Azolla feeding trials continued with promising results, and Patikaadu Eco Poultry is the new initiative of IAPCL. Each farmer unit was facilitated with 300–500 country chicken. The company provides day-old chicks, feed, and healthcare system, and the farmers are required to maintain the unit. Within 90 days, the company takes back the matured birds and markets them. The farmer gets Rs. 20/kg of bird. So far, seven such units have been established as pilot units. In all, 5,040 kg of country chicken were produced by farmers, who received Rs. 1.08 lakh as additional income for their families. As the demand for this intervention is high among the farmers at present, IAPCL is trying to increase the number of such units in the coming year.

Grass-roots institutions

After the incorporation of IAPCL into the Ministry of Corporate Affairs in January 2015, the first level of shareholders reached 1,000 (768, women; 232, men) with 71 agriculture producer groups at the village level, which meets every month. So far 779 such meetings have been held in this reporting period. Also, these groups do monthly internal savings and have saved Rs. 24.5 lakh, which is used for consumption purposes. Tamil Nadu Small Farmers' Agribusiness Consortium (TNSFAC) has been supporting IAPCL activities for 3 years, and Kalanjiam Tholizhagam Limited (KTL) is providing support for capacity building of IAPCL. During the financial year 2015–16, IAPCL provided Rs. 41 lakh of credit facility for various purposes, which resulted in a sales turnover of Rs. 48.5 lakh and Rs. 2.3 lakh of net profit from various business activities. IAPCL is now identified as one among the developing model producer companies in Tamil Nadu. The district collector, Pudukkottai, many higher officials from the Agriculture Department, Agricultural Marketing Department, Agriculture Engineering, Ministry of Rural Development (MoRD), and Agriculture Commissioner Punjab visited IAPCL and appreciated its activities. Moreover, 274 representatives from various Farmer Producer Organizations in Tamil Nadu also visited IAPCL and learned the FPO activities.

402.3 Villupuram District

Land and water management

During 2015–16, 212 soil samples were collected and tested for pH, electrical

conductivity, major nutrients, and organic carbon. The soil pH showed normal range and electrical conductivity ranged from 0.06 to 1.96 m.mhos/cm. The available nitrogen content was low and ranged between 37.2 and 94.6 kg/acre. Available phosphorous was medium to high and ranged from 4.7 to 21.7 kg/acre, and available potassium was ranged low to high at 45.5–500 kg/acre. Organic carbon was low to high at 0.08–0.99%. Micro-nutrient (copper, iron, manganese, and zinc) analysis in 20 random samples showed normal range for copper, 0.05–3.35 ppm; iron, 1.11–47.8 ppm; manganese, 1.0–60.5 ppm; and zinc, 0.13–2.78 ppm. Based on the soil test results, soil health card was prepared and distributed to farmers. The farmers adopted soil test-based fertilizer recommendations.

The project on Enhancing Crop Diversity and Productivity of Small Farmers through Augmentation of Water Resources in Mailam block,” through their CSR programme. The project enabled the rejuvenation of 45 open wells belonging to 67 small and marginal farmers from six villages benefiting more than 200 acres of rainfed lands. Some of the open wells are shared by family members who benefit directly. Significantly, the project was able to reclaim more than 100 acres of fallow lands. Crop area has increased by 156 acres for promoting crop diversity. The baseline of cumulative water holding capacity was 6,077.784 m³, which increased to 16,106.231 m³ after the rejuvenation process. This has significantly contributed to ground water as well as to surface water storage.

Nallamur Periya Arie Neer Pasana Vivasayigam Sangam was formed with 96 farmers who are command area farmers. It has a surface area of 87.12 acres and huge catchment even though water storage was not possible due to damaged sluice and weir. With the support of Bank of India CSR programme two sluices and weir were constructed. As a result of this, 100.18 acres were irrigated for two seasons.

Sustainable farming systems

Participatory varietal trials conducted in pulse (black gram and green gram) and groundnut in the previous Rabi season showed that Vamban-4 performed better in Nallamur and Thazuthali villages. Among the green gram varieties, ML-618 and VRM-1 exhibited highest yield, in groundnut varietal trial, VRI-2 performed well in both locations.

In continuation, three varietal trials were conducted in black gram in three villages, Chinanergunam, Kezhedayalam, and Thazuthali, in both Kharif and Rabi seasons in 2015–16. Varietal trials in Kharif season in Chinanergunam village with six varieties of black gram showed that Vamban-4 and -6 reported highest yields and were resistant to yellow mosaic virus. The 2016 Rabi season trials are in progress. Three groundnut varietal trials conducted in the two seasons in two locations showed that in Thazuthali village among the seven varieties, ICGV00350 and CO-7 obtained highest yields and were moderately resistant to leaf miner. They were also more resistant to root rot. Two varietal trials of Rabi season 2016 are in progress. Two demonstrations were conducted in black

gram variety. Vamban-4 in two locations during the previous Rabi season with different treatments showed that herbicide + hand weeding provided better results in Thazuthali and hand weeding alone gave good results in Chinanergunam village. Among foliar spray, diammonium phosphate (DAP) application in Rabi and Pulse wonder performed well in the Kharif season. In Rabi 2015–16, two research studies on foliar applications are under way.

In both Kharif and Rabi seasons in 2015–16, input support for black gram cultivation was provided to 741 farmers through Nallavur Farmer Producer Company Limited (NAFPCL). About 1,156 farmers adopted integrated crop management (ICM) practices in black gram and green gram cultivation (Table 4.2). Among 741 farmers, 301 adopted seed treatment with *T. viride* and Rhizobium; 452 followed reduced seed rate; 540 followed foliar application of DAP and Pulse wonder. Of those farmers who adopted IPM practices, 41 adopted castor and 311 adopted cowpea as trap crops. Average yield in the Kharif season was 254 kg/acre, and in the Rabi season it was 384 kg/acre.

In groundnut cultivation 415 farmers availed input support during Kharif and Rabi seasons. Seed treatment with *T. viride* was followed

by 208 farmers. Line sowing through gorrul/seed drill was adopted by 259 farmers. Of those farmers who adopted integrated nutrient management (INM), 196 followed soil-based fertilizer recommendation; 144 used foliar application of DAP; and 194 applied gypsum. As a part of IPM practices, 232 farmers cultivated cowpea, and 49 adopted castor cultivated as trap crop. Average yield in the Kharif season was 429 kg/acre and in the Rabi season it was 840 kg/acre.

Seed enterprise

In Rabi 2014–15, 5 tonnes of black gram seed were procured at Rs. 60,000 and stored in innovative Purdue triple-layered polythene bags. During Rabi 2015–16, it was sold at Rs. 160,000, and therefore NAFPCL earned Rs. 1 lakh as profit. The success of seed business enhances the confidence of the Board of Directors to get involved in pulse seed business enterprises. During Rabi 2016, 12.5 tonnes of black gram were procured of which 7.3 tonnes were grain and the remaining was for seed purposes for the next season. Besides this, 2.25 tonnes of groundnut seeds were procured at Agriculture Service Centre at Kooteripattu village. Seven technical pamphlets on pulse and groundnut

Table 4.2 ICM in Black gram and groundnut in Villupuram—Kharif and Rabi seasons, 2015–16

Crop	Best Varieties (Area Scaled Up)	Total Acres
Black gram	Kharif—VBN-4 and -6 (260 acres)	741
	Rabi—VBN-4 and -6 (481 acres)	
Groundnut	Kharif—JL-24 and TMV-13 (118 acres)	415
	Rabi—VRI-2 and TMV (297 acres)	
Total		1156

crops were developed and distributed to 827 farmers. About 112 farmers received voice messages during the reporting period. One phone-in programme was conducted in which 45 farmers participated. Sixty-one students received knowledge in basic computer use. Four cattle health camps (116 cattle) and two medical camps were organized through Village Knowledge Centre in which 99 farmers participated. Community newspaper was distributed to 366 farmers, and 770 farmers gained knowledge on agriculture and allied activities.

Sustainable livelihoods

Asia Initiative supported SoCCS Programmes was implemented in Nallamur and Keezhedayalam villages covering 188 families. Farmers could earn credit points for every activity involved (pre-defined activities); these could be used as virtual currency to be redeemed after the points reached a target of 400. Based on this concept the first 50 farmers were selected for milch animals support. Co-3 fodder cuttings were provided for 50 farmers for cultivation to ensure green fodder for cattle. Three milk collection centres at Nallavur, Keezhedalayam, and Thazhuthali villages were established in the month of March 2016 by an NAFPCCL tie-up with a private dairy company. Daily 350 litres milk are procured from three centres, and it ensures a better price to the farmers. Kalamkari unit sales turnover was about Rs. 3,13,265 during this reporting period. Besides, it has established export tie-up with an individual from United States who buys Kalamkari bags. Three

consignments have already been sent under this arrangement.

Grass-roots institutions

NAFPCL was registered under the Producer Company Act 2013 in the month of February 2015. Presently the number of shareholders is 932 from 12 panchayats. Fifteen members were selected to the Board of Directors by the general body of NAFPCCL, of which 11 are women. Each director represents at least one village, and he/she communicates the decisions of the Board of Directors to the villages. Board of Directors' meeting is organized on the 10th of every month to discuss about NAFPCCL progress and seasonal plans.

NAFPCL in the Kharif season provided inputs for 260 acres of black gram and 118 acres of groundnut. In the Rabi season inputs were provided for 481 acres of black gram and 297 acres of groundnut. In addition, F2 Seed were also sourced with support of NAFPCCL to provide seed growing farmers in the Rabi season. To establish a community managed pulse resource centre at Kooteripattu, 2.88 acres of land worth Rs. 30 lakh was purchased by NAFPCCL.

NAFPCL also played an active role in rejuvenating 45 open wells which was supported by WABAG CSR project. Through this effort nearly 200 acres of rainfed lands were provided with supplementary irrigation which contributed to increased pulse productivity. Cluster-wise accounts trainings were organized for 43 animators to improve

the skill of handing double-entry system in their respective farmer producer groups. NAFPC was recognized by NABARD under the PODF programme to implement various activities for 3 years.

Sub Programme Area 403

Hill Regions

403.1 Koraput District

Sustainable farming systems

The IMFLI project was launched in Boipariguda block, Koraput district, Odisha, during the year 2012–13 with the objective of increasing food legumes production and of strengthening food and nutrition security. Initially, different varieties of red gram, black gram, green gram, and groundnut seeds (about ten varieties each) were collected in large quantities from Odisha, Tamil Nadu, and Andhra Pradesh. The yield results of the past 4 years revealed that three varieties of pulses and groundnut are most suitable for this area. These varieties of black gram are PU-31, TK-94-2, and CO-6; and in case of green gram, they are CO-7, SML-668, and Tarm-1. Similarly, in the case of groundnut, the suitable varieties

are Kadri-9, Kadri-6, ICGV-9114, and ICGV-0351. However trials conducted on farmers' fields were a failure because of the rainfall pattern and sowing time. This year red gram perennial varieties, ICPL-7035 and ICPH-2470, were taken on trial, and it was found that ICPL-7035 is suitable. Again, during February 2016, extra short duration red gram varieties such as ICPL-161, ICPL-11242, ICPL-88039, ICPL-20228, and ICLP-20338 received from ICRISAT were tested in the office campus and in a village at Doraguda. Though the crop is harvested, the results are yet to be analyzed. The super early variety of red gram ICPL-20338 is found to be good for early sowing in highlands and as winter crop for February sowing. This variety matures in 85–90 days.

Large-scale cultivation of pulses was taken up in 28 villages under Boipariguda and Kundura blocks. As shown in Table 4.3, area under pulse and groundnut cultivation and participating farmers have increased over a period of time due to increased productivity and realization of monetary profit. Total coverage area of crops was 857 acres by 854 farmers. Out of this, the coverage area for groundnut was 399 acres, green gram 310 acres, and black gram 148 acres. Triple-layer

Table 4.3 *Year-wise coverage of pulses and groundnut in Boipariguda and Kundura blocks*

Sr. No.	Particulars	Achievement			
		2012–13	2013–14	2014–15	2015–16
1.	No. of panchayats	2	3	6	8
2.	Villages	12	15	18	28
3.	No. of households	466	782	1492	1992
4.	Total farmers	197	336	535	854

poly bags were distributed to the farmers for safe storage of pulses and groundnut seeds. Damage of seeds in triple-layer poly bags is less than 2% whereas damage in normal storage is 28%.

Cultivation of pulses and groundnut on high and sloppy lands has been introduced during Kharif particularly to address the seed requirement for the Rabi season. In Kharif 2015, the area covered under red gram cultivation was 65 acres, black gram 101 acres, groundnut 25 acres, and other pulses 67 acres. Introduction of groundnut cultivation and pulses after harvesting Kharif crops generated a huge impact among the farmers, thereby increasing the scope for substantial expansion. Tables 4.4 and 4.5 show the effects of ICM practices on yield over the traditional cultivation practices.

As indicated in the tables both during the Kharif and the Rabi seasons pulses productivity was higher in the field where farmers followed the ICM package of practices.

Grass-roots institutions

Vikas Maha Sangh: There has been an increase in the number of members and of villages as the Vikas Maha Sangh (VIMAS) activities reached 866 members from 29 villages belonging to nine gram panchayats.

VIMAS supported its members by providing loans on time for agricultural operations at low interest rates for different crops and also supports them to go for value addition (Table 4.6). The members can avail loans twice in a year during Kharif and Rabi seasons. At present VIMAS has given loans up to

Table 4.4 **Effect of ICM practices adopted by farmers**

Crop	Kharif 2015		Avg. Yield (kg/acre)		Rabi 2014–15		Avg. Yield (kg/acre)	
	Area in Acres	No. of Farmers	ICM	Non-ICM (control)	Area in Acres	No. of Farmers	ICM	Non-ICM (control)
Groundnut	25	25	492	NA	235	187	675	432
Green gram	3	5	198	NA	227	138	213	138
Black gram	101	193	215	162	103	123	228	159
Total	129	223			448	565		

Table 4.5 **Significant outcome of the ICM interventions of the project**

Sr. No.	Crop	Crop during Rabi 2015 (ICM)		Average Yield (kg/acre)	Total Qty. (MT)	Rate per Tonne (Rs.)	Sale Value (lakh)	Average yield (Non-ICM) (kg/acre)	Value of Produce (lakh)
		No. of Farmers	Area in Acres						
1	Groundnut	187	235	675	65.14	47,000	74.55	422	47.60
2	Green gram	138	227	213	48.35	55,000	28.04	138	18.16
3	Black gram	123	103	228	23.48	60,000	21.13	159	14.73
	Total	448	565		147.97		127.63		80.49

Table 4.6 *Present financial status of VIMAS*

Particulars	Rupees (lakh)
Received funds through different source up to March 2015	2707950
Received during the year up to March 2016	653320
Funds debited for different purposes/loans etc. up to March 2015	1306255
Funds debited for different purposes/loans etc. up to March 2016	1306255

Rs. 11 lakh to 514 farmers. Preparation of value-added products from groundnuts was promoted by the organization. Value-added products such as *chikies*, laddus, and fried kernels were prepared and marketed by the groups. Two training programs were organized where 60 women were trained in preparation of value-added products. They prepare and sell products in the local markets and at exhibitions and also supply to small traders in their localities. VIMAS procured raw tamarind from the farmers for value addition and sold

it in the local market at good price. During the year 2015, 4,914 kg of raw tamarind was procured at the rate of Rs. 22/kg, which was then processed. About 2,457 tetra packs, each weighing 1 kg, were packed and sold at Rs. 60/kg. The farmers took a loan of Rs. 95,000 in advance to procure raw tamarind. VIMAS procured 1,930 kg of pulses from the farmers and stored this seed in triple-layer bags for safe storage and gave the seed on a loan basis to 194 farmers during the 2016 Rabi season.

FOOD SECURITY

The Food Security programme attempts to address issues related to ensuring food and nutrition security of marginalized sections of rural communities by promoting focused interventions, research, and advocacy, specifically on food availability, access, and absorption. Several initiatives toward strengthening household food security were promoted during the course of the year. Some highlights are: Programme for Empowerment of Women Farmers (Mahila Kisan Sashaktikaran Pariyojana or MKSP) in Vidarbha and Koraput have promoted sustainable agricultural practices among women farmers, and adoption of such recommended practices have reduced the costs of cultivation; women farmers' federations have provided credit support to members to diversify their on-farm and off-farm livelihood options; women farmer producer groups are engaged in various income-enhancing activities. A pilot programme to address the nutritional problems of pregnant and lactating women and young children (0–2 age group) in 13 villages in Wardha district has been initiated.

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Sub Programme Area 501

Community-based Interventions

501.1 Odisha

Mahila Kisan Sashaktikaran Pariyojana

The Mahila Kisan Sashaktikaran Pariyojana (MKSP) in Odisha focuses on improving the socioeconomic status of women through promotion of sustainable agriculture practices and livelihoods and convergence with entitlement schemes. Ensuring food and nutrition security of each household, in particular, the extremely poor, is also a major focus of the project. It is being implemented in 46 hamlets under Boipariguda and Kundura blocks, with more than 2,500 women farmers (Mahila Kisans) as members. A series of training programmes on sustainable agricultural practices and exposure visits was organized for the women farmers, “community resource persons” (CRPs), and para professionals (CRPs are best practicing farmers while para professionals are the village youth who are trained to provide training to women farmers) to enhance their skill, and appropriate handholding support was provided for them to take up developmental activities. Participation of women farmers in different decision-making processes at the household level and at the community level is a very important empowering measure and the programme focuses on this aspect. The trained CRPs and para professionals act as the resource persons in the community-level training programs and also in training

programmes organized for women farmers. During the reporting period, 973 training programmes and 47 exposure visits were organized for the member women farmers, CRPs, and para professionals. Training programmes were organized on the following themes: (a) Sustainable agricultural practices mainly focusing on soil health, seed selection, collection and preservation, non-pesticide management (NPM), preparation of organic pesticides and fertilizers. (b) Establishment of *Annadata* model kitchen gardens. (c) Promotion of sustainable micro-enterprises including trainings on oyster and straw mushroom cultivation; preparation of value-added products from rice and millet; business plan preparation, book keeping, group management, micro-enterprise promotion for the producer groups and the cluster federations and (d) Entitlement schemes. The women farmers are organized as 62 producer groups that have been formed into four cluster-level federations, which in turn federated into an apex body. Bylaw for the apex body has been prepared by its executive committee.

Some of the significant results during the reporting period

- 2,552 women farmers adopted sustainable agricultural practices in paddy and vegetable cultivation in 1,185 acres of land. They practiced non-pesticide management in the cropping field by using organic pesticides and organic manure. The average input cost in cultivation for farmers is reported to have reduced by 20–25% in 2015–16 compared to 2014–15.

- 2,252 women farmers prepared organic pesticides and organic fertilizers at the household level for their cropping fields. In addition to this, two producer groups from two villages prepared organic fertilizers and organic pesticides for sale. The groups got a marginal profit of Rs. 2,000 each and have prepared a business plan for expansion in the future.
- 963 kitchen gardens including 214 *Annadata* model kitchen gardens have been promoted by women farmers. the *Annadata* model of kitchen garden is a structured garden that requires larger area than a backyard kitchen garden and hence is practiced by few women farmers who have a suitable place. The gardens cover both perennial and seasonal crops vegetables and fruits that provide all-time food to a family. Maintaining a kitchen garden during the summer season is a critical task due to water scarcity in the area.
- 1,567 women farmers preserved seeds of vegetables and paddy for their own use. The capacity-building programmes organized at the community level along with handholding facilitated them to collect seeds through a seed selection process.
- The vegetable seed banks established at the community level were used by the farmers during the cropping season. So far 32 seed banks have been established at the community level to cater to the needs of the community. However, the seed banks have to be strengthened further to fulfil the requirements of the community.
- 13 audio-visual Information Education and Communication (IEC) materials have been developed with the support and guidance of Digital Green on sustainable agricultural practices and food security and nutrition. The CRPs and the para professionals are trained in shooting and editing of the film. These IEC materials were used in the community-level training programmes organized for different groups. A total of 1,163 dissemination sessions were organized at the village level during the year.
- Various training sessions were organized to strengthen the process followed by 62 producer groups and 4 cluster federations with regard to group management, record keeping, business plan preparation, promotion of micro-enterprises, marketing, and so on. A total of 43 Participatory Rural Appraisal (PRA) exercises were conducted with producer groups to identify suitable micro-enterprises and to prepare business plans. In addition to this, regular meetings were conducted with 62 producer groups to facilitate them to review their progress and to help them take decisions on functioning and management of the groups.
- 16 producer groups are involved in tamarind procurement and processing value-added products. Each group has managed to secure an average annual profit between Rs. 12,000 and 23,000.
- 4 producer groups are involved in the preparation of value-added products from rice and millet. The groups sold their

products in exhibitions and in the local market. They managed to gain an annual profit of only Rs. 6,000 to Rs. 8,000 amidst low production and poor market linkages.

- The 4 producer groups involved in fish farming in the leased pond each earned a profit of Rs. 7,000–10,000 in addition to the increased fish consumption of their family members. .
- 8 producer groups and 146 women farmers were involved in large-scale vegetable cultivation. As a result, each group was able to earn an annual profit between the range of Rs. 18,000 and Rs. 25,000. The profit was divided among the members involved in the activity. Besides, this intervention has also enhanced the consumption of fresh vegetables at the household level.
- Convergence of various government schemes was facilitated to the tune of Rs. 1.8 crore for community development, especially for pond digging, construction of latrines, establishing water tanks for drinking water facility through solar pumping, and so on.
- 2 hamlets where the MKSP is in operation were adopted by the government of Odisha as model villages. The government has provided facilities such as drinking water, road, electricity, and sanitation in the model villages.
- 1,272 households were facilitated to get at least 10 days of work under Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS). A total

of 686 women farmers were facilitated to be covered under Pradhan Mantri Jana Dhan Yojana. Participation of women farmers in the Pali Sabha and Gram Sabha increased by 25% compared with last year.

- 43 Community Facility Centres (CFCs) were utilized by the women farmers. The management committee raised funds through collection of user fee from the women farmers. Each village mobilized fund between Rs. 4,000 and Rs. 7,000, which they use for the maintenance of the CFCs.

Community Foodgrain Banks

Community-managed grain banks are in operation in 20 hamlets in Koraput district of Odisha. During the reporting period, 935 member households used and benefited from the grain banks during the lean season. The members of the grain bank development committees across the 20 hamlets are encouraged to organize monthly meetings with the member households. Educated youth in five villages have been trained to maintain the transaction records of the grain banks, keeping the sustainability of the operations in mind. The interest rate for grain loan reduced from 15% to 10% in Boliguda village because of sufficient grain stock. Grain stock in 4 grain banks has increased by 5% to 10% through interest collection on loans, and 4 grain banks have more than 3 tonnes of grain, which is sufficient to fulfil the requirement of the community. However, 16 banks have less than 20 qtl grain stock, and they require more stock to fulfil the demands of the member households.

501.2 Maharashtra

Mahila Kisan Sashaktikaran Pariyojana

The MKSP in Maharashtra has been focusing on enhancing the skills and knowledge of women farmers to sustain their livelihoods. Currently, the programme has a total membership of 3,265 women farmers, formed into 215 groups (referred to as *samitis* or women farmers' groups) and federated into three block-level federations, spread across 60 villages in the districts of Wardha and Yavatmal. The major focus areas over the reporting period have been the initiation of a credit programme by the federations, promotion of non-farm enterprises by women farmers, and adoption of practices aimed at enhancing household food security and sustainability of agriculture. Further, the cadre of community resource persons trained and deployed were recognized as resource persons by the community and government agencies. The following are the results achieved during the reporting period.

- The credit programme initiated by the federations helped members to strengthen their livelihoods. About 125 members have taken loans from the federations to the tune of Rs. 8.87 lakh. Around 12 members availed loan to set up their enterprises: 6 members bought machineries—pulverizer and noodle maker; 2 set up mini CFCs; 4 availed loan to initiate enterprises that support sustainable agriculture, namely, preparation of *nimark* (extract of neem plant) and vermicompost, setting up a flour mill, and sericulture activity. Majority of the

members, 100 of them, availed loans to purchase agricultural inputs.

- All three federations along with groups have facilitated the convergence of different government schemes to the tune of Rs. 1.5 crore.
- Some visible evidences were observed with regard to empowerment of women farmer in the villages:
 - Ralegaon cluster federation submitted a memorandum to State Transport Department and to the Tahsildar, Ralegaon, in coordination with Adivasi Jan Sangram Sanghatana to provide bus connectivity to Vihirgaon and Zargad villages. This memorandum was considered and accepted for further action by the State Transport Department.
 - Group members from 27 villages actively participated in prevention of liquor brewing in the villages with the support of the Police Department.
 - Group members from 15 villages actively participated in Mahila Gram Sabhas and raised issues related to employment under MGNREGS, provision for Gharkul scheme (construction of house), installation of dustbins, construction of toilets and soak pits, and supply of seeds for kitchen garden.
 - Issue of irregular water supply in Ajgoan village was resolved by the village panchayat following the constant pressure exerted by group members.

- A special camp to apply for Aadhar card was organized in village Zargad on the request of group members; 20 group members and other villagers benefited.
- Indira Meshram, president, Ralegaon Federation, has been selected as a member in a district-level advisory committee of Agricultural Technology Management Agency (ATMA). She actively participated in meetings and raised relevant issues in her capacity as president of the federation. She also resolved the issue of land title for plots allotted by the government for the poor in the village.
- Group members actively participated in Gram Sabhas and facilitated various government schemes to the villages through their effective interaction and negotiation with government officials. The results achieved during the reporting period are as follows:
 - 93 toilets were constructed in 12 villages;
 - In 12 villages, Gram Sabhas passed resolutions for installation of meter on drinking water taps and succeeded in installing it in 1 village;
 - 34 wells were dug and became operational in 16 villages;
 - 23 houses were constructed in 12 villages under Gharkul scheme;
 - 4 villages received seeds for kitchen garden under 10% fund of panchayat income.
- Building the capacities of women farmers on enhancing their household food security and promotion of sustainable agriculture practices have been major focus areas of the programme. The major achievements in this regard pertaining to the reporting period are the following
 - Of the 2,080 women farmers who have done soil testing, 1,706 farmers adopted soil test based nutrient application in their fields;
 - 87 women farmers have erected farm bunds covering 268 acres of land to arrest soil erosion and improve soil moisture in their field;
 - 1,781 women farmers adopted the practice of sowing across the slope to prevent soil erosion and water runoff;
 - 2,329 women farmers adopted the practice of opening ridges and furrows in their fields that helped to drain out excess water from the fields and also improve soil moisture;
 - 1,870 women farmers adopted a mixed crop system that helped to enhance household food security and also improve the soil fertility;
 - 1,700 women farmers adopted integrated nutrient management and integrated pest management through application of various bio-inputs;
 - 259 women farmers of 41 villages joined together to purchase 4.08 qtl. of seed (newly released variety of pigeon pea PKV-TARA) in kharif 2015;

- 123 group members of 42 groups from 15 villages collectively sold 585 quintals of pigeon pea in the market yard for Rs. 49,26, 200. This was facilitated by the respective federations. This collective sale enabled them to minimize the transport cost and resulted in substantial gain to each women farmer involved in collective sales;
- 89 women farmers from 10 villages of Wardha block adopted high-density plantation system for the cultivation of non-Bt cotton with the support of CICR and College of Agriculture, PIPRI, Wardha;
- 4 videos were produced on good agricultural practices adopted by the farmers this year, and 791 dissemination sessions were organized by women farmers for the available videos;
- 8 community kitchen gardens are functional in 8 villages. The vegetables produced were shared by the community and also used for the mid-day meal in the village schools;
- Kitchen gardens have been promoted in 21 government schools in 21 villages and are nurtured by the students. The vegetables and fruits are used in the mid-day meal prepared for the children;
- 1,873 group members out of 3,265 (about 57 per cent) have kitchen gardens that ensured access to fresh vegetables and fruits; 63% of the poorest of the poor households (124 out of 196) also have kitchen garden on their homestead land;
- planting material of vitamin A rich orange flesh sweet potato was distributed for cultivation in kitchen gardens among 35 women farmers and 6 community kitchen gardens of 20 villages. A total of 110 kg of sweet potato was harvested and consumed by members;
- VHNSCs were inactive in many villages. With the facilitation of Community Hunger Fighters, new committees were formed in Takli, Sonegaon (Bai), Dhamngaon, and Wathoda villages through Gram Sabha resolutions;
- 725 group members and 2,315 family members were covered under health insurance of Mahatma Gandhi Institute of Medical Sciences, Sewagram;
- 18 group members from 3 villages got ration cards after long follow up by group members;
- In collaboration with Primary Health Centre (PHC), 13 blood test camps, 5 health camps, and 2 eye camps were organized covering 480, 113, and 122 group members, respectively, and 7 members were referred for cataract operation.

Soil and Water Conservation Activity

A substantial part of the Vidarbha region is covered by light black soil, which has low organic carbon content. The other dominant physical limiting factor of the soils of the region

are its poor texture, low water holding capacity, and high erodability.

A CSR initiative, with funding support from India Medtronic Private Limited, enabled erection of farm bunds (peripheral bunds) in farmers' fields in Bhidi village of Taluk Deoli, district Wardha. Bunds serve as fences and reduce soil erosion from water and wind in low rainfall areas. The water runoff can be trapped by these "walls" and therefore the moisture content of the soil improves leading to increased crop yields. Farm bunds avoid inundation of water runoff from neighboring fields. The two major activities undertaken were the following:

- Farm bunds were erected on contiguous field of more than 400 acres covering 107 farmers. These measured 47,127.16 m; waterways measuring 5,142.32 m were covered with a total number of 164 stone outlets.
- 145 women farmers received various combinations of biofertilizers (*Rhizobium*, *Azotobacter*, Phosphate Solubilizing Bacteria, and biofungicide as *Trichoderma virideae*) to cultivate cotton in 300 acres and soyabean in 80 acres.

A mini CFC was also set up in Bhidi village with 67 sprinkler pipes in November 2015 as part of CSR initiative. This CFC was inaugurated by the district superintendent agricultural officer. Around 25 members have hired pipes to irrigate their field, which enabled an earning of Rs. 9,570 for the CFC between November 2015 and March 2016. An 11-member steering committee was formed to manage the CFC.

An Initiative to Address Zero Hunger Challenges

A project to address the Zero Hunger Challenges was initiated in December 2015, with funding support from H. T. Parekh Foundation, Mumbai. The major objective of the project is to address food, nutrition, and health challenges with specific reference to the first two components of UN zero hunger framework, namely, zero stunted children less than 2 years and 100 percent access to adequate food all year round. This is an action-education project based on the premise that behavioural changes of pregnant women and young mothers combined with appropriate interventions and effective utilization of government entitlements/schemes would have enormous scope in addressing maternal and child nutrition challenges. This project is being implemented in 13 villages of Wardha district covering 397 target households with pregnant women and children in the age group of 0 to 2 years. A series of training sessions were undertaken during the reporting period in the areas of nutrition knowledge and health and hygiene practices. Facilitation for government entitlements and promotion of kitchen gardens were undertaken. A total of 13 CRPs have been trained on various issues of food, nutrition, and health using seven training modules.

Sub Programme Area 502

Research

A study was undertaken on the role of Public Distribution System (PDS) in providing food

security to households in the state of Tamil Nadu given the backdrop that household food security is a complex phenomenon and is determined by a number of socioeconomic variables specific to a household. Furthermore, the food security status of a household is not merely a ‘technical’ matter of food production but one that gets determined by the socioeconomic location of households is a view that was explored. The thesis relied on primary and secondary sources of data. The focus of the secondary data analysis was to understand the macro scenario with respect to PDS use across different sections of the population in Tamil Nadu and in the whole of India during 2004–05 and 2011–12. The analysis revealed that the reach of PDS, measured in terms of number of households accessing the service as well as the quantity of major cereals accessed, is far higher in the rural and urban areas of Tamil Nadu compared with the country as a whole. The reach of PDS in every monthly per capita consumption

expenditure (MPCE) class is much higher in Tamil Nadu than in the rest of India with respect to the major cereals, rice, and wheat. Further, over the period 2004–05 to 2011–12, the share of PDS cereals to total cereal consumption recorded an increase in Tamil Nadu and in India indicating the increasing importance of PDS in the overall food economy of a household. In the primary survey, the attempt was to understand the role played by PDS in the household food security, across different socioeconomic groups in the selected village and slum. A set of indicators that have a bearing on the food security status were used to derive a composite index of household food security, and this index was then used to classify the households in the village and slum as low food insecure, moderately food insecure, and severely food insecure. The thesis explores the factors underlying the variations in access to PDS between the three broad socioeconomic categories and suggests areas for improvement.

INFORMATION, EDUCATION AND COMMUNICATION

The Information, Education, and Communication (IEC) programme serves as a platform to address the changing knowledge needs of the rural community. It has connected even the last person with locale-specific and demand-driven scientific information and knowledge through multiple technology pathways. The IEC programme has initiated the implementation of an online learning module for public library professionals in association with International Network of Emerging Library Innovators (INELI), a global library leadership capacity building programme. Furthermore, 21 Village Knowledge Centres (VKCs) in Tamil Nadu were integrated with the Common Service Centers of the Department of Electronic and Information Technology, Government of India. The IEC programme has reached 130,486 rural people (21% of them being women) through various Information and Communication Technology (ICT) action platforms. The plant clinics developed to provide real-time advisories about the pests and diseases of multiple crops in Tamil Nadu and Maharashtra have been very popular among farmers. The existing Fisher Friend Mobile Application has emerged as a scalable model to be promoted across other Indian states.

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Sub Programme Area 601

Jamsetji Tata National Virtual Academy for Rural Prosperity

The Jamsetji Tata National Virtual Academy (NVA) for Rural Prosperity programme encompasses National Virtual Academy, VRC and VKC, the Informatics Division and Grameen Gyan Abhiyan (GGA).

601.1 National Virtual Academy

The Academy is involved in two major activities; first, inducting the torch bearers of rural knowledge providers, who have expertise on topics such as agriculture, animal husbandry, fisheries, civil services, digital literacy, and linkage and network services and who, as Fellows of the Academy, have committed socially to help fellow community members improve their lives and livelihoods; and second, capacity building of these Fellows and knowledge workers through the Jamsetji Tata Training School (JTTS).

NVA Fellows

The Academy is in the process of selecting Fellows for its 11th convocation to induct them into the group of 1,800 Fellows (1133, male; 667, female) from 25 states across India and 38 International Fellows (31, male; 7, female) from 12 countries.

601.2 Jamsetji Tata Training School

In August 2015, JTTS started a new capacity-building initiative titled 'International Network

of Emerging Library Innovators India' (INELI India) aimed at strengthening the capacity of 50 public library innovators as knowledge workers. It offers a 20-month online course with eight modules on leadership and innovation using MOODLE platform in two cohorts following a blended adult learning approach involving online instruction coupled with a few face-to-face exchanges to promote interactive learning. A total of 26 library innovators from 18 states in India have been identified through a systemic process for Cohort 1. Six eminent professionals have been identified and inducted as mentors for Cohort 1, and a group of innovators are assigned with each of the mentors for effective learning, other than facilitation by two learning coordinators. An eight-member steering committee has been constituted with the representation of relevant experts for guiding the implementation team to take the objective of the project forward.

The first convention was held in Chennai during February 9–12, 2016, to induct the 26 innovators and to orient them about the course; this also helped in facilitating networking between fellow cohort members and mentors. Two topics in the first module, 'Understanding Self,' have been released for the innovators to learn. They have now completed the first topic in module 1 and advanced to the second topic on 'time management', and the outcome has been promising. Thus far, they have accessed the two topics in the online module a total of 12,924 times and created 531 forum discussions regarding them.

601.3 Village Resource Centres and Village Knowledge Centres

The hub-and-spokes model and VKCs have reinvigorated their information dissemination, knowledge enhancement and skill-building activities in the rural communities in 36 districts of Tamil Nadu, Puducherry, Kerala, Andhra Pradesh, Odisha, Telangana and Maharashtra using various Information and Communication Technologies (ICTs). The primary objective of providing real-time information and enhancing knowledge following the land–land, land–lab, lab–land and lab–lab approaches is to facilitate two-way communication and thereby enable rural community to get scientific and pragmatic solutions to address issues and problems related to their lives and livelihood.

In order to address the changing knowledge requirements of the rural community, needs based farmer friend and fisher friend programmes have been instituted along with health- and education-focused interventions. The ICT action platform chosen to channel the ICT-based information and knowledge services is through text and voice SMSs, phone-in programmes, audio and video conferences, webinars, helplines, mobile-based applications, WhatsApp, Facebook, public address systems and knowledge management systems.

As given in Table 6.1, in all, a total of 1,30,486 people from 1,757 villages of 36 districts of the 7 states mentioned earlier have accessed knowledge services in various programmes through 10 VRCs supporting 58 VKCs and 10 VKGs.

Table 6.1 *Reach of knowledge services*

Themes	Male	Female	Total
Agriculture	40,485	20,572	61,057
Fisheries	57,191	1,682	58,873
Animal husbandry	674	493	1,167
Health and education	2,805	3,223	6,028
Government schemes	1,431	884	2,315
General	688	358	1,046
Grand Total	1,03,274	27,212	1,30,486

Sustainability of Village Knowledge Centres

The CSC has been integrated with 21 VKCs by providing appropriate training to the knowledge workers. They are the access points for delivery of various e-governance services to the village community thereby contributing to a digitally and financially inclusive society. Currently, the 21 VKCs are providing CSC services such as the National Digital Literacy Mission (NDLM) course (computer course), passport services, PAN card services, Election Commission of India services, Aadhaar card services, insurance premium collection, data card and DTH recharge. So far, 400 students have enrolled for the NDLM course in these centres.

601.4 Farmer Friend Programme

Farmers express their critical issues in agriculture due to changing climatic factors compounded with stress for water and soil nutrition in the states where VRCs are located. The variations in temperature and humidity and lack of soil moisture have caused a drought-like situation in the Vidarbha region of Maharashtra, while Tamil Nadu scored better with good soil moisture due to copious

rainfall 2015. Farmers seek timely information on the appropriate cropping pattern, seed varieties and soil nutrition management for getting maximum yield. Livestock care and management has also been a major priority due to better returns at shorter intervals compared with agriculture.

The Farmer Friend Programme was facilitated to address the changing knowledge needs of the farming community in the states of Tamil Nadu, Puducherry, Maharashtra, Andhra Pradesh, Telangana and Odisha. The major crops covered were paddy, pulses, vegetables, oilseeds, cotton, soybean, citrus and flower crops in addition to coconut and banana, and the major features of the programme involved providing advisories and knowledge enhancement on topics starting from land preparation to post harvesting. The ICT-based interventions rendered knowledge services on climate literacy, soil health management, seed treatment, integrated nutrition management, integrated pest management, cultivation practices, harvest and post-harvest technology and market linkages.

Apart from agro advisories through voice messages and helpline services, knowledge-based interactions with experts on specific

topics in agriculture have been organized through other channels of ICT such as audio and video conferencing and phone-in programmes as mentioned in Table 6.2. Table 6.3 shows participation of farmers in various capacity-building programmes. These programmes helped the farmers to deepen their understanding of the subject of farming by rendering technical solutions to issues and challenges that they face on a day-to-day basis. In this series, the e-plant clinic is one of the major interventions to have impacted most of the farmers optimistically, while soil testing laboratories extended adequate support to know the soil conditions and nutritional requirements for the ensuing crop.

Table 6.2 *ICT-based interventions in agriculture*

Programme	Male	Female	Total
Audio advisories	7,279	3,929	11,208
Helpline services	4,008	1,524	5,532
Audio conference	3,395	1,628	5,023
Phone-in programmes	2,652	1,024	3,676
Video conferences	1,263	747	2,010
Grand Total	18,597	8,852	27,449

Table 6.3 *Capacity-building interventions in agriculture*

Programme	Male	Female	Total
Soil testing and fertilizer management	1,651	310	1,961
Seed treatment and irrigation	947	301	1,248
Pest and disease management	5,478	1,943	7,421
Value addition and storage	2,510	1,552	4,062
Best-fit technology helpline and insurance	7,173	3,015	10,188
Grand Total	17,759	7,121	24,880

Plant Clinic Programme

The concept of plant clinic and later e-plant clinic piloted by MSSRF in collaboration with CABI for promoting plant health witnessed intense participation, wide acceptance and appreciation by farmers due to its nature of (a) diagnosing the problem, (b) unveiling the invisible pest and disease in the crop using microscopes via tablets and laptops, (c) prescribing pragmatic and instant recommendations through SMSs and in person to address it. The electronic factsheets uploaded in the Android platform led to an increase in the availability of contents to the plant doctors for immediate reference while conducting plant clinic sessions.

These plant clinics brought about radical advancement in knowledge and significant motivation among farmers to approach plant doctors for appropriate diagnosis and recommendation, to distinguish between harmful and beneficial insects, to become aware of the ill-effects of blanket recommendation approaches, to differentiate between the pest and the disease and its damage in different stages and to ensure that they purchase only what is recommended in the clinic sessions. This programme has helped farmers to overcome disease and pest problems, thereby ensuring food safety and improving crop management for better yield and thus better income.

Farm School

The farm school at Nuaguda in Odisha has conducted three farm-based training programmes and four exposure visits to

various institutions. Farm schools have also organized programmes such as tamarind processing, preparation of value-added rice products and so on. Each family earned Rs. 62,500 that year from vegetables, pulses, mushroom cultivation and tamarind value addition. The farm school at Pasupathikoil village in Papanasam block of Thanjavur district has organized 12 training programmes on pest and disease management in paddy, black gram and gingili in which 240 farmers have participated. The school has been visited by 135 farmers for agriculture-related discussions.

Animal Husbandry

VRCs have played a vital role in extending interventions related to animal husbandry as it has contributed to the economy of the farming families. Veterinary doctors are contacted for knowledge on topics such as vaccination schedules, artificial insemination (methods and precautions), fodder production, nutrition and feeds, breeds, diseases management and clean milk production in Tamil Nadu, Maharashtra, Andhra Pradesh, Telangana and Odisha. When there was an outbreak of foot-and-mouth disease in Tamil Nadu, VRCs established timely linkage with local veterinary hospitals to conduct vaccination camps in which 1,900 cattle were vaccinated; this reduced risk and saved capital investment as narrated in the outcome.

Output

- In total, 16,740 farmers, including 5,453 women from 166 villages in 13 districts of 5 states, have accessed season and

crop based advisories through audio and helplines.

- A total of 19 plant clinics have been established in Tamil Nadu, Puducherry and Maharashtra, and thus 284 plant clinic sessions have been conducted. Moreover, 4,472 farmers, including 601 women farmers, have accessed plant clinics from 85 villages; 4,003 crop samples brought by farmers were analyzed, and they were provided with appropriate recommendation.
- There have been 26 soil testing awareness programmes, and 761 soil samples have been tested; soil health cards have been distributed to 708 farmers (men, 615; women, 93) in 114 villages in 2 states.
- Irrigation water testing has been conducted for 74 farmers in Tamil Nadu where it was observed that the chemistry of water was changing the chemistry of soils thus affecting crop growth. Farmers have been advised appropriately for treatment with gypsum or by draining excess water.
- A case study documented with the participants showed that 83% of the farmers followed the recommendations; of these farmers, 67% stated that they had realized an increase in income of between Rs. 8,000 and Rs. 10,000 per acre.
- A farmer who precisely followed the fertilizer advisory and crop management practices and whose soil samples have been continuously tested for 3 years got 500 kg additional of paddy) per acre.
- Minor millets have been cultivated in 26 ha by 223 small holding farmers for the first time in the Trichy region.
- Of the farmers, 80% have turned/switched to System of Rice Intensification (SRI) and Alternate Wet and Dry (AWD) in Andhra Pradesh and Telangana states.
- A total of 102 farmers who participated in various programmes gained an additional income of Rs. 11.85 lakhs in Tamil Nadu, Andhra Pradesh and Telangana states.

Outcome

- About 30% of the farmers who visited plant clinics are now opting for bio-inputs, reduced use of red-labeled chemicals and increased use of green and yellow chemicals; they now negotiate with agro dealers to get the recommended solution and save economic losses on their crops.
- A total of 4,472 farmers, including 601 women, received timely and suitable recommendations for their problems and thus saved 30% of the crop yield thereby preventing economic loss.
- Eight training programmes on the care and disease management of livestock have been conducted. These programmes were exclusively for women involved in poultry farming in Puducherry—205 women from 8 villages participated—and as a result 200 women have purchased birds as a micro-enterprise activity.
- *Peste des Petits Ruminants* (PPR) disease vaccination was done for 1,200 goats and sheep, which helped save nearly Rs. 1.5 lakhs worth of goat and sheep in Kalinkippatti village of Pudukkottai district.

601.5 Fisher Friend Programme

The Fisher Friend Programme (FFP) offers a combination of services crucial for fisherfolk to take informed decisions and thereby reduce risks and lead to economic enhancement in their occupation in the entire coastal districts of Tamil Nadu and Andhra Pradesh and selective districts of Puducherry, Kerala and Odisha. The nature of the profession demands information well in advance to make accurate decisions, due to the paucity of connectivity for two-way communication beyond 20 nautical miles in the ocean. Other compelling needs, such as the changing climate and the depleting nature of marine resources, necessitate knowledge services on sustainable fishing. Irrespective of variations in the uptake of technology across the coastal states, issues such as poor or lack of timely communication on early warning information, potential fishing zone information, market price, government schemes and knowledge on sustainable fishing techniques remains the same.

Against this backdrop, the FFP promotes awareness creation on the use of scientific information and knowledge, timely dissemination of scientific inputs, and capacity development on sustainable fishing, marine biodiversity conservation, safety measures, global positioning system and hygienic handling of fishes through multiple technologies including mobile application. In order to provide locale-specific scientific information services, the entire coastal states have been divided into seven clusters due to variations found in the ecology and environmental conditions.

Capacity Development

This has been done using multiple strategies including (a) knowledge dissemination through voice messages, helplines, public address systems and social media such as WhatsApp; (b) awareness creation through village- and district-level meetings, exhibitions in the *melas* (fairs) and science forums, umbrella stalls in the landing centre; and (c) knowledge and skill building on sustainable fishing practices through ICT-enabled interventions and on-site training.

Fisher Friend Mobile Application

Fisher Friend Mobile Application (FFMA) is a decision support system for fisherfolk; it has been refined consistently over a period of time after factoring in the requirements of fisherfolk and the dynamic nature of technology development. Since the new version of FFMA gained overwhelming reception from multiple stakeholders, it was decided that a multilingual scalable model of the app would be developed as a pan-India app for making it popular across the nation. In this series, Malayalam and Odia versions have been developed and launched for pilot testing in Kerala and Odisha, respectively. Similarly, the integration of the existing Tamil, Telugu and English versions into the scalable FFMA has been done and is under piloting. The development of FFMA in other languages such as Bengali, Marathi, Kannada, Gujarati and Hindi is under progress.

Policy-level discussions with Indian National Centre for Ocean Information Services (INCOIS) has been done to auto port the

scientific information into the application for sustained flow of information and wider reach, which has turned out to be positive and progressive. Policy advocacy with state-level officials in Andhra Pradesh, Tamil Nadu, Puducherry, Kerala and Odisha have been done for scaling up of FFMA.

Seasonal Fish Catch Calendar

A participatory research study was undertaken to capture the species-specific fish catches across different seasons to compare and contrast with the species-specific forecast of INCOIS and thereby enable their research in strengthening their advisory services. Seasonal variations of fish catches including species, wind pattern, wind direction and availability of juveniles were documented in the states of Odisha and Kerala covering 12 and 19 marine fishing villages, respectively, and is ready for publication. A total number of 135 and 297 small, marginal fisherfolk participated in the exercise.

All these interventions have positively impacted the fisherfolk, and the results are stated as follows:

Output

- On a daily basis, 42,757 fisherfolk from 322 villages of 26 districts from 5 states received potential fishing zone (PFZ), ocean state forecast (OSF) and sustainable fisheries-related information through voice messages.
- A total of 15,777 fisherfolk (men, 14,900; women, 877) from 149 villages across 5 states were made aware of the FFP and

its scientific information and knowledge services.

- Piloted FFMA in 3 states during October 2013–January 2015 with 1,500 fisherfolk across 10 districts, which has now grown to 9,343 fisherfolk across 27 districts in 5 states.
- A total of 4,63,659 screen views of fisherfolk have been recorded in FFMA exclusively on PFZ, OSF and weather information across 27 districts in 5 states.
- Launched full-fledged 24X7 helpline services for the Odisha coast.
- Trained 5,448 fisherfolk (men, 4,623; women, 825) on sustainable fishing practices and marine biodiversity conservation; 2,060 fisherfolk (men, 1,550; women, 510) on on-board hygienic handling of tuna fishes and other fish species caught in the PFZ zones; 635 fisherfolk from 26 villages in 5 states on GPS for effective navigation to the PFZ and TUNA forecast zones; and 24 fisherfolk from Puducherry district on sea safety measures and first aid tips.
- Promoted 92 master trainers from 22 districts of 5 states to disseminate the information among their peers, which has enhanced the existing list to 477 in 22 districts of 5 states.
- Developed a comprehensive tool kit in Odia and Malayalam explaining various scientific information services of INCOIS.
- A total of 17,590 fisherfolk have accessed the multilingual 24/7 helpline, of which

2,921 approached the helpline during night hours and 14,595 during the daytime.

Outcome

A total number of 65 fisherfolk and 12 PFZ advisories were selected as samples for a study; of these, 38 mechanized boats and 27 motorized boats responded. Here are some of the outcome-level results:

- Of the respondents, 80% expressed that PFZ helped them make informed decisions on the quantity of diesel/ice to be taken for fishing, duration of fishing days and fishing methods.
- Fisherfolk using mechanized methods reported that their fishing days had reduced in half from 8–10 days with an increase in fishing trips, while motorized fisherfolk reduced the time from 48 hours to 24 hours.
- Of the respondents, 60% said that due to PFZ information, the laborers got an increased income.
- Tuna forecast services enabled 75 fisherfolk from 5 villages in 3 districts to change their fishing practices from bottom trawling to gillnetting leading to sustainable fishing.
- Seven fisherfolk have been rescued from life-threatening maritime distress through 24/7 helplines in Tamil Nadu and Puducherry.

601.6 Health and Education Interventions

VCKs fulfill the health and educational needs of the community, especially women and adolescent girls, as it emerges from the regular needs assessments with the community.

During the year, 6,028 people have participated in various health programmes that included awareness camps, tele-education, phone-in and video and audio-conference programmes, in which women outnumbered men by 3,223. The topics varied from nutrition and balanced diet, heart care, diabetes and blood pressure to the importance of exercises and orthopedics. Specialist doctors from Apollo Hospital, Chennai, addressed the rural people on these topics with the general education highlighting causes, problems, symptoms and preventive and control measures.

In the education sector, 190 youth, including 80 girls, participated in the basic computer literacy, computer hardware, spoken English and abacus courses and career guidance programmes. The career guidance programme was targeted at students who had passed their tenth and twelfth standards. The face-to-face interaction space is created between the experts and the students immediately after the announcements of the results.

Sub Programme Area 602

Informatics Division

The Informatics Division provides technology options and solutions to the VRC–VKC programme for diversifying the information and knowledge dissemination channel to the rural community based on the context of the dynamic nature of technology development. Here are the key interventions and results:

An exclusive Moodle platform has been created for effective online learning under the International Network of Emerging Library

Innovators (INELI) India project integrating user tracking systems for monitoring. The platform has features such as discussion forums, postings, exercises, quizzes and surveys for each topic to improve reading and understanding efficiency and also to assess the learning curve of the Library Innovators. A new website for INELI India has been prepared; this contains details of the project, partners and the material on selection procedures and is linked to the MSSRF website (www.mssrf.org).

Fisher Friend Mobile Application: The Malayalam and Odia versions were developed in the new structure and released in Kerala and Odisha. The Google analytics was also developed for tracking the access and progress of the scaling-up process in the five states. The Tamil and Telugu versions have also been brought to the new system to ensure an integrated single application and to work on Android phones 5.0 and above.

Pulses Ultimate Link of Solution Exchange (PULSE) Application: This is an Android application being developed exclusively for Pulses in regional languages; it will have features such as weather-based crop advisory, soil watch, diseases and pest management, market prices, seed and sowing, water and irrigation requirements. The application will also have real-time advisory based on the picture of the affected crop and field descriptions.

Soil Watch: This is a web-application for accessing results of soil sample testing and related crop management advisories for crops such as groundnut, paddy and vegetables and is now in the piloting stage.

Fifteen years old *Community News Paper* in Tamil in the print form has been brought into digital form. An Android based m-CNP (mobile) has been launched; this has district-wise contents on crops, animal husbandry, fisheries, job opportunities, health and education apart from general season-based information.

A web-based *Library management system* has been prepared exclusively for accessing MSSRF publications, which has been linked to the MSSRF website for public access.

Rural Knowledge Movement (Grameen Gyan Abhiyan)

The GGA has been facilitated to integrate CSCs in 21 VKCs in Tamil Nadu providing all government services to the rural community. The state-level discussions and clear understanding of the services and the knowledge connectivity programme of MSSRF were worked out to ensure that they complement the objectives of NVA.

Sub Programme Area 603

Youth in Development

In order to attract and retain youth in agriculture, a few programmes have been organized. These are as follows:

- The 7th Youth Science Congress (January 2016) working on the theme “Food Security and the Zero Hunger Challenge” at KIIT University, Bhubaneswar, in which a total of 724 students (men, 380; women, 344) and 112 delegates from 26 states across

India participated. This congress marked the publication of a compendium of abstracts from invited speakers representing academia, research institutions and NGOs.

- Two district-level workshops for rural youth in agriculture in Thanjavur and Trichy districts, Tamil Nadu, were organized; a total of 376 rural youth (men, 276; women, 100) participated.

Sub Programme Area 604

Every Child A Scientist

The Every Child A Scientist (ECAS) programme is a unique initiative from MSSRF for economically underprivileged students of Chennai schools (presently from Zone X, XI and XIII) with the broad objective of creating a scientific temper among children in the age group of 13–15; each batch of 15 students runs for two weeks from each school with prior permission from the Education Officer of Chennai Corporation; it follows a combination of methods such as lectures, related documents, films and project works.

The major objective of this programme is to create awareness on science, nutrition, health and hygiene, environment, biodiversity and bio-resources. The ECAS centre is well equipped with scientific equipments, which can promote the interest of students towards basic science along with computers and multimedia learning materials, and uses ICT in education. During the academic year, about 245 students (boys, 119; girls, 126) benefited from this programme.

Touch and Smell Garden

This garden helps visually challenged individuals to experience the joy of nature and learn by exploration through the senses of touch and smell. In this academic year, with the help of Scope International Pvt. Ltd, more than 200 visually challenged students from Little Flower Convent School for Blind & Deaf, Nungambakkam, visited the Touch and Smell garden. Apart from this, more than 2,000 students from 15 academic institutions and nearly 150 volunteers from Scope International visited the garden.

Sub Programme Area 605

The Hindu Media Resource Centre, MSSRF

The Hindu Media Resource Centre (THMRC) serves as a link for society with media and other approaches to enable knowledge sharing and discourse on scientific issues. Set up in 1998 through an endowment from *The Hindu* group of publications, THMRC aims to:

- maintain resources on science and sustainable development for media and society;
- engage in media outreach to facilitate reporting across various formats and regions;
- develop capacities of media and stakeholders for communicating on development;

- advocate with public, key policymakers and stakeholders in development; and
- facilitate discussion platforms for scientific and development concerns.

Resources for Media and Society

The MSSRF website is updated regularly with news, information on latest events at the Foundation and social media updates as well as articles, publications, videos and photographs to provide a resource of reading material and media for internal and external stakeholders.

- The Foundation website (www.mssrf.org), which serves as an important contact point, had an average reach of 20,000 page views each month during the year.
- The Foundation publications were migrated to an e-library, “MSSRF digital repository,” with keywords and author names indexed for browsing through it.
- The home page, latest news and events, MSSRF in the news, and social media updates (Facebook and Twitter) are integrated through the website on a daily basis, with an average of four to five updates per day, making it more vibrant and dynamic.
- During every month of this year, MSSRF’s social media engagement on Twitter reached an average of 15,000 reads and on special occasions, it doubled.
- The Foundation reaches out to over 20,000 people every month through Facebook with regular posts, campaigns and event updates. During the annual conference, the reach was over 100,000 reads.

- Professor M. S. Swaminathan, who started using Twitter in March 2015, has been consistently engaging on this platform with an average readership of over 200,000 every month for his messages, with over 8,000 regular followers.

- E-newsletter for mailing list of internal and external stakeholders, including media persons, scientific, academic and student community, reaches over 1,000 contacts. Sixteen e-newsletters were sent out during the year, in addition to special issues and event invitations. The MSSRF print newsletter, “*Synergy*,” edited by THMRC, initiated during the previous year, was continued during the year with three new issues being brought out.

- In addition to news clippings, social media updates and publications, over 208 event and content updates were posted on the website during the year.

Media Outreach

THMRC reaches out to journalists on a regular basis through press releases, story ideas and event-related invitations. Media persons also reach out to the centre for quotes, story inputs or for discussing development stories.

- MSSRF impacted over 670 news stories through 2015–16, an average of over 55 news stories each month in mainstream English and language newspapers and web editions.
- During the year, 24 press releases were issued to media in connection with events, updates and statements from the Foundation.

- Interviews and media coverage were facilitated for various national and international media organizations and journalists contacted the centre on their own. Between July 2015 and March 2016, there were 75 requests received from media persons for interviews, stories and quotes.

Capacity Building

Four capacity-building workshops for media persons to facilitate greater understanding of issues related to reporting on climate change with a local perspective were held during the year at Kolli Hills, Chennai, Trichy and Hyderabad. Over 100 journalists from across the country participated in these workshops resulting in regional and national capacity building as well as footprint of stories related to work on climate change and local action. Two workshops were held in partnership with the Forum of Environmental Journalists in India and two in partnership with the Clima Adapt programme.

Publications Committee

The Publications Committee was set up during 2015 to facilitate screening of publications emerging from the Foundation's work and individual staff member's contribution, research, documentation, print material and others, with Head HMRC (Chair) and Head Admin. A total of 27 publications were submitted to the committee for review during 2015–16 and were recommended for publication.

Sub Programme Area 606

Library and Information Services

The library at the Foundation plays an important role in facilitating access to information resources for academic and research purposes. It has 18,481 books of which 210 were newly included during this year. In addition it also holds 556 CDs, 140 journals, 111 newspapers clippings for the year 2015–16 and 4,424 bound journals. Adding more current and important scientific and technical books further enriched the existing collection. Besides, the library has a precious collection of technical reports, and annual reports from various institutions. It also provides digests of information downloaded from the Internet, and an alert service tailored to suit to the needs of individual researchers in MSSRF.

The library services, such as Current Awareness Services (CAS), Selective Dissemination of Information (SDI), Article Alert Services (AAS), Document Delivery Services, Publication and Distribution Services, Reprographic Services and News Letter Alert Services, are given to the end users.

The library provides assistance through CABI Abstracts to the research students working in the areas of biotechnology, agricultural sciences and life sciences. During the past year, around 410 students have benefited from various universities located at the national and international levels.

CROSS-CUTTING THEMES

Gender and grass-roots institutions (GRIs) and climate change are cross-cutting themes. The programme works in partnership with other programme areas and interdisciplinary projects in mainstreaming gender in-house. As a first step, gender-specific tasks are built into the roles and responsibilities of all senior staff members, the role of gender is considered during project design and development, and gender-specific and sex-segregated indicators are used to measure the changes at the outcome and impact levels for monitoring and evaluation of the proposals. During the reporting year, how gender and socioeconomic issues were shaping the adoption of technologies among small holders was studied in the interventions implemented by the Biotechnology and Ecotechnology programmes. As a part of gender research, a study was conducted to build the evidence base for improving the effectiveness of energy interventions by quantifying the factors that are impacting use of energy by women. The grass-roots programme is working with 16 GRIs functioning across different MSSRF project sites. It facilitates collective action in mainstreaming gender to bring voice and opportunity for women in accessing productive resources. The Climate Change programme focuses on enhancing the adaptive capacity of farmers against the emerging ill effects of climate change through information and training for adopting climate smart technologies. This programme provides climate literacy to the farmers via ICT platforms using webinars, weather-related crop management advisories, adaptation technologies, pest and disease diagnosis and remedial measures, and care and management of livestock.

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Sub Programme Area 701

Gender

701.1 Gender integration and mainstreaming

Efforts have been on to institutionalize the gender mainstreaming process at the organizational level by changes in structures and procedures. Gender-specific tasks are in built into the roles and responsibilities of all the senior staff members' work profile, and structure has been established to critically look at the inclusion of gender in the design and development phase of new proposals. Also gender-specific and sex-segregated indicators were evolved jointly with other programmes to measure the changes at the outcome and impact levels as part of regular monitoring and evaluation. The strategic plan for the programme has been developed for five years (2016–20) with the aim of strengthening gender mainstreaming through (a) interdisciplinary approaches and (b) research and interventions that are pro-poor and pro-women using sustainability mandate through grass-roots institutions (GRIs). The plan was shared with subcommittee members of Board of Trustees (BOT and three main action areas were identified: (i) building capacities, (ii) nurturing interdisciplinary research on science and gender, and (iii) carrying out gender impact studies.

Building capacities

Cultivating the knowledge and skills of the Gender Institutionalization and Mainstreaming

(GIM) group members has been adopted as an important strategy to achieve the twin objectives of strengthening the gender integration at programme/project levels and organizing a network of gender focal points at the organizational level to support and embed the practice of gender mainstreaming. To achieve this, four meetings were organized during the past year. The first was in August 2015 to discuss and learn interdisciplinary approaches adopted by different members with specific reference to gender. Following this, a panel discussion on gender and agricultural productivity was organized in September 2015, in which seven GIM members from different field centres shared their experiences in improving productivity and in addressing gender equity strategies. The discussion clearly indicated that in the changing agrarian structure and economic relations, women's role in family farms is constantly changing. They described the existing gender gap in access to productive resources such as land/livestock, credit, technology, and information and provided a detailed account of how their projects are addressing the challenges in strengthening women's role.

The third workshop was a discussion using photographs shared by the GIM group members on different concepts of gender. The final workshop was organized in January 2016 for GIM and GRI group members. The objectives were: (i) to strengthen the capacity in identifying gender issues, (ii) to document and share how gender issues are being addressed in the interventions and how changes are taking place in women's

and men's livelihoods and lives, and (iii) to review GIM activities and performance in mainstreaming and integrating gender at the programme level.

With regard to documentation, GIM members have been motivated to document the gendered changes in their respective projects in the form of photo stories/case studies/best practices; eight case studies were received and discussed. The discussion helped to evolve a common framework covering (a) key gender issues or gaps identified for intervention, (b) strategies adopted to address the issues, (c) gendered results obtained, and (d) key gender outcomes for women and men. On the second day of the workshop, both GIM and GRI group members jointly met and discussed the strategies adopted and outcomes expected with reference to women's empowerment and gender equality. The team identified and discussed common gender indicators such as role changes, personal empowerment strategies, women's agency, and power relations perceptions at public and private domains. To encourage the documentation of the gendered processes, methods, and results, seven discussions on different kinds of research articles and individual face-to-face discussion and via skype and email were carried out. As an outcome of this activity, eight gender outcome stories and four research articles were documented, of which three outcome stories and two research articles were finalized and shared.

During January 2016, the activities of the GIM group were evaluated by the members on the

aspects of knowledge, their role, and results. It was compiled and shared with the programme directors for further discussion. The major points were allocation of nodal person with defined roles and responsibilities for gender integration in all programmes and structures to ensure gender integration at the different phases in the project.

Gender impact studies

Six main themes were identified across programme areas to study the gendered outcomes and impact after a considerable project period (more than five years) in partnership with the respective programme areas. To start with, a study on the gendered impacts of Fisher Friend Mobile Application (FFMA) was conducted, and the framework for the study was completed with Information Education and Communication programme; more over, steps have been taken to commission the research study.

Gender integration in Clima Adapt Project

The needs-based technical guidance and inputs for gender integration in different work packages with four different organizations have been continued in strengthening the field-level actions and to distil learnings for policy inputs. As part of gender sensitization programmes workshops were organized for Andhra Pradesh and Telangana state government officials in October 2015 in collaboration with WALAMTARI, Hyderabad. Similar programmes were organized for Tamil Nadu officials during November 2015 in partnership with Tamil Nadu Agricultural University (TNAU). Follow-up workshops

on gendered monitoring and evaluation of previous season data were conducted with all team members and sex-segregated data collection was ensured with all partner institutions. This helped them to understand the level of participation of men and women farmers and revisit the strategy for equal or higher proportion in its different interventions. A detailed assessment of alternate livelihoods for women farmers, which is reported as an important climate change adaptation strategy in Ponaniyar basin, was conducted and discussed with the local women's group and banks. Potential enterprises were shortlisted and discussed with TNAU for further inputs. Also a concept note to organize a national-level workshop on gender, climate change, and water management based on field experiences was prepared and a detailed plan was evolved. The climate change and irrigation water related policies of three states as well as overarching central government policy related to climate change was studied and analyzed through agender lens. This was shared with team members to identify potential areas of contribution based on the results and experiences from the project.

701.2 Inter-disciplinary research initiatives

The focus areas for research, action, policy, and impact studies with gender perspectives were discussed in the research subcommittee of BOT, and four major themes were prioritized: (i) Gender and resource rights; (ii) gender, climate change, and natural resources, including biodiversity; (iii) gender, science

and technology, including ICTs; and (iv) gender, sustainability, collective action, and institutions. Efforts have been initiated to mobilize new projects to build around the themes. The progress made under these components is as follows:

Empowerment of Farm Widows and Other Single Women Farmers in Vidarbha Region:

The intervention has three specific objectives: (i) to mobilize and organize single women farmers into collectives (*EkaNariSangh—ENS*), (ii) to raise awareness on access to and control of productive assets and services for better livelihoods, and (iii) to enable the creation of institutional linkages and access to schemes and entitlements. So far 760 single women have been mobilized which is 11% higher than in the previous year; 28 Joint Liability Groups with 419 members have also been formed, of which a large proportion, that is, 55.60%, are engaged in crop cultivation and 52% are engaged in small-scale livestock rearing and work as agricultural labourers.

Access to services and entitlements by members of the ENS improved during the past year in receiving widow pension (17), separate ration card (5), Aadhar card (3), old age pension, (6) and counseling (7), which created confidence among the women. With reference to land access, in continuation of the previous year's training, a detailed capacity-building workshop was organized for 3 days in February 2016 with the support of Working Group for Women and Land Ownership, Gujarat, to the block-level committee members on local specific strategies in securing land

rights. This initiative supported the team and the institution in claiming land and property rights for three women, and four women raised the issues related to land. In the process, ENS has established a linkage with District Legal Services Authority, who can be approached for similar issues, and established a cadre of three para legal workers. In order to ensure the effective utilization of credit for livelihoods, credit linked learning approach is introduced in collaboration with Department of Agriculture and Animal Husbandry under ATMA scheme which provides opportunity to access needs-based technologies.

ENS has also established its linkage and network with civil society organizations working in Maharashtra and is a member in the Mahila Kisan Adhikaar Manch (MAKAAM), a nationwide network of organizations working for the welfare of women farmers. During the past year the members participated in the annual meetings of National Network of Single Women as well as MAKAAM and shared their initiatives to improve their access to productive resources and services for improved livelihood.

Biofertilization and “Bioirrigation” for Sustainable Mixed Cropping of Pigeon Pea and Finger Millet (BIOFI): The gender programme serves as a socioeconomic partner to assess the results of participatory on-farm trials (OFTs) in Kolli Hills to select the best performing biofertilization and intercropping combination and for the promotion of ecoenterprises for decentralized production of bio-inputs. The field experiments were conducted by the biotechnology consortium partners in Kolli Hills during 2014–15.

Consultative meeting was organized with ten men and ten women farmers in June 2015 to understand their perspectives and challenges in adopting mixed cropping systems. The biotech partners MSSRF along with HAFL’s team (Swiss partner in the project) specifically developed the planting pattern and five biofertilizer/fertilizer application treatments to be tested in the OFT with existing farmers practice. Twelve farmers participated in the OFTs from Thirupuli and Gundaninaadu panchayats located at different altitudes. The results clearly showed the benefit of biofertilizer application, both in monocropping and in mixed culture. The women farmers were interested in taking up the finger millet based mixed cropping, but expressed their concerns on the high labour demand to adopt this BIOFI package. The farming system in Kolli Hills is largely family labour dependent, and hence it would be difficult for women to spend more time and energy on these aspects. In the case of men farmers too, they view this package as labour and knowledge intensive, and the yield obtained from both the crops is not sufficient to justify the extra efforts invested in planting methods and inputs use. Men farmers also mentioned that it would increase the women’s labour demand and time spent during the sowing season. Based on this feedback, the research team is involved in further refining the package of technologies involved in BIOFI in the forthcoming season.

In case of ecoenterprises, Kolli Hills Agro Biodiversity Conservers Federation (KABCOFED) is involved in local-level production of biofertilizers to increase the

adoption rate among small farmers by providing access to quality and timely availability of these inputs at affordable cost. The biofertilizer production process was simplified so that it can be handled by tribal women farmers and youth enabling them to earn an additional livelihood and to generated 40 days of additional employment. A business plan was prepared, and two batches of production were completed (2,000 kg) with three different strains suitable for small millets, legumes, and other crops such as coffee, tapioca, and so on, of which 75% has been marketed sofar. Thus the aforementioned strategy helped the women farmers and youth with a new economically viable and ecologically sustainable livelihood option.

Gender factor in political economy of energy sector dynamics

The primary focus of the project is to build the evidence base for improving energy interventions' effectiveness by taking a gender approach. This is a 4-year research programme(2015–18), established by the ENERGIA International Network on Gender and Sustainable Energy, “to generate and analyse empirical evidence on the links between gender, energy and poverty and to translate this evidence into recommendations for energy policy and programmes.” The research is being carried out in India and Nepal, and MSSRF is the lead organization in the consortium and the Centre for Rural Technology is the partner organization in Nepal. This has two important phases: scoping phase in the first year, and main research

phase in the next 3 years. In the first phase, scoping study was conducted in India (Koraput district of Odisha) and Nepal (Kailali district) which was completed in December 2015. This study was based on the premise that it is necessary to include gender concerns in the political economy of energy access. This gendering of political economy combines an analysis of both structural and agential power; this combination should allow for its application to problem-solving in the field of modern energy technologies.

Three major questions were studied: (i) How is formal/informal control exercised on women's use of clean energy in cooking, agriculture, and industries? (ii) What is the response of government agencies in women's access to clean energy as fundamental to well-being? (iii) What is the influence of social/gender norms in households, communities, markets, and state structures of energy-governance?

The empirical investigation was initiated in Phase 2 by adding two case study locations for comparison. The study sites were differentiated by extent of remoteness. This would give some basis for comparison of gender and energy interaction in the context of economies with lesser or greater demands on women's time for production. The case study sites in India are Koraput and Mayurbanj in Odisha, Wayanad in Kerala, and Dindigul in Tamil Nadu. In addition, the empirical investigation in Phase 2 is designed to pay more attention to macro- and meso-level decisions and processes and their interaction with the micro-level in producing gender-sensitive outcomes in energy use. The

questionnaire for the quantitative method to be administered at the micro level and a detailed checklist for the qualitative method to be collected at all three levels, micro, meso, and macro, was developed and field tested in one of the field sites and finalized in consultation with CRT, Nepal.

Climate information to enhance the adaptive risk of men and women farmers

MSSRF is facilitating a farmers’ association, Reddiyarchatram Seed Growers Association, in managing a “B” type weather station in Kannivadi, which has been recording the daily weather parameters since 2003. This station acts as a nodal center to receive scientific medium-range weather (3–5 days in advance) and extended range forecast (15 days to 1 month) from the Indian Meteorological Department (IMD), which is operating at the spatial scale of district and is recognized as Agro Meteorological Field Unit (AMFU). MSSRF is responsible for developing and sharing the locale-level agro advisories for major crops to six districts in the south zone through NGOs, knowledge centres, agricultural departments, and KVKs, and through email, website, short messages and voice mails with due attention to reach women farmers. The Kannivadi AMFU is documenting the gendered traditional knowledge systems and making an attempt to harmonize the two different knowledge systems through interactive discussion with farmers and agricultural laborers. As a part of the Gramin Kissan Mausam Sewa (GKMS) initiative of IMD, three Farmers Awareness Programme on weather-based agriculture in

three different blocks of three districts, to whom agro advisories are provided regularly, were organized in Theni, Dindigul, and Pudukkottai districts between March and April 2016. A total of 174 farmers participated in the programme of which 70% are women farmers. Special efforts were taken to mobilize the women farmers, and the programme used simple language throughout. The weather/climate and crop interaction was discussed in detail with respect to the crops which are cultivated primarily in the region as well as the potential of medium-range weather forecast in agriculture. As part of the programme, a training module on “Role of Medium Range Weather Forecast in Agriculture and technologies related to weather management” was developed in the local language (Tamil), and case studies on how men and women farmers are using the climate information to reduce the risk in crop production was documented to share with other farmers.

Social and ecological rationale of conservation of paddy land and wetlands in Kerala

An interdisciplinary research study on Ecosystem Valuation of Paddy Wetlands is being implemented in Wayanad district, Kerala, since April 2015. The study has its roots in the Kerala Conservation of Paddy Land and Wetland Act (2008). The Act is being implemented with the aim of protecting paddy wetlands in Kerala to improve the ecological services associated with this land use. It is planned to study the factors that explain the differences in the extent of conversion of paddy

lands across panchayats and villages and find out its ecological and socioeconomic rationale. The ecological services being captured in the study are: (i) change in soil organic carbon and (ii) change in population of keystone faunal species along with its implications on gender and other social factors. The outcome of the study is expected to add supportive evidence for/against the state land use legislation as well as payment of ecological incentive for paddy farmers.

Changes are being measure at plot level using ecological indicators. Plot selection is done through a process of stratified purposive sampling, with the first strata being the three agro-climatic zones of Wayanad, namely, (i) drought area, (ii) valley paddy area, and (iii) humid high altitude areas. Wards with equal distribution of the three crops studied, namely, paddy, banana, and arecanut, have been chosen in consultation with local farmers and Agricultural Department of the respective panchayat. About 300 sample plots of minimum 1 acre each have been identified from the selected wards using snowball technique. Survey Schedule and checklists for capturing the plot and farmer's socioeconomic characteristics including questions to understand the changes in the gender and social relations at the household and community levels due to the shift in the paddy cropping system was designed.

Two projects, namely, collective farming and economic empowerment of women farmers through value chain development, which were reported in the past year's report were

completed and final project reports were prepared. The results were analyzed and three draft research articles were prepared.

Sub Programme Area 702

Grass-roots Institutions

MSSRF has been promoting GRIs to institutionalize the development interventions adopting process mode in the institution-building process with due attention to socially and economically disadvantaged groups. During the past year two new GRIs were promoted (Jeypore and Puducherry) and as of now 16 GRIs have been facilitated across programme areas, of which three institutions are focusing on common property resources, three are SHG federations, and the remaining ten are Farmer Producer Organizations (latter two are working with private property resources owned by farmers). Of the sixteen institutions, five are exclusively women managed and the remaining eleven are with mixed membership of men and women. Also, efforts are being taken to promote fishing women's association to strengthen their participation in fish processing and value chain initiatives in Poompuhar. At the organizational level technical support has been extended by close interaction with concerned leaders of the programme and GRI nodal persons in the site. In the past year, activities were focused towards strengthening the sustainability perspective of the GRIs.

The institutional sustainability depends on how the processes and structures of governance

have competence to continue its functions for longer term. Since the different GRI's are in the various stages of development, need based handholding technical support was extended. In case of Women Farmers Federation in Jeypore, Wayanad Tribal Development Centre and Single Women Farmer's Collectives strengthening the groups and its clusters were given focus by developing operational guidelines and implementing in the field. Technical guidance was extended to seven GRI's to follow the legal compliances of auditing and reporting to the registration authorities. Specifically the books of accounts was checked in six GRIs and supported for rectification and correction work and finalized the balance sheets for external auditing. Support was extended to organize effective board meetings adopting all the protocols in six GRIs. Also, technical guidance was give to design the formats for account registers and records for Famer Producers' Organizations (FPOs) and developed two training modules on inculcating good governance and values in the GRI's for the board members. Two capacity building programmes were organized to GRI nodal persons; the first one wason the organizational sustainability and role change process of MSSRF in Oct 2015 and the second one was on documenting the changes and key gendered indicators to measure the changes among men and women producers.

Farm Producer Organizations and collective action

The purpose of the initiative is to study how collective action supports women

farmers in accessing technology, credit, and markets. The main activities are to collectivize small farmers, especially women farmers, for improved technology adoption and better access to inputs and services and to effectively participate in agri-business and value chains to achieve higher productivity and incomes. Currently it is supported by the National Bank for Agriculture and Rural Development (NABARD) for 3 years, and MSSRF is recognized as one of the Producer Organization Promoting Institutions in Tamil Nadu. Under this programme, MSSRF is supporting the formation and nurturing of three FPOs in three different field sites— Kolli Hills, Mailam, and Puducherry—with focus on millets, fruits, and spices in Kolli Hills and pulses and vegetables in Mailam and Puducherry FPOs. Between 2016 and 2018, the project aims to mobilize 1,000 farmers (with more than 75% being women farmers), an optimal size required to sustain business activities. So far, capacity-building programmes have been organized on how to target small holders and women farmers, on the concept of Farm Producer Organizations, on mobilizing the share capital from members and on maintaining books of accounts, on preparation of operation guidelines and management information systems (MIS), on exposure visit, on methods of interaction with the manager of the company, and so on. The formation of a Board of Directors has been facilitated by identifying suitable farmers for the Board as well as for the position of director with defined criteria, and member-level baseline information has been collected. Technical guidance has been given for the registration

process under the Company Act. The Mailam FPO has already been registered and support has been provided to the Pondicherry and Kolli Hills FPOs for registration under Producer Companies Act.

Programme Area 703

Clima Adapt Project

The Clima Adapt project is being implemented in the districts of Tiruchirapalli and Erode in Tamil Nadu, Guntur in Andhra Pradesh, and Nalgonda in Telangana. The project focuses on ensuring water use efficiency in the context of climate change through integrated science stakeholder approach. Gender has been mainstreamed across the project cycle, while eight Village Knowledge Centres (VKCs) in a centric location of the project site cater to the changing knowledge needs of the farming community.

This year, climate literacy through webinars, weather-related crop management advisories,

adaptation technologies, pest and disease diagnosis and remedial measures, and care and management of livestock have been provided to the farmers through ICT action platforms. Improving crop production in view of the changing climatic factors by enhancing water use efficiency has become the paramount focus behind these interventions. Table 7.1 gives a summary of ICT action platform through which the farming community accessed the knowledge services.

The following are the outputs realized from the Clima Adapt project:

- 28,899 farmers, including 20,748 men and 8,151 women, received climate-focused information and knowledge through the VKC action platform
- 261 farmers (87, women; 174, men) have participated in the climate literacy programme conducted through 14 webinars besides knowledge on climate change and adaptation practices, water use efficiency, and seasonal crops among farmers

Table 7.1 *Members who participated in different interventions under the Clima Adapt project*

Name of the Programme	No. of Programmes	No. of Participants		
		Male	Female	Total
Direct users to VKCs	0	8524	3136	11660
Training and awareness on VKC, agriculture and livestock	169	4165	2651	6816
Audio advisory	0	4085	1245	5330
Audio conference	70	1063	406	1469
Phone-in programme	63	689	146	835
Video conference	48	530	276	806
Plant clinic	19	319	109	428
Total	369	19375	7969	27344

- a total of 761 soil samples have been tested by the mobile soil testing lab in Tamil Nadu, which has benefited 682 men and 79 women farmers
- a total of 643 farmers, including 48 women and 595 men, contacted the helpline for addressing their real-time knowledge needs on agriculture
- 855 farmers, including 336 women, got oriented on gender and partook in the gendered needs assessment in the three states

Due to consistent knowledge services, the farmers were able to realize the following results:

- Cultivation of minor millets in 26 ha by 223 small holding farmers for the first time in Trichy region
- 80% of the farmers have adopted System of Rice Intensification (SRI) and Alternate Wet and Dry (AWD) in Andhra Pradesh and Telangana

Sub Programme Area 704

Institutional Initiatives

Social Science Unit

Data Management

During the reporting period, MSSRF's database on community-based interventions, pertaining to September 2013, have been linked to its Knowledge Management Services (KMS). The compilation of this database reveals the extent of coverage of MSSRF's community-

based interventions, in 2013, across 7 states of India, 31 districts in the 7 states, 452 revenue villages, 849 hamlets, and 1.83 lakh persons. Of the total coverage of MSSRF, 14% belonged to Scheduled Castes, 15% to Scheduled Tribes, and 50% were women.

It has been decided that the MSSRF's database shall be updated every year, beginning 2016. Facility has been created for each programme area to update the data on community-based interventions, pertaining to March 2016, and the compilation of data has begun.

Detailed profiles for revenue villages and districts, where MSSRF has a presence, are under preparation. So far, the profiles of 23 districts and 60 revenue villages have been uploaded in the MSSRF database web portal. Common templates for collection of baseline information of households have been developed and uploaded in the MSSRF database web portal for use by new projects, with suitable modifications to cover the project objectives.

Post-Project Evaluation

Alleviating Poverty and Malnutrition in Agrobiodiversity Hotspots

MSSRF has initiated a post-project evaluation of the project Alleviating Poverty and Malnutrition (APM) in agrobiodiversity hotspots, which was implemented during March 2011 and August 2014. The aim of the project was to address food and nutrition insecurity and poverty among the people in three distinct agrobiodiversity hotspots in India: Kolli Hills in Tamil Nadu, Wayanad in Kerala, and Jeypore

in Odisha. The project interventions covered 4,004 households with a total population of 19,835 in the three project sites.

The post-project evaluation of the APM has been undertaken as a learning exercise. This evaluation began in April 2016 and focuses on factors underlying success or failure of various major initiatives undertaken as part of the project. The evaluation assesses the relevance, effectiveness, results, and sustainability of the project:

- Relevance of the project objectives with respect to the needs of the target population
- Effectiveness of the project with respect to the achievements of the proposed objectives

- Impact of the project pertaining to the positive and negative changes, intended or otherwise
- Sustainability of the project seen in terms of continuation of project initiatives during this evaluation

The evaluation relies largely on primary data collection across the three sites, focusing on key interventions undertaken in the project. The primary surveys cover different stakeholders of the project through detailed interviews and focus group discussions using a check list. In addition, interactions with office bearers of groups/panchayats were undertaken. This is supplemented by a detailed review of the reports, documents, and paper publications produced in the project. The post-project evaluation report is under preparation.

SPECIAL PROJECTS

Leveraging Agriculture for Nutrition in South Asia (LANSA) is a multi-country and multi-institutional research programme consortium led by MSSRF; it addresses the disconnect between agriculture and nutrition. Four studies on different aspects of enabling environment of women’s agency, water, sanitation and health and their effects on agriculture–nutrition links in India have been published during the year. Farming System for Nutrition (FSN) interventions were undertaken in Wardha district of Maharashtra and in Koraput district of Odisha in close partnership with the community, taking into account the results of the baseline nutrition status assessment. School nutrition gardens were promoted in the study villages and their produce linked with the midday meal. A stakeholder consultation in Kabul in April was a key research uptake initiative. Research uptake activities, including a regional online consultation and a stakeholder consultation, were held in Kabul, Afghanistan. At the international level, MSSRF is establishing a Rice Bio-Park at the Yezin Agriculture University, Nay Pyi Taw, Myanmar. During this year, the necessary infrastructure for housing the unique rice mill machinery was erected. As a special programme two faculty members from Afghanistan National Agricultural Science and Technology University (ANASTU) visited MSSRF and received training for establishing a genetic garden and prepared detailed plans for the conservation and preservation of Afghanistan’s rich plant genetic resources.

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Sub Programme Area 801

Leveraging Agriculture for Nutrition in South Asia

Leveraging Agriculture for Nutrition in South Asia (LANSA) is a multi-country and multi-institutional research programme consortium led by MSSRF; it addresses the disconnect between agriculture and nutrition. Four research studies on India by MSSRF have been published during the year. Farming System for Nutrition (FSN) interventions were undertaken in Wardha district of Maharashtra and Koraput district of Odisha in close partnership with the community, taking into account the baseline nutrition status assessment. Research uptake activities, including a regional online consultation and a stakeholder consultation in Kabul, Afghanistan, were carried out and the details are provided in the section titled “Research Uptake.”

Research

The three research themes under the project are: 1) Enabling environment for connecting agriculture and nutrition, 2) Agriculture policies and strategies for making agriculture and agri-food value chains pro-nutrition and 3) Pro-nutrition agriculture interventions and their impact

Enabling Environment for connecting agriculture and nutrition: Four studies using state, district, and household level data on different aspects of enabling environment of women’s agency, water, sanitation and health

and their effects on agriculture-nutrition links in India were published during the year. The findings were discussed in a consultation meeting with stakeholders for their feedback. Based on the inputs and suggestions, a policy brief is being developed.

Agriculture policies and strategies for making agriculture and agri-food value chains pronutrition: A study has been initiated in Karnataka and in Andhra Pradesh to assess the feasibility and challenges of introducing millets in the public distribution system (PDS). The government of Karnataka has started procurement for supplying millets under PDS, as provided for in the National Food Security Act. This study, with its focus on Karnataka, will examine all aspects related to millet production, pricing, supply, demand, storage, and consumer preference.

Three case studies were undertaken during the year on agri-food value chains in South Asia. Each case study examines how markets and, by implication, value chains can bring about substantive and sustained consumption of nutrient-dense foods by the poor in households that are post farm-gate with particular focus on children and adolescent girls:

1. Supplementary Nutrition Programme (SNP) under the Integrated Child Development Service (ICDS) as a pro-nutrition food distribution value chain was studied, with a focus on delivery of hot, cooked meals and fortified food at ICDS centres. The study undertook a detailed analysis of the SNP models in operation in Tamil Nadu and Telangana and looked into the innovative

elements in each, the state commitment and the lessons they hold for policy-makers at large.

2. Amul Spray, a product of the Gujarat Cooperative Milk Marketing Federation as an example of pro-nutrition business value chain is an infant milk substitute to be given after the first six months; however it seems to be used more as a milk substitute.

3. Tiger Brand iron fortified biscuits from Britannia Industries as a case of pro-poor targeting of nutrient-enriched product by business. The case study was taken up to analyze the fortification initiative in an agri-food value chain. It was found that two kinds of value chains were operational; high iron fortified biscuits under supervised consumption and low iron fortified biscuits for unsupervised consumption through the commercial value chain.

In the case of the first two studies, besides discussion with officials concerned, a qualitative assessment at the consumer level was also undertaken. In the case of the third, the company informed that the product was undergoing reformulation; the case study was therefore confined to secondary sources of information and interaction with a former key company official besides a current one.

The three case studies from India were discussed along with the case studies from Bangladesh and Pakistan by LANSAs partners BRAC and Collective for Social Science Research, respectively, to understand the common elements of regional relevance emerging from the different case studies. The

study on Amul Spray is being taken up for detailed quantitative impact assessment at the consumer level in India.

Pro-nutrition agriculture interventions and their impact: This research theme focuses on how agricultural interventions in the field can be designed to improve nutritional outcomes. Under this, the FSN study in India is underway in Koraput and Wardha districts. The study is examining the feasibility of a farming systems approach to address nutritional deficiencies in the population identified through nutrition status assessment. Following demonstrations in the previous 2 years, discussions were held with village community members with the findings from the baseline nutrition status assessment in context. Several trials were initiated keeping nutrition sensitivity in focus. This comprised a combination of improved crop varieties of nutritious cereals and pulses and improved package of practices.

Koraput

Subsistence farming has been and still is the main source of livelihood among the indigenous population of Koraput district of Odisha. During the 2 years since the commencement of the FSN study, it was observed that improved agronomic practices and high-yielding nutritious crop varieties that are most suitable for the location have not been adapted due in large part to traditional farming systems, lack of awareness, and poor economic status. In both Kharif and Rabi seasons in the past year, the focus has been on better cultivation practices for improving the yields of nutritious crops in the seven villages under the study.

During Kharif 2015, the performance of high-yielding variety of nutritious finger millet GPU-67 was studied with 15 farmers. The selected land area of 0.5 ha was split into four portions to accommodate four treatments including (i) GPU-67 + line transplanting, (ii) GPU-67 + farmers practices, (iii) farmers' varieties + farmers practices, and (iv) farmers' varieties + line transplanting. The results showed that GPU-67 with line transplanting gave higher grain yield (2,224 kg/ha) followed by GPU-67 with farmers' practices (1,808 kg/ha), compared with the other two treatments. Similarly, with 19 farmers, a study was conducted to promote the production of pulses through intercropping of black gram and pigeon pea with finger millet. The selected land area of 0.9 ha was divided into four parts containing (i) black gram (var. NUL-7) and finger millet (var. *Bhairabi*) intercropped in a ratio 2:6, (ii) farmers' mixed broadcasting of black gram and finger millet, (iii) pigeon pea (var. NTL-724) and finger millet (var. *Bhairabi*) intercropped in a ratio 2:6, and (iv) farmers' mixed broadcasting of pigeon pea and finger millet. Intercropping black gram (seed yield: 75 kg/ha) with finger millet (grain yield: 1,147 kg/ha) and pigeon pea (seed yield: 66 kg/ha) with finger millet (grain yield: 1,125 kg/ha) showed superior performance in comparison to mixed broadcasting of black gram (seed yield: 58 kg/ha) and finger millet (grain yield: 985 kg/ha) and pigeon pea (seed yield: 18 kg/ha) and finger millet (grain yield: 991 kg/ha).

Diversified cropping with high-yielding and nutrient-dense maize (var. NHM-51) intercropped with pigeon pea (var. NTL-724)

in a 1:1 ratio was undertaken with 17 farmers covering an area of 0.6 ha. Harvest results indicate 4,585 kg of tender maize, 341 kg of grains, and 4,128 kg of green fodder along with 349 kg of pigeon pea tender pod and 356 kg of pigeon pea seeds. After harvest, tomato was planted only in three selected farmers' fields on the basis of availability of residual moisture. A total of 625 kg tomato was harvested from the intended land area. Overall, in general, the area under Kharif pulse cultivation increased by 15%, compared to previous years.

The performance of four short duration rice varieties—MTU-1010, *Khandagiri*, *Mandakini*, and *Jyotirmayee*—was studied over 7.3 ha of land and with 40 farmers. Among the short duration varieties tested, MTU-1010 followed by *Mandakini* showed superior yield performance and also outperformed most of the farmers' varieties.

At the field level, 22 farmers cultivated both orange-flesh and white-flesh sweet potato varieties. The average production was 11 t/ha, of which 11% was used for consumption, 5% was shared with communities, and 84% sold in the market. Farmers reported retaining the beta carotene rich orange-flesh sweet potato for their own consumption.

During the Rabi season in 2014–15, the performance of high-yielding variety of nutritious green gram SML-668 was studied with 79 farm families. The total agricultural land area for green gram cultivation was 15 ha with half of the land under high-yielding variety and the other half with traditional farmers' varieties. The results showed that

SML-668 (486 kg/ha) gave 12% superior yield than farmers' traditional varieties (435 kg/ha). Similarly, a trial with 35 farm families covering a total land area of 3 ha to study cultivation of high-yielding black gram showed TK94-2 (351 kg/ha) as best performing variety with 17% higher yield compared with NUL-7 (300 kg/ha). In Rabi 2015–16, trials of green gram, black gram, finger millet, Dolichos bean, French bean, and maize was undertaken over 15 ha of land involving 77 farmers. Harvesting of maize, Dolichos bean, and French bean has been completed and the others are yet to be done and will be reported next year. A farmer's field day was organized in Chikima village in which 82 farmers from the seven FSN study villages participated. Besides reviewing the standing crop, there was sharing of the Kharif experience and planning of interventions for this year.

Freshwater aquaculture

Fish farming activities covered 81 farmers managing 31 ponds (27 individual, 1 group, and 3 community ponds) with 68,000 fingerlings of catla, rohu, and silver carp. It was observed that of the 725 kg of fish harvested, 28% was used for consumption, 18% distributed among the communities, and remaining 54% sold at the rate of Rs. 130/kg.

Nutrition Garden

A total of 413 anaemia-affected households were supported to initiate nutrition garden activity on homestead land or a patch in their farm land during Kharif 2015. Fruit trees such as papaya, drumstick, custard apple, guava, pomegranate, lemon, and other species such

as curry leaf and wild leafy vegetable (*Bauhinia purpurea*) were supplied to each household according to land availability. Seasonal vegetables such as red amaranthus, Indian spinach, coriander, ridge gourd, pumpkin, cow pea, lady's finger, and orange-flesh sweet potato cuttings were supplied to each household for cultivation. During Rabi 2105 vulnerable households from the larger group, with members affected by anaemia and vitamin A deficiency (VAD), were supported with seeds of Dolichos bean, French bean, pumpkin, cucumber, ridge gourd, cluster bean, red amaranthus, multicut green amaranthus, spinach, and Indian spinach (*Poi*). In addition, nutrition gardens have been established in the premises of the government schools in four villages and ICDS centre in two villages. Produce from the gardens was used for the midday meals provided to children at the school and ICDS centres. The objective is to increase nutrition awareness among the children as well as to ensure fresh supply of nutritious vegetables for the midday meal.

Wardha

In contrast to Koraput, this region is characterized by commercial agriculture with cotton and soybean being the predominant crops during the Kharif season. In recent times, *desi* cotton varieties have come to occupy only 3% of total acreage as compared to high input and high output Bt cotton hybrids. In Kharif 2015, 36 farmers from four of the five villages under study were part of an initiative supported by the Central Institute of Cotton Research (CICR), Nagpur, to study the performance of

three *desi* cotton varieties: Suraj, NH-615, and Phule Dhanwantary. The *desi* varieties are of early maturing and short duration, and often recommended under high-density planting to compensate for fewer pickings. Although high-density planting incurs more seeds, the seed cost is considerably less, compared to Bt hybrids. Among *desi* varieties tested, NH-615 showed superior performance in terms of yield parameters and yield (750 kg/acre) followed by Suraj, compared with Phule Dhanwantary. In general, yields were less, in most cases half that of Bt hybrids (1,300 kg/acre protein-dense pigeon pea or red gram is often grown as an intercrop with cotton in the ratio of two rows of pigeon pea for every six rows of cotton). Improved pigeon pea variety NTL-900 was intercropped with *desi* cotton varieties and with farmers' Bt hybrids. In addition, an improved variety of green gram (Kopergaon, short-duration—70days) was also studied. Regardless of cotton types, intercropped pigeon pea produced 1,026 kg/ha of grain yield and that from green gram was 611 kg/ha. Green gram is normally not cultivated as an intercrop and was an innovation tried out last year.

Pigeon pea is generally not cultivated as a sole crop in the region. Understanding the dual role of pulses in the farming system, both as a climate-smart and nutrition-smart crop through awareness programme, 38 farmers participated to test improved red gram variety NTL-900 against traditional farmers' varieties. The results indicated that NTL-900 showed superior performance in terms of yield contributing components (e.g., number

of pods/plant, number of seeds/pod, and seed weight) and yield (1,425 kg/ha) in contrast to farmers' varieties (1,336 kg/ha).

Limitation in securing good quality hybrid sorghum seeds motivated farmers to test advanced sorghum variety recommended by Panjabrao Deshmukh Krishi Vidyapith (PDKV), Akola. The performance of late Kharif advanced sorghum dual-purpose variety CSV-20 was studied with 70 farmers. The agronomic practices followed PDKV recommendations for both the sorghum types. On an average, CSV-20 yielded 320 kg/ha in contrast to 387 kg/ha from farmers' hybrid. To improve the productivity of soybean, a high-yielding variety N-15 was recommended. A total of 26 farmers' land area was divided to include N-15 and traditional farmers' varieties. Recommended variety yielded 1,008 kg/ha in contrast to farmers' varieties (770 kg/ha).

During Rabi 2015, the performance of zinc and iron-rich (bio-fortified) wheat varieties, namely, Abhay, NIAW-1415, and AKAW-4210, was studied with 35 farmers. Among improved micro-nutrient wheat varieties tested, NIAW-1415 showed superior yield performance (1,775 kg/ha) followed by Abhay (1,662 kg/ha), compared with AKAW-4210 (1,546 kg/ha). On an average, traditional farmers' varieties yielded around 1,520 kg/ha. On the basis of these results, the recommended wheat varieties have the potential to improve the productivity with additional benefits of increased micro-nutrients, in contrast to the existing varieties being cultivated by farmers. Similarly, the performance of improved chick pea varieties, namely, Jacki-9218 and Digvijay,

was studied with 24 farmers. The obtained grain yield followed the sequence: Jackie-9218 (897 kg/ha) > Digvijay (667 kg/ha) > farmers' varieties (555 kg/ha).

Poultry intervention

Backyard poultry enterprise was initiated in January 2016 with 25 landless and households with incidence of anaemia from the five villages. For each household, a poultry unit comprising low-cost iron cage, 25kg starter feed, and 16 chicks of Giriraj, Vanraj, Swarnadhara, and Khadaknath varieties were provided. Veterinary support was provided by the Maharashtra Animal and Fishery Sciences University (MAFSU), Nagpur. Nearly 30% of meat produced was used for consumption by the household. The economics of the enterprise activity and its sustainability are being worked out.

Genetic garden

A genetic garden of nutritionally rich plants has been established in the campus of the primary school in Heti village. The school teachers and village leaders supported the initiative and were part of the garden layout plan, contributing to operations such as land preparation and sowing. Different nutritious root and tuber crops, pulses, vegetables, and fruit trees have been sown/planted in the garden. Each plant has been labeled with its common and scientific name and nutritional quality. The objective of the garden is to serve as an educational demonstration to make farm families in Heti and neighbouring villages aware of the nutrient-rich plants available to address different nutritional deficiencies.

Besides the produce of vegetables going into the midday meal prepared for the school students, planting material and seeds will be made available to farmers for cultivation.

Nutrition garden

Households with backyard area and with incidence of anaemia and VAD were particularly targeted for cultivating nutrient-rich vegetables and fruits. The average area of backyard land available is low, ranging from 6.3 to 15.8 sqm. In fact, since a large part of the time is spent in the fields, many households preferred to cultivate vegetables on a patch in the field itself and were encouraged to do so. A seasonal calendar of vegetables was prepared and seeds/saplings were distributed accordingly.

During Kharif 2015, 401 seed kits of leafy vegetables such as *asrajgeera* (amaranthus), *shepu*, *colocasia*, and *chavalai*; roots and tubers such as sweet potato and turmeric; and other vegetables such as cowpea, bitter gourd, pumpkin, brinjal, cluster bean, ridge gourd, cucumber, and lady's finger were distributed to the households. Saplings of papaya, lemon, curry leaves, *moringa*, *karonda*, *amla*, wood apple, tamarind, guava, and *jamun* were also distributed to the households. A total of 86 households cultivated vegetables in their backyard, 274 households in the field and 21 in both backyard and field, while 20 did not cultivate after having initially committed. The initiative did not yield good results in 175 households due to erratic rainfall and water scarcity, lack of germination, damage by animals, and, in a few cases, lack of time and interest.

During the Rabi season, kits with seeds/saplings/suckers of leafy vegetables such as spinach, fenugreek, and coriander; roots and tubers such as carrot, radish, beetroot, and onion; and other vegetables such as cauliflower, and tomato were distributed to 122 households: 34 households cultivated in the backyard, 83 in the fields, 3 in both places, and 2 did not cultivate.

Community nutrition gardens have been operating in Saheli, Heti, and Borgoan Gondi since late 2013. They are maintained by a group of women in each village (leafy vegetables such as spinach, amaranth (*rajgeera* and *chavalai*), fenugreek, coriander, and cabbage; roots and tubers such as carrot, radish, beetroot, and garlic; and other vegetables such as chillies, tomato, brinjal, lady's finger, cauliflower, cucumber, and ridge gourd; and cereals such as maize were planted). The community initiative is an effort to create greater awareness on the importance of cultivating and consuming vegetables.

Nutrition gardens were established on land within the school in all the five villages. The area of the gardens ranges from 7 to 24 sqm. Seeds of leafy vegetables such as *asrajgeera*, *shepu*, *chavalai*, spinach, and coriander and other vegetables such as cowpea, cluster bean, ridge gourd, cucumber, lady's finger, and beetroot were sown, and saplings of lemon, curry leaf, and moringa were planted. The gardens are maintained by the school cook and the village volunteer. The school children also get involved in watering the plants.

Nutrition Awareness activities in both locations

Nutrition awareness has a major role to play in improving dietary diversity at household level for better nutritional outcome. From the baseline nutrition status assessment, it was observed that in both Koraput and Wardha, there is higher prevalence of chronic energy deficiency among adults, with the women being worse off than men; high level of undernutrition among children less than 5 years; micronutrient deficiency such as anaemia (more than 60%) among children, adolescent girls, and women; and VAD among 1- to 5-year-old children (34%). The diet survey revealed cereal-dominated diets with consumption of all other food groups being less than the recommended level.

The results on prevalence of under nutrition and micronutrient deficiency were communicated to the community. Focus group discussions (FGD) were conducted for adolescent girls, pregnant, lactating, and NPNL (non-pregnant and non-lactating) women and school going children to know their basic knowledge about food, cooking, and consumption pattern, and personal hygiene and health. In both locations, hygienic practices were not observed, though there seemed to be greater awareness about these in Wardha.

Following this, a number of awareness programmes were organized at the village level around important days/events. Lectures and demonstrations were undertaken with the help of local resource persons. Other activities such as cookery demonstration

(recipe on cassava, radish leaves, and drumstick), awareness on addressing anaemia and VAD, importance of balanced diet, and awareness on pre- and post-natal care were also conducted. Posters, leaflets, and flash cards have been developed in Marathi and Odiya on different aspects. A drawing competition was conducted for schoolchildren around the themes of sanitation, hygiene, micronutrient deficiencies, dietary diversity, and balanced diet. The drawings have been used for preparing a nutritional calendar in Marathi and Odiya with awareness messages for wider dissemination.

Gender Research in the study villages

The time spent on different activities by gender and seasons (lean, planting, and harvesting) was studied for selected households in Wardha and Koraput (30 households each). The households were stratified based on the criteria of landed and landless, sub-caste, and nutritional status. A detailed qualitative survey was conducted to understand the gendered drivers/determinants of under- and malnutrition, which included household characteristics, land ownership, cropping pattern, forest, livestock, other sources of credit, labour, diet, entitlements, water and sanitation, health, expenditure patterns, decision-making pattern, and gender relations. Time use survey was conducted on male and female respondents of the selected households to study the time spent on SNA (System of National Accounting), extended-SNA, and non-SNA during different seasons. The food intake pattern and anthropometry measurements of the households were also

studied for three seasons. In both locations, men and women were found to spend most of their time in SNA activities during the planting and harvesting season. Extended-SNA activities (household activities including child care) were done only by the women in both locations. It was also observed that men take rest more often than women (sleeping pattern). The energy spent by men and women on different activities was compared with the energy intake, and it was found that their energy intake was much lower than energy spent. Socioeconomic parameters such as caste, sub-caste, and family size also showed influence on under nutrition status.

Research Uptake

Research uptake under LANSAs during the year included constant engagement with agriculture-nutrition stakeholders across the country and particularly in Odisha and Maharashtra, where the feasibility study on FSN is in progress.

The Research Uptake Strategy drafted at the inception phase of LANSAs has been adapted to meet stakeholder needs and preferences over the past 2 years. A total of 926 agriculture-nutrition stakeholders (447 in India, 176 in Pakistan, 275 in Bangladesh, 28 in Afghanistan) are now engaged with LANSAs. Of the total, 218 (24%) are decision-makers and policy influencers engaged with LANSAs research in the country and region, and 341 (37%) are engaged with women's activities.

An online interactive dialogue on FAO's Global Forum on FSN in May 2015 was the very first

and most productive stakeholder engagement of the year. The event also marked the first time stakeholders in Afghanistan were involved in a major way in a LANSA engagement activity. Participants made several important contributions to the discussions. Inputs from these refined LANSA's second call for proposals under the Responsive Window in July 2015.

Collaborations with agri-nutrition networks on a global level have been an outcome of this online dialogue; FAO recognized that South Asia is opening up the nutrition-food-policy dialogue space and was encouraged to collaborate with LANSA for a global e-discussion planned in June 2016 on the theme "Gender and Nutrition."

Along with supporting and leading on the many stakeholder engagement activities in Bangladesh, India, and Pakistan, the Research Uptake team continued to innovate to promote LANSA research, strengthen the capacity of stakeholders, and to find out and respond to stakeholders' communication needs and preferences. Some of the highlights of the Research Uptake activities are given below

- Media interaction and field visits to FSN sites, Wardha, in May 2015 led to several news articles and reports published in Maharashtra state press as well as in the English national press.
- The LANSA Public Forum on Agriculture and Nutrition for Health held at MSSRF, Chennai, in September 2015 brought

international participation, and media reports were published.

- Stalls displaying LANSA work and distribution of LANSA research outputs at a national and an international conference at National Institute of Nutrition, Hyderabad, in October and November 2015.
- Following two Knowledge-Exchange Roundtable Dialogues in November 2015, 56% of stakeholders were of the opinion that brainstorming with different stakeholders strengthens engagement with policy influencers and decision-makers.
- Social media campaigns during National Nutrition Week (September 2015), commemorating World Food Day (October 2015) and International Women's Day (March 2016), saw plenty of activity on LANSA's Twitter and Facebook accounts, as well as a series of blogs published on LANSA website. These were well supported by LANSA partners.
- LANSA stakeholder engagement strategies were presented at the FAO FSN forum workshop on policy dialogues contributing to food and nutrition security policy processes at country and South Asia region levels in December 2015 at FAO, Rome.
- LANSA research work was recognized and felicitated for advancing nutrition in India by Odisha Environment Congress at Bhubaneswar in December 2015.
- LANSA Research-to-Policy consultation to discuss research evidence in India was

organized at MSSRF, Chennai, in February 2016.

- MSSRF-led capacity strengthening and research uptake workshop was organized for faculty and students of ANASTU, Afghanistan, at IARI, New Delhi, on “Tackling Under nutrition in Afghanistan” in April 2016.
- Research uptake at MSSRF took the lead in partnering with AREU, Afghanistan, to organize a research uptake cum capacity strengthening agriculture–nutrition stakeholder consultation in Kabul in April 2016 to present LANSAs research evidence and seek feedback.

Capacity Strengthening

Capacity strengthening of research staff is an ongoing process under the value chain and farming system for nutrition studies. Reaching out to researchers outside LANSAs, a 5-day workshop on “Using Optifood software for diet analysis” was organized during April 4–8, 2016. This was a follow-up to the first workshop conducted in October 2014. Optifood is a software tool that applies linear programming to locally specific dietary intake, food cost, and food composition data. It helps to identify the need for alternative nutrition intervention strategies to address nutrients that likely cannot be provided in adequate amounts using local foods and the population’s food patterns. The main aim of the workshop was to analyze Indian dataset and to design a diet using locally available foods. Elaine Ferguson and Frances Knight from LANSAs

partner LCIRAH were resource persons for the workshop. Following on from this, D. J. Nithya from MSSRF joined Frances Knight as resource person to conduct a similar workshop in Dhaka in late April. Researchers from LANSAs partnered BRAC and others participated in the workshop.

Coordination

The Consortium Advisory Group (CAG) meeting was held at MSSRF in September 2015, followed by the LANSAs Annual Partners’ meeting and Consortium Steering Group (CSG) meeting, which was also held during this period. Seven formative and feasibility studies from across the region were selected for funding under the second Responsive Window Call. Contracts have been drawn up and the studies have commenced from January 2016. The Consortium Management Team and CSG met again in April 2016 to review the feedback from DFID on the LANSAs Annual Report for 2015.

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International Project

MSSRF supported by the Ministry of External Affairs, Government of India, is establishing a Rice Bio-Park at the Yezin Agriculture University, *Nay Pyi Taw*, Myanmar. During this year, the work for housing the unique rice mill machinery was taken up. Equipments necessary for the physical refraction analysis laboratory, nitrogen flushing in pouches, destoning and removal of broken rice, roasting, pulverizes, stabilizer for refined bran for food

purposes were purchased and will be installed shortly. In addition, equipments/devices for rice straw crushing, preparing enriched rice straw blocks, mushroom culture, hand-made paper incorporating rice straw, expanded rice, cattle, poultry and fish-feed, ethnic food nutritional

laboratory etc., were procured. So far two site meetings were conducted with the University staffs and scientists for explaining the features of the Rice Bio-Park. The Indian Mission at Myanmar is advising in procuring the furniture and fittings for the Rice Bio-Park.

Workshops and Conferences

Media Workshop: Sharing knowledge on Climate Change and Agriculture, 18-19 May 2015, Kolli Hills

In order to bridge the knowledge gap between research and society through the media, a two-day media workshop was organised by MSSRF in partnership with PANOS South Asia at Kolli Hills on 18 & 19th May 2015. The workshop provided an overview of existing knowledge and research initiatives in the context of climate and agriculture along with information on existing climate-resilient activities. Fifteen journalists from mainstream media from Tamil Nadu, besides Andhra Pradesh, Kerala and Maharashtra participated in the workshop. The media workshop was a capacity building initiative for journalists, who have the interest in, and knowledge of agriculture, environment and gender issues to be able to delve deeper into this subject of global interest and generate greater awareness among members of the general community. Two field trips conducted as part of the workshop gave journalists an opportunity to understand first-hand by interacting with the community members, men and women farmers and understand millet value chain, community seed bank, and sacred groves besides an event to distribute smokeless chulhas to community members.

Workshop on Attracting and Retaining Youth in Agriculture, 6-7 June 2015, Tiruchirappalli

MSSRF in partnership with Tamil Nadu Agricultural University (TNAU) organized a

two-day workshop on “Attracting and Retaining Youth in Agriculture” at the Horticultural College and Research Institute for Women, Tiruchirappalli to address the essential steps be taken to attract and retain educated youth in farming. This workshop focused on emerging technologies such as biotechnology, information and communication technology and renewable energy to help the rural women and men. Further it addressed the provision of need based services including appropriate and good quality seeds and other inputs at the right time and place. The participants were drawn from youth farmers and agricultural graduates. The outcome of the workshop suggested practical action plans that are essential for developing Agribusiness. Dr. K. Ramasamy, Vice Chancellor, Tamil Nadu Agricultural University, Dr. M. Rajendran, Director of Agriculture, Government of Tamil Nadu and other dignitaries spoke at the function.

International Conference on Science, Technology and Public Policy to Achieve the Zero Hunger Challenge, 7-9 August 2015, Chennai

Over 500 delegates including national and international organization representatives, academicians, scientists and policy makers attended the conference from 7th to 9th August 2015 to discuss “Science, Technology and Public Policy to achieve the Zero Hunger Challenge.” The conference, held at MSSRF, Chennai in partnership with International Crop Research Institute for the Semi-Arid Tropics (ICRISAT), Harvest Plus and Borlaug Institute for South Asia (BISA), was inaugurated by the

Governor of Tamil Nadu, HE Dr. K. Rosaiah, Union Ministers Smt. Nirmala Sitharaman and Shri. Venkaiah Naidu, Members of Parliament Shri. Jairam Ramesh and Shri. H.K. Dua and senior government representatives participated in the concluding session on 9th August 2015. Recommendations and outcomes of the discussions are being submitted to the government, multilateral organizations and policy makers in India and across the world. This conference was organised in commemoration of the 90th birthday of Prof. M.S. Swaminathan. During the conference thematic sessions on Science Technology and Political Support for Achieving the Zero Hunger Challenges, Smallholder Production Systems, Agriculture, Health and Nutrition were organised.

Public Forum on Leveraging Agriculture for Nutrition and Health, 14 September 2015, Chennai

A Public Forum under the research programme on Leveraging Agriculture for Nutrition in South Asia (LANSA) was organized in September 2015 to build awareness on how agriculture has a reflection on nutrition and health, especially in the case of women and children, in the South Asia region. Dr. Prakash Shetty, CEO, LANSA, while introducing LANSA, pointing out the programme's focus and challenges of addressing undernutrition especially among children and women in South Asia - a region of fast economic growth, through improved agriculture. The LANSA's Research Directors, presented the future focus in the four focus countries, viz. India, Pakistan, Bangladesh

and Afghanistan. This was followed by a panel discussion on 'Leveraging Agriculture for Nutrition and Health'. Dr. Barbara Harris-White, Dr. Mahendra Dev, Dr. Jeff Waage, Dr. Soumya Swaminathan and Dr. John McDermott were among the speakers and the discussion was moderated by Professor M.S. Swaminathan.

Media Workshop Chennai to Paris, 27 October 2015, Chennai

A workshop for media persons was held at MSSRF. Fifteen participants from various media houses from Chennai were present in the workshop. The workshop conducted jointly with the Forum of Environmental Journalists in India (FEJI) titled "Chennai to Paris" focused on developing stories in the context of Tamil Nadu, Environment and Climate Change in light of the upcoming Conference of Parties 21 in Paris later this year. Professor M.S. Swaminathan, Dr. Ajay Parida, Mr. Gopikrishna Warriar, Dr. V. Selvam, Professor Kavi Kumar, and Ms. Vidya Soundarajan made presentations during the workshop. It also included interactive sessions on climate negotiations and story ideas.

Stakeholders meeting at State and District Level on Gender in Energy Sector Dynamics, 5 November 2015, Bhubaneswar

The State Level Stakeholders consultation was conducted to discuss the macro level issues on Gender in Energy policy, design, formulation and implementation. The participants are from

government agencies and departments such as Odisha Rural Development and Marketing Society (ORMAS), The Odisha Renewable Energy Development Agency (OREDA), GRIDCO Limited, academic representatives from Kalinga School of Rural Management and Central Institute of Women and Agriculture and civil society organisations working on energy issues viz., Practical Action and Gram Vikas. The research outputs of the scoping study carried out at the site was discussed in which areas of concerns reiterated was women's labour, opportunity cost, health and its impact on their livelihoods vis-a-vis environment. Subsequently, district level stakeholders consultation was organised at Jeypore, Koraput district on 6th November 2015 to discuss the meso level issues in implementing the policies and schemes. The participants are civil society organisations, women's groups, panchayat leaders, representatives of government line departments like agriculture, tribal development, electricity, OREDA etc., and corporate like cashew industry and rice mill representatives, LPG and Kerosene dealers, etc. The meso level stakeholders discussion was held in ten villages during June and July 2015 to understand the ground level energy related issues pertaining to agriculture, enterprises and domestic use.

Knowledge Sharing Stakeholder Dialogues, 17 and 25 November 2015, Mumbai and Bhubaneswar

MSSRF, the lead partner for the LANSAR research programme, organized two agri-nutrition knowledge exchange roundtable

dialogues at Mumbai and Bhubaneswar on the theme: 'Tackling Undernutrition in India'. The purpose of the dialogues was to appreciate the benefits of linking together agriculture and nutrition stakeholders in the Indian policy environment. The meeting contributed immensely to MSSRF understanding the agriculture-nutrition dynamics in the current policy environment and how the LANSAR programme could be leveraged to open up not just dialogue, but also to prompt that nutrition must be prioritized in agriculture policy space for holistic advancement in India. This was a second effort by LANSAR Research Uptake to strengthen capacity of agriculture-nutrition stakeholders in India, and the state capitals: Mumbai and Bhubaneswar were specifically chosen for these workshops since the Farming System for Nutrition (FSN) study led by MSSRF is underway in Wardha district in Maharashtra and Koraput district in Odisha.

Workshop for Developing Monitoring Framework for MSSRF, 4-5 January 2016, Chennai

This workshop was organised in Chennai office. Seventeen senior staff of the Foundation participated and was facilitated by a resource person from, Association for Stimulating Know-How, Gurgaon, who is a specialist in capacity building on monitoring and evaluation. The workshop covered two aspects: i) Impact brought about by the Foundation at the societal level; ii) Indicators to assess the identified impacts. It was decided that the organizational level impact is a summation of impacts

by different programme areas. Therefore, participants formed into various groups based on the programme area they represent. Each group had detailed discussions on the impact of their work and arrived at an impact statement that best describes the changes envisaged by their programme. This was followed by an exercise of arriving at measurable indicators to measure the specified impact. The results achieved are summarised below:

As a follow-up to the Workshop, the programme areas are deliberating on suitable indicators to measure the impact of their programme area.

Gender and GRI Institutions and GRI group (Grassroots Institutions) 21-23 January 2016, Chennai

A three day workshop was organised at MSSRF for the GIM group (Gender Integration and Mainstreaming) members with the

Programme Area Programme Impact/Goal

Coastal Systems Research	Enhanced Ecological and equitable livelihood security of marginalized coastal communities
Biodiversity	Conservation, enhancement and equitable utilisation of wild and agrobiodiversity of marginal and indigenous communities in agrobiodiversity hotspots.
Biotechnology	Development and adoption of suitable biotechnology products in stressed environment; conservation and prospecting of genetic resources using biotechnological tools for marginalized farmers in coastal, hilly and semi arid regions.
Food Security	Ensure household food & nutrition security for the marginalized (Socially & Economically) sections of the society in MSSRF operational areas.
Ecotechnology	Improved economic well being of vulnerable communities such as small marginal and women farmers and landless communities of semi arid areas through better natural resource management, value chain based sustainable agriculture and livelihoods
Information, Education and Communication	Reduced risk in fishing and farming livelihood leading to increased profit (productivity) margin among the marginalised families in TN. Pondicherry and Maharashtra.
Common Impact	Policy influencing: Evidence based results main-streamed into policy and practices for sustainable development

objectives (i) to strengthen the capacity in identifying the gender issues, (ii) to document and share how gender issues are being addressed in the interventions and changes happening in women and men's livelihoods and lives and (iii) to review GIM activities and performance in mainstreaming and integrating gender at the programme level. The discussion helped to evolve a common framework covering key gender issue or gap identified for intervention, strategies adopted to address, gendered results obtained and key gender outcomes to women and men. On the second day of the workshop, the approach adopted and differences in three types of GRI's (right based approach, livelihood based and common property resources based) were discussed. Specific activities with reference to empowering women and achieving gender equality were also identified along with indicators to assess the achievements.

SEED Fest, 28-30 January 2016, Wayanad

Around 400 people participated in the Seed Fest 2016. It was organised by Wayanad District Tribal Development Action Counsel, Seed Care, Association for Traditional Rice Farmers, and Kerala State Biodiversity Board, NABARD and MSSRF at Community Agrobiodiversity Center, Wayanad. All Grama Panchayaths and Municipalities in Wayanad along with NABARD, ATMA Wayanad, and *Malayora Vikasana* Agency joined in the fair. The conservation, enhancement and sustainable utilization of the traditional seed diversity of Wayanad and adjoining regions

of the Nilgiri Biosphere Reserve of Western Ghats were the focus of the SEED Fest.

INELI India: Cohort I, First Convening 9-12 February 2016, Chennai

MSSRF is partnering with the Global Libraries initiative of the Bill & Melinda Gates Foundation in the International Network of Emerging Library Innovators (INELI) for building the leadership capacity of Public library professionals. The programme is implemented in India and led by MSSRF. The commitment in the project is to develop forty (40) public library professionals as emerging library innovators and leaders to steer the future of Indian public library movement during the project period in two cohorts. The first convening of Cohort 1 focused on introduction of INELI India leadership program, online platform, inspirational interactive and networking sessions on self-development and leadership, library and hub and spokes model of MSSRF - exposure visit and adequate space for mentor and innovators interaction. There are 26 public library professionals including 8 women drawn from public libraries across 16 states and 2 Union Territory of India in Cohort 1. These library professionals have been selected through a systemic process from 58 nominations including 19 women that were received from 16 states and 2 union territories. The duration of the programme is 20 months with a mix of online modules, and three face-to-face convening including one in a neighboring country.

Research to Policy Dissemination Meeting, 24 February 2016, Chennai

A LANSAs ‘Research-to-Policy’ consultation was organised to present and discuss research evidence emerging on the theme of ‘enabling environment for agriculture and nutrition linkage’, under the programme in India. The event had participation of officials from Agriculture, Fisheries and Integrated Child Development Scheme (ICDS) departments of the government of Tamil Nadu, representation from National Bank for Agriculture and Rural Development (NABARD), and several economists, nutrition scientists, and academics. There were suggestions on how LANSAs research could impact Action Plans and procurement policies in the state; the need to look at good practices in other Indian states and policies that influence dietary diversity was also suggested. Prof. Swaminathan, in his concluding remarks summed up the proceedings and reiterated the importance for research to reach policy.

Media Workshops 23 February & 18 March 2016, Tiruchirappalli and Hyderabad

Two media workshops were held along with the Clima Adapt project at different locations to facilitate interaction and strengthening of media interest and emphasis on the subject of climate change and local adaptation. The workshop in Tiruchirappalli was held on February 23, 2016, where journalists from Pudukkottai and Tiruchirappalli districts participated while another workshop was held in Hyderabad on March 18, 2016 for journalists from the city. A total of 60 journalists attended

the two workshops also writing and reporting in their media about the issues related to climate change and agriculture that were discussed.

Research Uptake and Capacity Building for ANASTU Scientists, 19 April 2016, New Delhi

On April 19, 2016, LANSAs partners – MSSRF and LCIRAH organized a research uptake cum capacity strengthening workshop in New Delhi for agriculture scientists from the Afghanistan National Agriculture Science and Technology University (ANASTU), Kandahar. The day-long workshop was facilitated and hosted by the Indian Agricultural Research Institute (IARI), New Delhi. The LANSAs workshop was aimed at shaping understanding of nutrition while looking to stimulate and sensitize agriculture scientists to consider how agriculture can help address the problem of undernutrition in Afghanistan. R.V. Bhavani, LANSAs Programme Manager, presented an overview of LANSAs work in South Asia, Nigel Poole from LCIRAH shared findings from LANSAs research in Afghanistan. Overall feedback at the end of the one-day workshop got participants admitting that their expectations were met, and that a long term ANASTU tie up with LANSAs would guide their knowledge and motivate them to be innovative toward leveraging agriculture for nutrition.

Knowledge-Sharing Dialogue with Afghan Stakeholders, 25 April 2016, Kabul

MSSRF and LCIRAH collaborated with the Afghanistan Research and Evaluation Unit

(AREU) for a LANSAs stakeholder event in Kabul, Afghanistan on April 25, 2016. The aim was to present LANSAs research plans, updated evidence reviews and summary reports of interviews with key agriculture and nutrition stakeholders, encouraging

feedback, and identifying research gaps in the process. Close to 40 participants from Kabul and neighbouring provinces engaged in meaningful discussion. Media was also present. This was the first LANSAs stakeholder knowledge-sharing dialogue in Afghanistan.

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Kumar, N. "Effectiveness of training methodologies with references to supporting staffs in healthcare industries in Tamil Nadu, India". National Seminar on Challenges of Business Leaders in the Changing Management World. RDB College of Arts and Sciences, Papanasam, Thanjavur. 9 March 2016.

Mahesh Maske, A. K. Panda, R. V. Bhavani and D. J. Nithya, "Promoting root and tuber crops for food and nutrition security of rural tribes in India". World Congress on Root and Tuber Crops. Guangxi, China. 18 - 22 January 2016.

Mathimaran, N., P. Mäder, A. Kahmen, D. Singh, T. Muthukumar, N. Sakthivel, R. K.

Varshney, R. Saxena, V. R. Prabavathy, S. Jegan, E. G. Ashok, C. Schader, M. Meier, B. Blättler, R. Rengalakshmi and T. Boller. "Biofertilization and bioirrigation for sustainable mixed cropping of pigeon pea and finger millet". The 5th World Sustainability Forum (WSF5) - Transitioning toward Sustainability. Basel, Switzerland. 7 - 9 September 2015.

Mathimaran, N., P. Mäder, A. Kahmen, D. Singh, T. Muthukumar, N. Sakthivel, R. K. Varshney, V. R. Prabavathy, S. Jegan, E. G. Ashok, C. Schader, M. Meier, D. Blättler, R. Rengalakshmi and T. Boller. "Biofertilization and bioirrigation for sustainable mixed cropping of pigeon pea and finger millet (The BIOFI project)". Symposium on Microbe-assisted crop production – opportunities, challenges and needs (miCROPe2015). Vienna, Austria. 23 - 25 November 2015.

Muthukumar, S. and G. N. Hariharan. "Initiation and establishment of *Roccella montagnei* Bèl. culture for the biosynthesis of secondary compounds". National Conference on Cryptogam Research in India. CSIR-NBRI, Lucknow. 28 - 29 September 2015.

Naresh Chandra Patro, Pramod Sahu, S. S. Chaudhury and B. Harijan, "Traditional knowledge for climate change adaptation in Koraput District, Odisha". 7th Indian Youth Science Congress. KIIT University, Bhubaneswar. 26 - 28 February 2016.

Nithya, D. J., Rohit Parasar, S. Raju, Mahesh Maske, A. K. Panda, R. D. Wagh, J. Padhy and R. V. Bhavani. "Relationship between household dietary diversity and nutritional

outcome". 47th Annual Conference of Nutrition Society of India, Hyderabad. 9 - 10 October 2015.

Nithya, D. J. "Impact of nutrient intake on prevalence of Anemia –evidence from two districts of India". National Seminar on Strategies for Women and Child Survival'. NIRD & PR (National Institute of Rural Development & Panchayat Raj), Hyderabad. 8 - 10 March 2016.

Padhy, J. and D. J. Nithya. "Profiling of nutrition status for strategising nutrition awareness programme in Boipariguda block of Koraput District, Odisha". 7th Indian Youth Science Congress. KIIT University, Bhubaneswar. 26 - 28 February 2016.

Prabavathy, V. R., V. Ganga and S. Jegan. 2015. "Evaluation of the antagonistic potential of pseudomonads for the control of fusaric acid producing *Fusarium* spp.". International Conference on Plant, Pathogens and People with the Mission Challenges in Plant Pathology to Benefit Humankind. NASC Complex, New Delhi. 23 - 27 February 2016.

Prashanta Kumar Parida, J. Naik and A. Laxman Rao. "Farm School for farm solutions in the era of climate change". 7th Indian Youth Science Congress. KIIT University, Bhubaneswar. 26 - 28 February 2016.

Purna Chandra Samantray and Tusar Ranjan Nayak. "Community gene-seed-grain bank: A community driven mechanism to address food and nutrition insecurity at the household level". 7th Indian Youth Science Congress. KIIT

University, Bhubaneswar. 26 - 28 February 2016.

Rajalaxmi Lenka and Anurakta Beuria, "Gender division of labour and work intensity in monsoon period: A study in Boipariguda block of Koraput District of Odisha". 7th Indian Youth Science Congress. KIIT University, Bhubaneswar. 26 - 28 February 2016.

Rajkumar, R. "Challenges in Indian agriculture". State Level Conference of Development Subcommittee. Tamil Nadu Science Forum, Karaikudi. 29 August 2015.

Rajkumar, R., T. Manju, P. Vinod and C. Malavika. "ICT Interventions in crop health knowledge management for small holder farmers". International Conference on Innovative Digital Applications for Sustainable Development. University of Agricultural Sciences, Bangalore. 5 - 7 January 2016.

Ramasubramanian, R. "Changes in vegetation in the Godavari mangroves". National Research Meet Workshop on Developing Knowledge Management System through Cross Sectoral Approach. EGREE Foundation, Priya Beach Resorts, Rushikonda, Visakhapatnam, Andhra Pradesh. 5 - 7 November 2015.

Ramasubramanian, R. "Climate change and mangroves". National Seminar on Inter Disciplinary Aspects of Environmental Science. Department of Zoology, Dr. S. R. K. Govt. Arts College, Yanam. 24 February 2016.

Ramasubramanian, R. "Sustainable aquaculture". Workshop on Financing Fisheries. National Institute of Rural

Development and Panchayati Raj (NIRD&PR), Hyderabad. 4 - 5 May 2016.

Ranjith, D., V. V. Sivan, K. Sindhu, N. Anil Kumar, Sanis Juliet and S. Suja Rani. "Scientific validation of poly herbal formulations for Pyrexia in animals used by local healers of Wayanad District, Kerala". XV Annual Convention of Indian Society of Veterinary Pharmacology and Toxicology (ISVPT). ICAR-National Dairy Research Institute, Karnal, Haryana. 14 - 16 January 2016.

Ranjith, D., K. Sindhu, V. V. Sivan, N. Anil Kumar and S. Juliet. "Documentation and standardization of poly herbal formulations for Diarrhea in animals". XV Annual Convention of Indian Society of Veterinary Pharmacology & Toxicology (ISVPT). ICAR-National Dairy Research Institute, Karnal, Haryana. 14 - 16 January 2016.

Ravinder Reddy, Ch., H. Sudini, G. V. Ranga Rao, C. V. Sameer Kumar and R. S. Shantha Kumar Hopper, "On-farm seed storage is critical in strengthening pulses seed systems in India". International Conference on Pulses for Health, Nutrition and Sustainable Agriculture in Drylands. Marrakesh, Morocco. 18 - 20 April 2016.

Ravinder Reddy, Ch., R. S. Shantha Kumar Hopper, C. V. Sameer Kumar, G. V. Ranga Rao and V. T. Rajendra Prasad. "Ensuring seed security and production of rainfed pulses in semi-arid tropics". International Conference on Pulses for Health, Nutrition and Sustainable Agriculture in Drylands. Marrakesh, Morocco. 18 - 20 April 2016.

Sakthivel, N., N. Mathimaran, B. Sundarakrishnan, S. Tamilselvan, S. Jegan, V. R. Prabavathy, T. Muthukumar, E. G. Ashok, D. J. Bagyaraj, P. Maeder and T. Boller. "Effects of biofertilizer inoculation on non-target native rhizosphere bacterial communities in pigeon pea and finger millet intercropping system in India". Symposium on Microbe-assisted crop production – opportunities, challenges and needs (miCROPe2015). Vienna, Austria. 23 - 25 November 2015.

Sangeetha Rajeesh. "Engaging stakeholders and key decision makers into nutrition policy processes at sub-regional level". FAO Food and Nutrition Security Forum Policy Dialogues: Contributing to Food Security and Nutrition Policy Processes at the country and regional level. FAO, Rome. 10 - 11 December 2015.

Selvam, V., P. Gnanamoorthy, A. Karipot and S. Chakroborty. "Eddy covariance measurements of Methane and Carbon dioxide fluxed over a mangrove ecosystem, South-eastern coastal India". Asia Flux Workshop 2015 and ISPRS TC WG VIII/3 Meeting. Indian Institute of Tropical Meteorology, Pune. 22 - 29 November 2015.

Selvam, V. "Sustainable management of coastal bioresources and biodiversity" National Symposium on Marine Bioresources and Coastal Livelihoods (NSMBCL). Gujarat Institute of Desert Ecology, Kachchh. 4 - 5 March 2016.

Sindhu, K., D. Ranjith, V. V. Sivan, Jayesh P. Joseph and Sanis Juliet. "Ethno- veterinary survey, standardization parameters of poly

herbal formulations used for Mastitis in animals". XV Annual Convention of Indian Society of Veterinary Pharmacology & Toxicology (ISVPT). ICAR-National Dairy Research Institute, Karnal, Haryana. 14 - 16 January 2016.

Sivan, V. V., Jayesh P. Joseph and N. Anil Kumar. "An analysis of the medicinal plant diversity in Wayanad District, Kerala". Silver Jubilee Conference of IAAT and Council Meeting of IAPT & International Seminar on Advancements in Angiosperm Systematics and Conservation. Department of Botany (University of Calicut), Indian Association for Angiosperm Taxonomy and International Association for Plant Taxonomy, Calicut. 19 - 21 November 2015.

Sophia, J. D., Justin Samuel and D. G. Poorani. "Enhancing quality of sugar effluent (SE) through hybrid model of vertical and horizontal flow constructed wetland and its reuse in an integrated Aqua-Agro Farming (IAAF) system". ICID 26th ERC and 66th IEC Conference. Montpellier, France. 12 - 16 October 2015.

Sophia, J. D., D. G. Poorani, Justin Samuel and Ajay K. Parida. "Efficiency of hybrid model constructed wetland in improving quality of sugar effluent". International Conference on Innovations in Sustainable Water & Wastewater Treatment Systems. Pune, India. 21 - 23 April 2016.

Sujana, K. A., Joseph John and N. Anil Kumar. "Lianas in forests of Kerala demands urgent conservation action". Silver Jubilee

Conference of IAAT and Council Meeting of IAPT and International Seminar on Advancements in Angiosperm Systematics and Conservation. Department of Botany (University of Calicut), Indian Association for Angiosperm Taxonomy and International Association for Plant Taxonomy, Calicut. 19 - 21 November 2015.

Tusar Ranjan Nayak. "Enhancing socio-economic and nutritional status of the Mahila Kisans in the tribal region of Koraput through promotion of sustainable agriculture". 7th Indian Youth Science Congress. KIIT University, Bhubaneswar. 26 - 28 February 2016.

Tusar Ranjan Nayak, Ajit Kumar Sahu, Rajdeep Behera and M. K. Nayak, "Promotion of sustainable agriculture practices by the Mahila Kisans in the tribal region of Koraput enhancing socio-economic status and ensuring food and nutrition security". 7th Indian Youth Science Congress. KIIT University, Bhubaneswar. 26 - 28 February 2016.

Velvizhi, S. "Transforming the lives and livelihood of fishers – Experiences of M. S. Swaminathan Research Foundation". Workshop on Innovations in Public Systems – Sustainable Agriculture. Centre for Innovation in Public Systems, Govt. of India, Hyderabad. 8 - 11 July 2015.

Velvizhi, S. "Transforming the lives and livelihood of fishers – Experiences of M. S. Swaminathan Research Foundation". Three Days Intensive Training Workshop on NeGP-Agriculture & Allied Sectors. Centre for Innovation in Public Systems, Govt. of India, Dharwad, Karnataka. 30 July - 1 August 2015.

Participation in Training Programmes/ Workshops

Akshaya Kumar Panda, B. Mohanty, S. K. Mishra, D. Gouda and M. A. Gill. 7th Indian Youth Science Congress. KIIT University, Bhubaneswar. 26 - 28 February 2016.

Akshaya Kumar Panda and Mahesh Maske. Strengthening the Design, Implementation and Learning on Agriculture-nutrition Interventions in South Asia: A Cross-learning Workshop. IFPRI, New Delhi. 30 - 31 March 2016.

Bhavani, R. V. A South Asia Regional Consultation on Nutrition, Agriculture and Food Systems in the Era of Sustainable Development. Public Health Foundation of India (PHFI) and The Global Panel on Agriculture and Food systems for Nutrition and Research and Information System for Developing Countries (RIS), New Delhi. 11 - 12 February 2016.

Charusheela Thakre. Workshop on Panchayati Raj (Participatory Planning of Village). Shri Krishnadas Jajoo College. Pipari Meghe, Wardha. 21 - 22 February 2016.

Gopinath, R. Seminar on Social Sciences in the Public Interest. State Planning Commission, Chennai. 19 June 2015.

Gopinath, R. Seminar on Nutrition and Agriculture – The Connect and the Disconnect. National Institute of Nutrition, Hyderabad. 9 - 10 October 2015.

Gopinath, R. ECOSAN in Tami Nadu. State Planning Commission, Chennai. 22 February 2016.

Gopinath, R. Seminar on WASH 2016 – Innovative Solutions for WASH. UNICEF, Chennai. 27 February 2016.

Jasaswini Padhy and D. J. Nithya. 7th Indian Youth Science Congress. KIIT University, Bhubaneswar. 26 - 28 February 2016.

Jegan Karuppiah, S. SARVASASTRA 2K16-National Conference on Food, Health and Environment. Dr. M.G.R Educational and Research institute (Deemed University), Chennai. 22 - 23 March 2016.

Jyotsna Raut. Workshop on Panchayati Raj (Participatory Planning of Village). Shri Krishnadas Jajoo College, Pipari Meghe, Wardha. 21 - 22 February 2016.

King, E. D. Israel Oliver. Session on Building a Network of Local Climate Smart Crops and Citizen Scientist. International Mei-Ramew, Indigenous Terra madre. Indigenous partnership for Agrobiodiversity and Food Sovereignty. North Eastern Hill University, Shillong, Meghalaya. 3 - 7 November 2015.

King, E. D. Israel Oliver. Session on Agricultural biodiversity, Value chain and Women's empowerment. Milan Expo 2015. Bioversity International, Milan, Italy. 17 September 2015.

King, E. D. Israel Oliver. Training programme on Farmer Producer Company and Producer Organization and Promoting Institution (POPI). NABARD and Agri Systems Foundation, Erode. 15 - 19 December 2015.

King, E. D. Israel Oliver. Southern State Workshop on Orientation on TDF Projects.

Bankers Institute of Rural Development (BIRD), Tirupathi. 21 - 23 December 2015.

King, E. D. Israel Oliver. Workshop on Attracting and Retaining youth in Agriculture. Tamil Nadu Agriculture University and M. S. Swaminathan Research Foundation, Horticulture College and Research Institute for Women, Trichy. 6 - 7 June 2015.

Kishor P. Jagtap. Workshop on Panchayati Raj (Participatory Planning of Village). Shri Krishnadas Jajoo College. Pipari Meghe, Wardha. 21 - 22 February 2016.

Kishor P. Jagtap. Workshop on Designing Curriculum for SHG Trainers in Maharashtra. Yashavantrao Chavhan Maharashtra Open University, Nasik. 20 March 2016.

Kumar, N. Workshop on Attracting and Retaining youth in Agriculture. Tamil Nadu Agriculture University and M. S. Swaminathan Research Foundation, Horticulture College and Research Institute for Women, Trichy. 6 - 7 June 2015.

Kumar, N. Training programme on Farmer Producer Company and Producer Organization and Promoting Institution (POPI). NABARD and Agri Systems Foundation, Erode. 15 - 19 December 2015.

Kumar, N. Southern State Workshop on Orientation on TDF Projects. Bankers Institute of Rural Development (BIRD), Tirupathi. 21 - 23 December 2015.

Kumar, N. State Level Review Workshop on Tribal Development Project. NABARD, Chennai. 20 January 2016.

Lakshmanan, P. Training programme on Farmer Producer Company and Producer Organization and Promoting Institution (POPI). NABARD and Agri Systems Foundation, Erode. 15 - 19 December 2015.

Mahesh Maske, A. K. Panda, R. V. Bhavani and D. J. Nithya. World Congress on Root and Tuber Crops. Nanning, China. 18 - 23 January 2016.

Nagarajan, R. Workshop on Integrated Coastal Zone Management in Tamil Nadu. National Centre for Sustainable Coastal Management, Ministry of Environment and Forests, Anna University, Chennai. 12 January 2016.

Nallu Shambharkar. Workshop on Panchayati Raj (Participatory Planning of Village). Shri Krishnadas Jajoo College, Pipari Meghe, Wardha. 21 - 22 February 2016.

Nithya, D. J., Rohit Parasar, S. Raju, Mahesh Maske, A. K. Panda, and R. P. Wagh. 47th Annual Conference of Nutrition Society of India. National Institute of Nutrition, Hyderabad. 9 - 10 October 2015.

Nithya, D. J. Workshop on Infant and Young Child Feeding Practices. National Institute of Nutrition, Hyderabad. 8 October 2015.

Nithya, D. J. Workshop on Use of Optifood Software. LANSAs and Helen Keller International, Dhaka, Bangladesh. 24 - 28 April 2016.

Prashant Laxman Deokar. Training on Sustainable Agricultural Practices for Physically Disable Farmers. Prerana Gram Vikas Sanstha, Ralegaon, Yavatmal. 20 November 2015.

Ramasubramanian, R. 2nd Research Advisory Committee Meeting for Conservation of Coastal, Estuarine and Marine Ecosystems in the EGREE (East Godavari Riverine Estuarine Ecosystem) Region. Govt. of India - UNDP-GEF- Govt. of Andhra Pradesh, Aranya Bhavan, Hyderabad. 2 July 2015.

Rajkumar, R. Plant wise South and West Asia Regional Conference. Pearl Continental Hotel, Bhurban Murree, Pakistan. 29 - 30 April 2015.

Raju, S. ICSSR Sponsored Orientation Programmes for Researchers and Faculty Members. MIDS (Madras Institute of Development Studies), Chennai. 7 - 11 March 2016.

Rengalakshmi, R. Open Space Workshop on Gender and Food Security, IFPRI and ANANDI, Ahmadabad. 14 - 15 December 2015.

Rukmani, R. Conference on Right to Food. India International Centre, New Delhi. 28 - 29 April 2016.

Sangeetha Rajeesh, M. Sadapture and E. Christy Leema Rose Mary. International Food Data Conference. National Institute of Nutrition, Hyderabad. 3 - 4 November 2015.

Selvamukilan, B. Workshop on Evergreen Agriculture and good Diet for Planet. PERAS International, Pillar Institution, Madurai. 21 - 21 November 2015.

Selvaganapathy, E. Workshop on Moving Towards Sustainability. Network for Fish Quality Management and Sustainable Fisheries (NETFISH), Chennai. 14 - 17 August 2015.

Sivakumar, M. N. Millet Awareness Campaign- Chennai Science Festival- 2016. Queen Mary's College, Chennai. 26 - 29 February 2016.

Sophia, J. D. Expert Consultation Meeting on Seagrass Project. IUCN, New Delhi. 8 July 2015.

Sophia, J. D. Expert Consultation Meeting on Community - Supported Management and Conservation Strategies for Seagrass beds in Palk Bay. Rain Tree Hotel, Chennai. 7 January 2016.

Takri, G., S. R. Benia, K. Panda, B. Mohanty, S. K. Mishra, D. Gouda and M. A. Gil. 7th Indian Youth Science Congress. KIIT University, Bhubaneswar. 26 - 28 February 2016.

Velvizhi, S. Stakeholders Meeting on National Marine Fisheries Policy. Central Marine Fisheries Research Institute, Chennai. 9 February 2016.

Velvizhi, S. Southern Regional Consultation (SRC). Forum for Indian Development Cooperation, Chennai. 15 March 2016.

Yamini, G. National Convention of Women Farmers. Forum for Women Farmer's Rights, Bapatla. 16 - 18 March 2016.

Awards/Honours

Institutional

M. S. Swaminathan Research Foundation. 2015. Earth Care Award, JSW Foundation and Times of India, New Delhi.

M. S. Swaminathan Research Foundation. 2015. Felicitations of LANSAs for outstanding work in the field of advancement of Nutrition, The Odisha Environment Congress, Bhubaneswar.

<http://lansasouthasia.org/article/lansa-felicitated-work-done-advance-nutrition-0>

M. S. Swaminathan Research Foundation. 2015. Agriculture Leadership Award, Agriculture Today, New Delhi.

M. S. Swaminathan Research Foundation. 2015. Saansad Adarsh Gram Yojana (SAGY) Award, Ministry of Rural Development, Government of India, Bhopal.

Individual

Manjula, M. and R. Rengalakshmi. 2015. Global Development Network Prize 2015 – Best Paper Award, GDN's 16th Annual Global Development Conference, Casablanca, Morocco.

Muthukumar, S. and G. N. Hariharan. 2015. Best Paper Award, National Conference on Cryptogam Research in India. CSIR- NBRI, Lucknow.

Swaminathan, M. S. 2015. Honorary Doctorate, University of Dharwad, Dharwad, India.

Swaminathan, M. S. 2015. Honorary Doctorate, Birsa Agricultural University, Ranchi, Bihar, India.

Swaminathan, M. S. 2015. Honorary Doctorate, Indian Institute of Science Education and Research (IISER), Kolkata, India.

About the Foundation

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

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World Food Programme

FINANCIAL STATEMENT 2015-16

M.S.SWAMINATHAN RESEARCH FOUNDATION

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

BALANCE SHEET AS AT 31ST MARCH 2016

FOUNDATION

Rupees in Lakhs

LIABILITIES	Sch. No.	2015-2016	2014-2015	ASSETS	Sch. No.	2015-2016	2014-2015
		Rs.	Rs.			Rs.	Rs.
OWN FUNDS							
OWN ASSETS							
CORPUS FUNDS	1	157.90	156.18	FIXED ASSETS	4	565.66	583.70
GENERAL FUND & OTHER FUNDS	2	3415.61	3336.81	INVESTMENTS	5	6068.19	5936.75
ENDOWMENT FUNDS	3	4613.83	4562.81	CURRENT ASSETS			
CURRENT LIABILITIES	10	771.90	572.78	CASH & BANK BALANCES	7	777.93	844.71
				ADVANCES	8	1547.46	1263.42
TOTAL [A]		8959.24	8628.58	TOTAL [A]		8959.24	8628.58

PROJECTS

LIABILITIES	Sch. No.	2015-2016	2014-2015	ASSETS	Sch. No.	2015-2016	2014-2015
		Rs.	Rs.			Rs.	Rs.
PROJECT FUNDS & OBLIGATIONS	4	1603.17	1437.27	PROJECTS RECEIVABLES	9	701.88	616.58
CURRENT LIABILITIES	10	861.88	741.98	ADVANCES	8	330.90	162.83
				BANK BALANCES	7	1432.27	1399.84
TOTAL [B]		2465.05	2179.25	TOTAL [B]		2465.05	2179.25
GRAND TOTAL [A]+[B]		11424.29	10807.83	GRAND TOTAL [A]+[B]		11424.29	10807.83

Provisional (Unaudited)

M.S.SWAMINATHAN RESEARCH FOUNDATION

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INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31ST MARCH 2016

EXPENDITURE	FOUNDATION				Rupees in Lakhs		
	Sch. No.	2015-2016 Rs.	2014-2015 Rs.	INCOME	Sch. No.	2015-2016 Rs.	2014-2015 Rs.
SALARIES	15	877.15	908.57	INTEREST INCOME	11	635.96	794.71
ENDOWMENT EXPENSES	16	121.35	141.85	DONATION	12	306.27	355.28
MEETINGS & OTHER RELATED EXPENSES	17	61.19	97.96	DST CORE GRANT	13	400.00	545.53
OTHER ADMINISTRATIVE EXPENSES	18	150.72	69.27	OTHER RECEIPTS	14		
DEPRECIATION ON FIXED ASSETS	5	41.79	46.52	RENTAL RECEIPTS		10.29	18.23
10% OF ENDOWMENT INTEREST INCOME TRANSFERRED TO ENDOWMENT FUNDS		51.02	89.26	CREDIT BALANCE WRITTEN BACK			
EXCESS OF INCOME OVER EXPENDITURE FOR THE YEAR TRANSFERRED TO THE GENERAL FUND		78.79	427.53	MISCELLANEOUS		29.49	67.21
TOTAL		1382.01	1780.96	TOTAL		1382.01	1780.96

Provisional (Unaudited)



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