



Science for Sustainable Development

2016-2017 TWENTY-SEVENTH ANNUAL REPORT

CENTRE FOR RESEARCH ON
SUSTAINABLE AGRICULTURAL
AND RURAL DEVELOPMENT,
CHENNAI

M. S. SWAMINATHAN RESEARCH FOUNDATION



Twenty-Seventh Annual Report

2016 - 2017



M. S. Swaminathan Research Foundation

Centre for Research on Sustainable Agricultural
and Rural Development
Chennai, India

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Chairperson's Introduction

This has been another exciting year for the Foundation with recognition from the Department of Science and Technology, Government of India, for a second phase core grant support to the Community Agrobiodiversity Centre (CAbC), Wayanad. CAbC also received a special grant from the Government of Kerala. Dr Ameenah Gurib-Fakim, Hon'ble President of the Republic of Mauritius, visited Chennai, delivered a Millennium Lecture and inaugurated the Genetic Garden of Halophytes at Vedaranyam, a garden initiated with a collection of 29 species of halophytes. Dr V. Selvam, Executive Director was honoured with the Emblem of the Her Royal Highness Princess Maha Chakri Srinidhorn of Thailand for his work on mangrove conservation and management.

The activities of the Coastal Systems Research programme were extended to the west coast of India with a project to revive the Kagga saline rice cultivation system in the coastal districts of Karnataka, and another to develop a Community Water Knowledge Centre in the Kuttanad region of Kerala. The Fish for All Research and Training Centre continued its outreach with training and capacity-building programmes in 163 coastal villages of Tamil Nadu and Puducherry. They also signed memorandums of undertaking with local colleges under the UGC Institute Industrial Collaboration Programme to train students in fish processing and post-harvesting technology.

Our focus on agro-biodiversity has involved working with communities in different parts of the country. The Kolli Hills Agri-Bioresource

Producer Company Limited, set up in the year 2015, has grown with 530 tribal farm households as members and a business plan to procure and market millets, fruits and spices under the brand name of Kolli Hills Natural Foods. In order to create economic stake in the conservation of agrobiodiversity, the CAbC in Wayanad facilitated formation of a farmer producer company named Wayanad Agri Marketing Producer Company Limited (WAMPCo), for marketing traditional varieties of rice, vegetables, coffee and pepper. Around 140 rice landraces and 20 millet landraces were conserved and grown at the Biju Patnaik Medicinal Plants Garden and Research Centre, Jeypore, and in a cluster of villages near the centre. In the Koraput region, 26 Biodiversity Management Committees (BMCs) were formed in 26 gram panchayats with the support of the Odisha State Biodiversity Board.

The Ecotechnology programme continued to work on enhancing the production of pulses in partnership with farmers' organizations and government departments, and covered around 4700 farmers and 3200 ha. Sustainable production technologies to raise crop productivity and a collective approach to input and output services was promoted through four farmer producer organizations so as to provide economies of scale to small farmers.

The Biotechnology programme continued to further our understanding of salinity tolerance mechanisms in wild rice, *Porteresia coarctata*, bringing us closer to developing saline-tolerant rice varieties. Extensive genetic diversity studies

of rice germplasm show encouraging prospects for the biofortification approach to address micronutrient deficiencies, particularly zinc and iron deficiencies. Genome editing tools are being employed to raise transgenic systems. Culture protocols of nine lichens have been standardized and three novel compounds were characterized this year. These compounds were screened against TB pathogens, of which one has shown promising results. Research progressed on biocontrol agents and methods of treating distillery effluents.

The Food Security programme has begun a major task of disseminating the concept of Farming Systems for Nutrition, across different stakeholders in the states of Andhra Pradesh, Bihar, Maharashtra and Odisha with support from TATA Trusts. MSSRF has implemented the Mahila Kisan Sashaktikaran Pariyojana in Maharashtra and Odisha, and undertaken capacity building of more than 5000 women farmers across 105 villages.

We celebrated 10 years of the development of the Fisher Friend Mobile Application or FFMA by scaling it up across India. The FFMA app is now available in nine languages on Google Play Store. FFMA was one of the four finalists among 245 nominations for the Mobile for Good (M4G) Award, instituted by NASSCOM Foundation, in partnership with Vodafone Foundation. The Information, Education and Communication programme extended its online learning programme of leadership and innovation for public library professionals in India through the International Network of Emerging Library Innovators for all countries of South Asia. The Village Knowledge Centres

in real and virtual forms disseminated location-specific information of contemporary relevance to nearly 160000 people in rural areas, two-fifths of whom were women.

The Gender and Grassroots Institutions programme continued to support other Programme Areas in integrating gender into all phases of project planning and implementation. They also implemented the Clima Adapt project on improving water use efficiency through integrated science-stakeholder approach in three states. A measure of success of the programme is that the eight Village Knowledge Centres established by MSSRF have now been handed over to relevant stakeholders.

The Leveraging Agriculture for Nutrition in South Asia (LANSA) partnership research programme entered its final synthesis phase of consolidation and writing. The programme aims to make its interventions sustainable in its two field sites in Koraput and Wardha. At the same time, evidence from ongoing research is being presented to policymakers for leveraging necessary support for uptake. An animation film titled *South Asia: Women in Agriculture – the Nutrition Connection*, conceived and developed by the LANSA Research Uptake team and launched globally on March 8, International Women's Day, received over 1000 views by June 2017.

The consistent efforts of *The Hindu* Media Resource Centre (THMRC) have resulted in a cumulative outreach of over 200000 persons every month through our website and social media spaces such as Facebook and Twitter, in addition to newsletters and mainstream media. We have a new website, redesigned

and launched at the trustees' meeting in May 2017, along with a plan for communication and research uptake. A good example of a strategic communication partnership during the year was working with International Crop Research Institute for the Semi-Arid Tropics (ICRISAT) to develop the Smart Foods campaign for millets, a campaign that was selected as one of 11 Global LAUNCH Innovations. THMRC is also partnering with UNICEF to set up a Nutrition Alliance for the state of Tamil Nadu.

MSSRF organized several seminars, workshops and conferences during the year. The first of these was a Regional Consultation on Pulses for Addressing Food and Nutrition Security held during our Foundation day last August. Many eminent scientists participated in the event, including Dr David Bergvinson,

Director General, ICRISAT, and Dr Mahmoud Solh, Director General, International Centre for Agricultural Research in the Dry Areas (ICARDA). Later in the year, Dr Matthew Morell, Director General, International Rice Research Institute (IRRI), visited and delivered the Millennium Lecture.

I end by thanking all the staff and scholars of the Foundation for their commitment and hard work. I am deeply grateful to the trustees for their active involvement and advice in defining the future of the Foundation. I thank our donors for their support and goodwill.

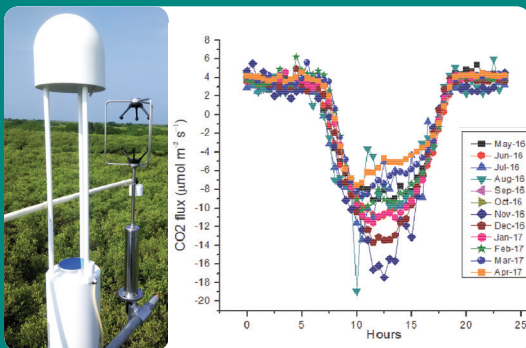
Dr V. Selvam, Dr G.N. Hariharan and Ms B. Jayashree coordinated the preparation of this Annual Report. Ms Suni Ann Sebastian edited the contents and AMM Prints printed it. I record my appreciation and gratitude to them.

Madhura Swaminathan
Chairperson

COASTAL SYSTEMS RESEARCH

The programme benefitted about 30000 people directly and 90000 indirectly in building their livelihoods. The Genetic Garden of Halophytes was inaugurated by Dr Ameenah Gurib-Fakim, the Hon'ble President of Mauritius. A total of 54 dry evergreen coastal forest species, planted earlier, had grown appreciably in nine locations. Reviving cultivation of the saline soil rice of Karnataka called "Kagga" and developing a decentralized pest and disease forewarning system based on weather variables were two projects that were newly launched. The Fish for All Research and Training Centre reached out to 163 villages and an MoU was signed with three colleges under the UGC Institute Industrial Collaboration Programme to train students in fish processing and post-harvesting technology. The activities of the Integrated Fish Farming System (IFFS) resulted in successful integration of various components of crop and animal husbandry and aquaculture, and farmers getting a net income in the range of Rs 40000–62000. A thematic WhatsApp group was started to enable sustainable fishery management in coastal Tamil Nadu.

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Sub Programme Area 101

Mangrove and Non-mangrove Coastal Bioshields

Navi Mumbai: Planting was completed in 5 ha of degraded mangroves using 4000 nursery-raised saplings of *Avicennia marina* and *A. officinalis*. In addition, 10000 *A. marina* seeds were dibbled. A mangrove nursery with 10000 multiple species was set up. Digging of canals was initiated in another 10 ha.

As part of education about and conservation of mangroves, training on mangrove restoration and nursery raising was imparted to both women and men belonging to the local fishing community. Street plays (in three locations), painting competitions (four schools) and an audio-visual programme were organized for the schoolchildren of the region.

Karankadu: Planting was done in 5 ha of the degraded mangroves in Karankadu village, in partnership with the Village Development Committee (VDC) members, using the canal method. Orientation regarding mangrove restoration techniques was organized for 40 members of the VDC.

Veerankoil: As reported in earlier years, the local community restored about 365 ha of degraded mangroves in Muthupet jointly with MSSRF during 1996–2003. In the same time period, 60 ha of degraded mangroves owned by the Tamil Nadu Forest Department have also been identified for restoration.

Krishna: The Andhra Pradesh Forest Department has given permission to restore 200 ha of degraded mangroves in Sorlagondi Reserve Forest to enhance the adaptive capacity of the local community to issues related to rise in sea level. About 1 lakh mangrove saplings of *A. marina* are being raised in two nurseries, and these will be planted in the restoration area.

Sub Programme Area 102

Integrated Mangrove Fishery Farming System

Tamil Nadu: In Veerankoil, the community started culturing sea bass in 3 ha of Integrated Mangrove Fishery Farming System (IMFFS) ponds with technical support from MSSRF. About 1000 wild seeds of the sea bass fish collected by fishermen were stocked. The average weight of the stocked seed was about 50 g. The survival and growth of the stocked fish seeds was also monitored. During the year, the entire area was fenced off, and mangrove saplings were planted along the bunds of the IMFFS ponds. The survival rate of mangroves was almost 90 per cent.

Andhra Pradesh: Twelve IMFFS ponds were established during this year with their bottom levels being 1 m below sea level. The excavated soil was used to strengthen the bunds and to form mounds inside the ponds. These ponds have approximately 60–65 per cent of water-covered area and the remaining 35–40 per cent is used for mangrove plantation

in the form of mounds. The water-covered area is being used to grow fishes/crabs/shrimps. About 4500 *Rhizophora* propagules were planted along the bunds as well as on the mounds at the high-tide level. Sluice gates were constructed for water exchange during tides.

Stocking of the ponds: Stocking of crabs in the IMFFS ponds was started in June. In all 12 ponds the farmers stocked a total of 2375 crabs. The crabs while stocking weighed between 100 and 150 g. Harvest was done after 3 months and a weight range of 400–800 g was recorder. In total, the farmers harvested 1801 crabs (76 per cent survival rate) and earned a net profit of Rs 527310. They used trash fish as feed, since the natural feed available in the pond was not sufficient for the crabs. They also expressed that the profit could be increased with poly-culture using shrimps and crabs.

Sub Programme Area 103

Biosaline Agriculture

The halophyte genetic garden in Vedaranyam was enriched with 29 halophyte species. Brackish water is used for irrigating this garden. Dr Ameenah Gurib-Fakim inaugurated the genetic garden on 18 November 2016.

The Department of Agriculture, Government of Karnataka, supported MSSRF, Chennai, in undertaking a programme entitled “Research on Halophyte Cultivation for Saline Soil Reclamation in Karnataka.” The aims were:

to identify saline-tolerant crops such as paddy and other traditional crop varieties by applying varietal characterization using conventional molecular methods; to assess vulnerability of agriculture livelihood systems of coastal communities in Karnataka to the adverse impact of predicted sea-level rise; and to identify suitable areas for cultivation. Further it will also identify different halophytes suitable for biosaline agriculture and appropriate agronomic practices in collaboration with University of Agricultural Sciences, Dharwad (UASD), and Zonal Agricultural and Horticultural Research Station (ZAHRS) in Brahavar.

The following objectives were taken up for implementation during this year:

- Documenting the salient features of Aghanashini estuary for recognition as a Globally Important Agricultural Heritage Systems (GIAHS), by FAO, for its dynamic conservation.
- Mapping of soil salinity for Developing Soil Watch, a web-based GIS decision support system for promoting soil health in the coastal districts of Karnataka.
- Carrying out phenotype and molecular characterization of salinity-tolerant Kaggla paddy (report given in Section 301.9 of PA 300).

As a first step, a rapid field survey was undertaken in the coastal districts of Karnataka during January 2017. This survey showed that farmers in the coastal areas of Uttara

Kannada, Udupi and Dakshina Kannada districts cultivate a traditional saline-tolerant variety called “Kagga” in saline-affected lands called *ghazani*. In the *ghazani* lands paddy cultivation is taken up during the monsoon season and prawn culture follows immediately after the paddy harvest. It is currently practiced in an area of about 2000 ha in the Aghanashini estuary. However, only few farmers are cultivating this paddy variety due to its poor yield, low market demand and conversion of *ghazani* lands to prawn farms. Moreover, small and marginal farmers expressed the non-availability of quality seeds of Kagga as one of the major problems in cultivating this variety. As a part of the drive to strengthen Kagga cultivation in the Aghanashini estuary two Village Seed Banks were established in Halkar-Hegde and Manikatta villages. MSSRF also released a brochure on Kagga paddy entitled “Community Seed Bank for *in-situ* Conservation of Kagga and other saline tolerant farmer’s varieties in Coastal Karnataka” both in Kannada and in English.

A questionnaire, in Kannada and English, was developed to document the details of Kagga farmers, farm families, associated agrobiodiversity, food and livelihood security, local and traditional knowledge systems, cultures, value systems and social organization, and landscape and seascape features of the Aghanashini estuary.

During this period, soil samples were collected from the Chakra River estuary (13°38’39.43”N, 74°41’28.68”E) with a grid size of 100 m by

100 m. The collected GPS data along with EC and pH were interpolated using ArcGIS software. Initially, 100 samples were collected in 10 clusters. Each sample was given a code. Further collection of soil samples and analysis of nutrients will be carried out by ZAHRS, Brahmavar.

Sub Programme Area 104

Integrated Coastal Zone Management of the Vedaranyam Coast

Major project activities are being implemented in six hamlets and a revolving fund for women salt workers covers another twenty-three hamlets. During the year, activities were initiated in two new villages. As a major activity non-mangrove plantation was established and maintained in 61 acres. Causality replacement and watering of the saplings were done. In this area, sizable populations of 54 species belonging to the tropical dry evergreen coastal forest (TDEF) are being grown in nine locations. Monitoring of the revolving fund provided to increase income from current livelihood in 12 project villages is ongoing. Necessary handholding and training activities were organized. A total of 101 women salt worker groups were formed with 707 enrolled as members. A revolving fund to the tune of Rs 14 lakhs was provided to 238 members belonging to 34 groups. This fund was used by the members for various needs such as developing micro-enterprises, children’s education, health and so on. Building of an

interpretation centre, landscape development and halophyte genetic garden activities are also happening. Three trainings sessions on crab culture, marine conservation and fish value addition were also conducted.

As part of the restoration of Sambalam Lake near Vedaranyam, participatory rural appraisal was carried out. The lake spreads across panchayats of Kadinalvayal (49.5 ha) and Aadhanur (17.5 ha). Farmers from Kadinalvayal, Kovilthav, Aadhanur and Karuppampulam are using the lake water to irrigate about 1000 acres of agricultural land. The lake receives water from the Manankondan River. A sluice gate in the river regulates the supply. The lake has 12 canals with 4 on the northern and 8 on the southern side. These canals act as inlets during the monsoon season and they are used as irrigation canals during the summer season. A topographic survey has been carried out to map the depth of lake water to plan de-silting activities. The elevation levels were surveyed in the grid size of 25 m by 25 m. The results showed that the depth of the lake varies from 2.0 m (in the periphery) to 2.5 m (middle).

Sub Programme Area 105

Fish for All Research and Training Centre

Fish for All Research and Training Centre is focusing on improving the socioeconomic condition of coastal communities by adopting

a holistic approach to resource management, sustainable livelihood and disaster preparedness. Livelihood programmes are being implemented in 17 coastal villages of Nagapattinam and Karaikal districts and the training programmes covered 163 villages across Tamil Nadu and Pondicherry coasts. During the year, new livelihood interventions, namely, ornamental fish culture, low-input aquaculture and using Global Positioning System in sustainable fisheries, were initiated (Table 1.1).

Table 1.1: *Livelihood interventions for women groups*

S. no	Livelihood interventions	No. of women involved	Income from the enterprises (Rs)
1.	Fresh fish trade	25	33341
2.	Dry fish processing	50	46071
3.	Fish value-added products	12	15357
Total		87	94769

Fish Processing Plant

The centre continued the strengthening of the capacity of *Winmeen* Mahalir Fish and Fish Products Producer Association for collective procurement, processing and marketing of fish products. The association has 132 fish vending women from 11 self-help groups (SHGs) of 6 villages, of which 40 women were newly enrolled during the year. Four livelihood activities, namely, fresh fish trade, dry fish production, value-added fish products and fish culture, were implemented through this association engaging 87 fisherwomen. From August 2016 to January 2017, the total

production of different fish items that were processed and sold from the unit stood at 4.78 tonnes, and the earned income was Rs 61428. Compost preparation using the waste from the processing unit has been standardized. During the year, 153 kg of fish waste compost was prepared. Since there is a good demand, upscaling this as one of the promising enterprises is being planned.

Winmeen Fisherwomen Association

On 8 March 2017, the *Winmeen* Fisherwomen Association facilitated by the centre entered into a trade partnership with a fish products chain, a Coimbatore-based for-profit social enterprise, to sell its high-quality fresh, dry fish and fish value-added products. Three groups from three different landing centres were formed and the centre provided credit and training on processing and packaging. Apart from this, they also established linkages with boat owners to ensure consistent supply of fish. The groups have purchased 1.83 tonnes of fish and earned a profit of Rs 33341.

As part of their CSR activities, the fish products chain from Coimbatore has given a fish van to Poompuhar village to support the livelihood activities of fisherwomen. Efforts are being made for an agreement among the Fisherwomen Association, the fish chain and Fish for All Centre to strengthen the activities.

Fish for All Training Centre

The centre gets regular requests for both residential and non-residential training

programmes from the fishing community, NGOs, students, bankers and fisheries department across the coastal districts of Tamil Nadu and Pondicherry. Based on the requests 54 training programs were conducted on topics related to integrated fish culture, fish farming, dry fish production and its quality management, ornamental fish culture, fish processing technology and value-added fish products. During the year, the centre has trained around 1295 fisherfolk and fish farmers (Table 1.2). Training course curriculum for ten major topics and two training manuals (fish processing technology and integrating fish farming system) were completed. Nearly 78 per cent of the participants rated the training programmes as useful and satisfactory. The feedback from the participants showed that the training sessions did improve their knowledge related to fish quality management and sustainable fisheries. As a result of awareness, fisherfolk in Poompuhar are avoiding plastic materials and not throwing waste nets into the sea, releasing mother crabs back into the sea, avoiding catching juveniles and regulating the dumping of garbage and waste on the shoreline. Two training courses, namely, field application of fisheries technologies and management of Fisheries Information Centre, were organized for the officials of the Fisheries Department of Tamil Nadu. A total of 45 newly recruited officials in the cadre of Assistant Director, Inspector and Sub-Inspector of fisheries have undergone a one-week training programme.

Table 1.2: **Training programme on marine and inland fisheries**

S.no	Topics	Total no. of participants	
		Male	Female
Marine fisheries			
1.	Marine biodiversity conservation and sustainable fisheries	265	57
2.	Dry fish production and quality management	0	150
3.	Fish processing and preservation technology	120	104
4.	Fish value-added products from low value fishes	0	98
5.	Effective management of fisheries information centre and fishing technologies	20	24
Inland fisheries			
6.	Integrated fish farming system	31	11
7.	Fish culture	82	6
8.	Ornamental fish culture	165	108
Total		683	612

Mass Awareness Campaign on Fish Quality Management and Sustainable Fisheries

Fish for All Research and Training Centre jointly with Network for Fish Quality Management and Sustainable Fishing (NETFISH), Nagapattinam, generated awareness on marine conservation and fish quality control measures. This programme was implemented in four districts of Tamil Nadu – Nagapattinam, Cuddalore, Ramanathapuram and Kanyakumari – covering seven major and minor fishing harbours. A total of 3037 fisherfolk from 46 fishing villages participated in the fish quality management and sustainable fisheries training programmes. On the eve of World Fisheries Day – 21 November – the centre organized a *coastal clean-up programme* at Poompuhar Fishing Harbour. Nearly 200 young fisherfolk, college students and traditional panchayat leaders collected about 500 kg of solid waste. After this event, the youth decided to clean the fish harbour every month.

MoU with Educational Institutions

Fish for All Research and Training Centre signed an MoU with three colleges (ADM College and GS Pillai Educational Institute, Nagapattinam, and Arignar Anna College, Karaikal) under the UGC Institute Industrial Collaboration Programme to train students in fish processing and post-harvesting technology. The aim of the initiative is to translate theoretical knowledge into practice and to create entrepreneurial avenues for students. A total of 144 students and 8 faculty members from these colleges completed the certificate course on the above subjects.

Integrated Fish Farming System

The Integrated Fish Farming System or IFFS is one of the major activities implemented and promoted by Fish for All Centre. Over a period of seven years, the Centre has facilitated fish farmers to integrate poultry, vegetable crops, cultivation of *Azolla*, vermiculture, apiculture,

dairy, goat farming, tree crops, fruit crops and fodder crops along with the fish pond. Out of 20 IFFS farmers, 8 integrated all of the above sub-components whereas the remaining have integrated three to five components due to the non-availability of land and water and distance between the house and farm land. On an average, a participating farmer was able to get a profit of between Rs 40000 and 62000 per acre during this year, which is considered as one of the worst drought years ever. Eight farmers harvested about 3243 kg of fish and sold it for Rs 486450 and got a net income of Rs 261204 from two fish crops.

The experiential knowledge of integrated fish farmers on the methods of fish fingerling stocking in farm ponds, *Azolla* production and concentrated feed preparation techniques was documented as a video training module by Access Agriculture with the technical support of Fish for All Research and Training Centre. The centre is analyzing the cost and benefit of IFFS in collaboration with the social studies division of MSSRF.

Community Pond Fish Culture

The centre extended technical support to 12 women fish farmers belonging to a scheduled caste (SC) from Thenpathi village for successfully managing the community pond fish culture programme. It helped them to harvest 171 kg of fish over a period of 6 months and earn an income of Rs 23160. The women were trained in water quality analysis, selection of quality fish feed, and feed and pond management practices on a regular basis. As a result, 36 underutilized farm ponds,

covering an area of 32.98 acres in 24 villages in and around Poompuhar, were identified for promoting fish culture.

A mini water-testing laboratory for measuring water quality parameters like salinity, pH, alkalinity, hardness, dissolved oxygen and ammonia was set up during September 2016 at the premises of the centre to address the needs of fish and shrimp farmers in and around Poompuhar. The main objective of this lab is to avail the appropriate services. The farmers are also linked with the Central Institute of Brackish Water Aquaculture (CIBA) and Fisheries Institute of Technology (FIT), Chennai, using ICT platforms for getting expert opinion for fish and shrimp culture practices and disease management.

Village Resource Centre in Fish for All Centre

During the year, 421 users (M: 246; F: 175) physically accessed a Village Resource Centre (VRC) and availed the knowledge services related to fisheries. A specific thematic advisory group has been formed for fisherwomen who are involved in fish processing and fish vending. So far 63 women from eight villages have registered in the group and are daily receiving one audio message on issues such as fish quality management, marketing, and personal and product hygiene.

A thematic WhatsApp group was formed by Fish for All Centre during May 2016 involving key stakeholders from Department Fisheries, Government of Tamil Nadu, Indian Coast Guard, Central Marine Fisheries Research

Institute (CMFRI), Tamil Nadu Fisheries University, fishermen leaders groups, students and MSSRF staff working in the coastal regions. A total of 298 individuals joined the group and shared information related to fisheries. So far, 322 posts related to fisheries schemes, marine conservation, job opportunities in fishing and marine sector, disaster alerts, government announcements, and schemes have been posted by the members.

Sub Programme Area 106

Remote Sensing and Geographical Information Systems

During this year, a project was initiated to develop a decentralized pest and disease forewarning system based on real-time, past and forecasted weather variables. The system will predict the occurrence of major pests and diseases in different stages of the major crops and identify the Economic Threshold Level for insects and pests and Critical Disease Level for pathogens. This generated forewarning information will be designed as simple information which is farmer-friendly and communicated through mobile network. The project is being implemented in three villages, Thennadar, Vanduvancheri (Thulasipatinam) and Kathiripulam, and village-level meetings were conducted to orient the project objectives and outcomes. Data was collected on seasonal crop mapping, crop types, cultivation practices and the major issues and solution for crop management through participatory rural appraisal. Traditional knowledge among the farmers on weather forecasting and its relation

to pest and disease incidence were also collected. GIS-based cadastral maps for the 36 village panchayats of Vedaranyam block were prepared.

The Field Measurement Boundary (FMB) level mapping was carried out in the above project villages. The responsive WebGIS-based pest management system has been completed using ArcGIS server and JavaScript and the testing is in progress. Automatic weather stations (AWSs) were installed in the three project villages. The collected weather data is analyzed and the forewarning sent to the farmers through SMS.

Spatial Distribution of Crops Using GIS and RS Technology in Karnataka

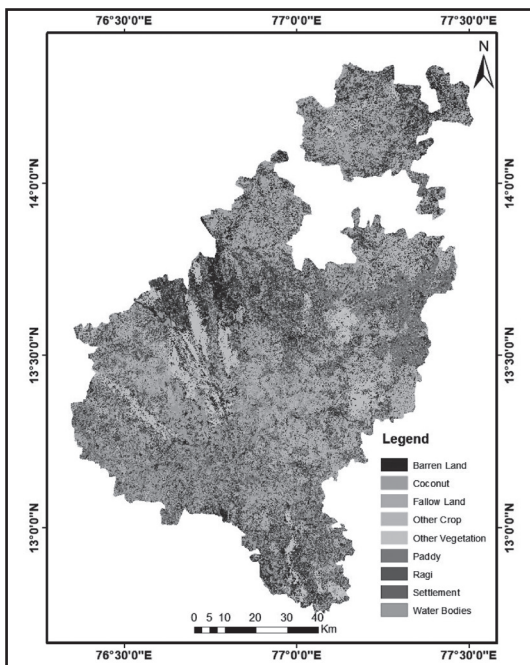
During the year, a study was carried out to identify and map ragi and other crops in Tumkur and Mandya districts for the years 2005, 2009 and 2015. Similarly the spatial distribution of jowar and other crops was carried out in Gadag and Dharwad districts using LISS III satellite images for 2005, 2010 and 2015. Geometric and radiometric correction was done for the satellite images using ERDAS imagine software and Google earth images as reference. To map ragi, jowar and other crops, a supervised classification method was used on preprocessed satellite image by means of spectral signatures and training sites of individual crops. The ground truthing was carried out to verify the crops in all four districts. The details of different land use classes and crops in Tumkur district are given in Table 1.3 and Figure 1.1. The results of the study revealed that remote sensing

technique is an effective tool for estimating crop areas and can be used for decision and policymaking.

Table 1.3: ***Different land use classes and the changes in land area in 10 years***

Land use classes with cropping pattern	Area (ha)		
	Dec 2005	Nov 2009	Oct 2015
Ragi	79344	82300	75507
Paddy	84451	79226	83833
Sugarcane	38640	27117	39803
Barren land	88177	67235	20902
Fallow land	17863	109781	58292
No data (cloud cover)	49669	6167	94877
Jowar	3583	9265	3899
Other vegetation	10859	109503	80736
Settlement	1254	12259	20918
Water bodies	1667	13685	14719

Figure 1.1: ***Spatial distribution of ragi and other crops, Tumkur district.***



Land use and land cover analysis around Sambalam Lake, Vedaranyam

The LISS IV (5.8 m resolution) satellite image was procured from National Remote Sensing Centre (NRSC) of the Indian Space Research Organisation (ISRO). The land use/land cover maps were prepared by classifying the satellite images using the visual classification techniques for the command area. The land area irrigated by the Sambalam Lake, the source of water and the main irrigation channels were mapped. The details of the land use/land cover of the area are given in Table 1.4.

Table 1.4: ***Land use/land cover around Sambalam Lake, Vedaranyam***

Land use/land cover	Area (ha)
Casuarinas	392
Paddy	924
Marsh land	12
Mud flat	2
Other crops (jasmine etc.)	61
Other vegetation (scrub jungle – Prosopis)	135
Plantation (mango, cashew etc.)	356
Settlement	12
Water	179

Sub Programme Area 107

Greenhouse Gas Fluxes in the Mangrove Ecosystem

This study aims to find out whether the mangroves act as a sink or source of CO₂ and CH₄. A 10-m tall eddy covariance (EC) flux tower was established in the Pichavaram mangrove

to measure CO₂, CH₄ and meteorological parameters such as air temperature, relative humidity, soil temperature, wind speed, wind direction, precipitation, solar radiation, photosynthetic active radiation (PAR) and line PAR. The tower is powered by three solar power systems (one of 24 v and two of 12 v each) with rechargeable batteries. In addition, soil heat flux, soil temperature and electrical conductivity are measured at two levels (2.5 and 5 cm). Automated soil CO₂ flux system was installed to monitor the soil CO₂ flux using four long-term chambers and eight atmospheric CO₂ profiling with multiplexer system.

Air-Mangrove CO₂ Fluxes: Regarding atmospheric CO₂, a maximum concentration of 466.28 ppm was observed during the night time in December 2016 and a minimum value of 376.44 ppm was observed during the daytime in July 2016. Preliminary analysis of EC-based data showed positive CO₂ flux values ranging from 0.39 to 7.03 $\mu\text{mol m}^{-2} \text{s}^{-1}$ during night time due to ecosystem respiration and negative CO₂ flux values ranging from -0.783 to -14.56 $\mu\text{mol m}^{-2} \text{s}^{-1}$ during daytime due to photosynthesis. Net annual ecosystem production (NEP) and seasonal and annual net ecosystem exchange (NEE) will be quantified next year.

EC Data CH₄ Fluxes and Concentration:

The mean concentration of CH₄ emission was 2033 $\pm$ 190 ppb or 1.436 mg m⁻³ (atmospheric methane concentration is 1847.9 ppb by NOAA 2017). The mean diurnal methane fluxes varied from -6.28 to 4.9 $\mu\text{mol m}^{-2} \text{s}^{-1}$. The maximum methane concentration of 4339 ppb

was recorded in November 2016 and minimum value of 1881 ppb was recorded during July 2016. The preliminary study showed that the mangroves act as a net source for CH₄.

Air-Water CO₂ Fluxes: Air-water fluxes were measured in and around the mangrove from January 2014 to April 2017. The mean value of CO₂ flux in water surrounded by mangroves was 57.10 mmol m⁻² d⁻¹, whereas the mean flux value in freshwater zone was 37.21 mmol m⁻² d⁻¹ and the mean flux value in marine zone was 21.48 mmol m⁻² d⁻¹ indicating that the water-covered area in the mangrove wetland is acting as a source of CO₂.

Sub Programme Area 108

Climate Change Adaptation

The United Nations Framework Convention on Climate Change (UNFCCC) has accepted establishing mangroves as a vital step towards combatting the ill effects of climate change and integrated mangrove fishery farming systems are identified as important interventions to enhance the adaptive capacity of local communities to rising sea levels. A project has been sanctioned to demonstrate this in the coastal areas of Krishna district. This project is being implemented in three villages, namely, Sorlagondi, Nalli and Basavanipalayam.

Entry point activities in all three villages were completed during the year. These activities were: (1) elevating the roads in the low-lying areas in Sorlagondi; (2) strengthening of bunds and fencing of freshwater ponds in Basavanipalayam; (3) desilting of drainage

canals for the freshwater ponds; and (4) laying cement pipes for passage over the drainage canal in Nalli.

During the reporting period orientation meeting was organized for the community on climate change vulnerability and sea-level rise. Forty members (24 men and 16 women) from the three villages participated. Awareness materials on climate change and sea-level rise and importance of mangrove resources and its conservation needs were distributed to people living in all three project villages.

As described elsewhere in this report, 200 ha of degraded mangroves are being restored and IMFFS has been established in 15 ha as part of the project.

Sub Programme Area 109

Integrated Rural Development

Awareness on Health, Sanitation and Safe Drinking Water: The local families were sensitized on the importance of health, sanitation and safe drinking water through village-level meetings and by using folk media (*Burrakhada*). Awareness materials in

Telugu on the aforementioned themes were distributed to the community.

Individual Household Latrines (IHHL): The Government of Andhra Pradesh sanctioned 720 toilets under the “Swachh Bharat Mission” (SBM) in the three project villages. Out of this, 317 toilets had been constructed in the past year, and during this reporting period another 250 toilets, where the construction cost was shared by the government (Rs 15000 per toilet) and the project (Rs 3000 per toilet), were constructed. Nalli village has attained “100 per cent open defecation free village” status as all the households have toilets. Awareness on health and hygiene and the project support have helped the villagers in constructing toilets in all houses. The use of toilets by the villagers has also improved appreciably in all the three villages due to regular awareness programmes.

Medical Camps: Eye, ENT, diabetes and general medical camps were organized in all the three project villages, namely, Sorlagondi, Nalli and Mangalapuram. MSSRF facilitated the visit of medical practitioners from Machilipatnam and Puritigadda PHC (Primary Health Center) in Challapalli Mandal and

Table 1.5: *Details of medical camps in the three project villages*

Village	Eye camp		ENT camp		Diabetes camp		General	
	Male	Female	Male	Female	Male	Female	Male	Female
Sorlagondi	43	16	47	20	34	12	—	—
Nalli	31	51	26	6	26	16	—	—
Mangalapuram	113	118	39	31	54	45	54	60
Total	187	185	112	57	114	73	54	60

their interaction with the village community members. A total of 842 village community members attended the medical camps. Medicines were provided free of cost. About 111 spectacles were provided to the villagers and the cost was shared equally by the community and the project. The details of the camps are given in Table 1.5.

Drinking Water Facility: As the drinking water supplied via the pipeline from the Mangalapuram main tank is not reaching the SC Colony (North) of the same village, a bore well was dug in this colony. As a result, water supply twice a day had been ensured. This has reduced the drudgery of the women. A similar set up was made for the benefit of Eenayapalem hamlet of Mangalapuram. In both these hamlets nearly 370 families utilize this facility.

Solid Waste Management: A total of 30 dustbins were provided in Mangalapuram, 13 in Nalli and 7 in Sorlagondi to avoid littering in the streets. These dustbins are 3 feet in diameter and 2.5 feet in height.

Solar Lights and Biogas Units: As the project villages are prone to cyclones, the

villagers face electricity problems during disasters. Moreover the power supply during the night time is erratic. Hence, 13 solar lights and 2 solar-powered LED lamps were installed during the reporting period. In Mangalapuram, 18 biogas plants were constructed with the support of New & Renewable Energy Development Corporation of Andhra Pradesh Limited (NERDCAP). The project provided Rs 5000 for 14 members (12 from backward class (BC) and 2 from general category) and Rs 3000 to 4 SC members and the government contribution to BC and other category is Rs 25000 and to SC it is Rs 27000. The villagers realized the usefulness of the renewable energy and also save on LPG cost.

Training and Capacity Building: Training programmes were organized for vermicompost preparation and *Azolla* cultivation in Mangalapuram for 48 farmers. One demonstration unit each of vermicompost and *Azolla* cultivation was established to understand the process. The Government of Andhra Pradesh has sanctioned two vermicompost units in this village, and another 15 units are in the pipeline.

BIODIVERSITY

Some of the key results achieved in the biodiversity programme in the Kolli hills, Wayanad and Koraput are reported. Farmers of Kolli hills processed about 12.96 tonnes of millets and sold value-added products worth Rs 11.41 lakhs. The “Kolli Hills Agri-Bioresource Producer Company Limited” has grown with 530 tribal farm households as members. The Kitchen Garden Programme reached out to 805 tribal families who have harvested about 21500 kg of vegetables. The Community Agrobiodiversity Centre (CAbC) at Wayanad received the second phase core grant support from the Department of Science and Technology, Government of India, and a special grant from the Kerala State Government. The centre facilitated the formation of Wayanad Agri Marketing Producer Company Limited (WAMPCo) to engage in production and marketing of traditional varieties of rice, vegetables, coffee and pepper. The food and nutrition programme reached out to nearly 500 families belonging to the Paniya tribes. The centre organized a series of training programmes for members of the Panchayat Raj Institution in the area of mainstreaming biodiversity in local development. The Botanical Garden raised and distributed about 100000 saplings of medicinal, rare, endangered and threatened (RET) species, ornamental and horticultural species. In Koraput, 26 Biodiversity Management Committees (BMCs) were formed in 26 gram panchayats with the support of the Odisha State Biodiversity Board. About 4423 medicinal plant seedlings of 12 species were raised and distributed and around 140 rice and 20 millet landraces were conserved on the farm. Several innovative actions were taken to improve the yield and consumption of the millet diversity found in this region.

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Sub Programme Area 201

Community Conservation Programme in Kolli Hills

201.1 Integrated Tribal Development Programme

The major components of this programme are Wadi development (orchards covering horticulture, agriculture and sylvi-culture crops in a 1-acre model), soil conservation, water resource development, women empowerment, community health, and training and capacity building. The project has so far covered 805 tribal farm families from 40 settlements of Thiruppuli (213 farmers), Gundur Alathur (212 farmers), Alathur (190 farmers) and Gundani Nadu (190 farmers) panchayats.

Orchard Maintenance and Monitoring:

Orchard monitoring is an ongoing process and during the year the Wadi farmers are assisted with the use of organic manure, bio-insecticides and bio-fungicides, basin weeding, shading, staking, mulching and irrigation of 805 acres of land.

Supply of Organic Inputs and Survival

Estimation of Horticulture Plants: Use of organic inputs like farmyard manure, neem cake, bio-fertilizer, bio-fungicide and bio-pesticides is promoted in 805 acres. About 483 metric tonnes of farmyard manure and 11.21 metric tonnes of bio-inputs are used for the same area. Mortality assessment is carried out every month on a participatory mode. The current survival rate is 93.40 per cent.

Intercropping in Wadi Farms: Wadi farmers are encouraged with the cultivation of little millet, finger millet, foxtail millet and sorghum; 142 farmers adopted millet intercropping and 16755 kg of millets were harvested. Nearly 60 per cent of the output is consumed by families and the remaining is value added and sold as Kolli Hills Natural Foods (Table 2.1).

Table 2.1: **Details of millet intercropping and yield, kharif 2016**

Panchayat	No. of farmers	No. of acres	Yield (kg)	Consumed (kg)	Sold (kg)
Thiruppuli	53	15	3755	2850	875
Gundur	47	25	5000	2000	3000
Alathur	27	27	5000	3000	2000
Gundani	15	15	3000	2000	1000
Total	142	82	16755	9850	6875

Soil Conservation and Water Resource

Development: Water resource development is a critical component of the Wadi, and so far 215 percolation ponds out of 400 have been completed in the project villages. The funds allocated for the remaining 185 percolation ponds were used for digging ten common wells, three each in Thiruppuli and Gundur Nadu and two each in Alathur and Gundani Nadu panchayats. These common wells are used for irrigation of Wadi farms and also as

Table 2.2: **Details of V bunds and trenches constructed**

Panchayat	Trenches (acre)	V Bund (acre)
Thiruppuli	140	180
Gundur	51	121
Alathur	37	53
Gundani	56	60
Total	284	414

a source of drinking water for villagers. In addition, compartmental bunds or V bunds and trenches were also constructed (Table 2.2).

Kitchen Garden and Nutrition Supply:

During the reporting period, several village-level awareness camps were organized to create awareness on nutrition-related issues. In addition, high-yielding varieties of vegetable seeds, including tomato, brinjal, chilly, green leaves, lady's finger, ribbed gourd, bitter gourd, cucumber, bottle gourd and pumpkin, were sourced and distributed to all 805 farmers. During the year, 805 tribal families harvested about 21,500 kg of vegetables (Table 2.3).

Table 2.3: ***Details of kitchen garden and yield, kharif 2016***

Panchayat	No. of farmers	Total yield (kg)	Consumed (kg)	Sold (kg)
Thiruppuli	213	7500	4995	2505
Gundur	212	6000	4000	2000
Alathur	190	4500	3800	700
Gundani	190	3500	2900	600
Total	805	21500	15695	5805

On-Farm, Off-Farm and Non-farm Enterprises through Credit Support:

There were 150 project participants who received a total loan amount of Rs 3005000 and individual loan amounts in the range of Rs 15000–30000 to start the on-farm, off farm and no farm enterprises.

201.2 Millet Cultivation and Expansion

Identification of Millet Farmers and Sources of Seeds: The project team has conducted orientation meeting in all 14 village panchayats and identified 214 millet-growing farmers to

take up activities in 148.8 acres. The project team sourced various local and high-yielding varieties of finger millet, little millet, Italian millet, common millet, sorghum and pearl millet from seed keepers and custodian farmers in Kolli hills and surrounding area of Namakkal district. The seeds were distributed after testing for viability and based on farmers' preferences. Recommended packages of practices for millet trials, such as supply of viable seeds, appropriate seed rate, locally suited high-yielding varieties, line and row planting, proper spacing, application of organic manure, proper thinning and weeding and so on, were promoted.

Yield Enhancement Trial: Yield enhancement trial was taken up to help farmers get higher yield from small millet cultivation by promoting farmer-friendly and improved agronomic practices. Two methods of cultivation were followed in the same field for comparative study: one was row planting (monocrop and intercrop) using a furrow maker and recommended packages of practices; and another was the broadcasting method or farmers' practices (monocrop and mixed crop). During kharif 2016, 100 farmers successfully organized a demonstration of these methods. Cost and return assessment trial was done for these 100 farmers using both line sowing and broadcasting methods. The results of the study show that average grain yield using the farmers' practices was 6.84 quintal per hectare whereas it was 8.39 quintal per hectare when using the improved agronomic practices. Table 2.4 clearly shows that the farmers got 22.38 per cent of higher yield than they would

using their practices by a simple modification of their method of cultivation. They received Rs 8634.88 as net return from the modified method while the return using their method stood at Rs 7014.64, which means that they got 23.10 per cent additional income from improved practices. The details of average costs and returns are indicated in Table 2.4. Farmers cultivated millets by using farmyard manure, vermicompost and neem oil. They learned to handle simple agriculture tools like furrow maker and cono weeder, and tribal farmers also got various trainings on production of vermicompost and bio-inputs.

Table 2.4: Average costs and returns of cultivation (demonstration)

Input	Average cost and returns (Rs/ha)	
	Improved practice	Farmers' practice
Seeds	449.50	525.80
Fertilizers	882.16	635.91
Plant protection	40.40	23.37
Irrigation	0.00	0.00
Ploughing	3696.92	2716.43
Human labour	13441.90	11642.43
Total cost	18510.88	15543.94
Grain yield (q ha ⁻¹)	838.642	684.42
Fodder yield (q ha ⁻¹)	797.296	736.75
Gross return	27145.76	22558.58
Net return	8634.88	7014.64
Cost-Benefit (B:C) ratio	1.47	1.45

201.3 Linking Agro-Biodiversity Value Chains, Climate Adaptation and Nutrition

Context Analysis, Livelihood and Gender Assessments on Millet Enterprises and Understanding Value Chain on Millets:

During this year, as a part of International Fund for Agricultural Development (IFAD) project, livelihood capital and gender assessment was carried out in Kolli Hills Agro Biodiversity Conservers Federation in Tamil Nadu and Maheshmati Tribal Farmers' Producer Company and Vindhavasini Farmers' Producer Company in Mandla and Dindori districts of Madhya Pradesh. The purpose of the study was to assess the livelihood capitals of farmer producer organizations (FPOs), such as physical, financial, social, human and natural capitals and gender participation, using the research framework of Bioversity International to understand the contribution of value chains related to underutilized crops in managing socioeconomic and climate risk. In addition to that, state-level millet value chain research was conducted in Tamil Nadu (in the millet growing districts, viz., Namakkal, Salem, Perambalur, Ariyalur, Villupuram, Thiruvannamalai, Vellur, Dharmapuri, Krishnagiri, Madurai and Virudhu Nagar) as well as in collaboration with Action for Social Advancement in Mandla and Dindori districts of Madhya Pradesh. In both sites, the research team interacted with various stakeholders involving millet farmers, procurers, middlemen, small traders, mundies, agriculture extension officers, PDS in-charge, processing mills, KVK, ICDS officers, project officers, cooperative society staff and NGOs to understand the roles of value chain actors and existing institutional arrangements. The results obtained through these studies are being analyzed.

With the support of IFAD, as a part of the handholding exercise, the project team

continuously extended support to address technical issues, facilitated monthly review meeting of community-based institutions and periodically assessed the status of mills, enterprises and weather stations.

Vermicompost Production: The project monitored 87 tribal farmers who have vermicompost production units. Adequate training was provided on production, handling and application of vermicompost. About 19005 kg of vermicompost was produced by these farmers and used for their crops.

Pulverisers of Finger Millets: The pulverisers being monitored were established in the previous years at Sempuvalvu, Navakkadu, Padasolai, Periyakovilur, Puliampatti, Thiruppuli Orpuram, Thuvareppallam and Vendalappadi of Kolli hills. These processing mills are managed by self-help groups (SHGs) and farmers' clubs and have helped in reducing the drudgery involved in millet processing as well as creating opportunities for additional income. Details of millet mills and processing are given in Table 2.5.

Village Knowledge Centres and Automatic Weather Stations: Village Knowledge Centres (VKCs) and Automatic Weather Stations are located in six places across Kolli hills and are managed by local SHGs and farmers' clubs. Strategies are worked out to help the VKCs and Village Resource Centres (VRCs) operate on their own with the involvement of local youth.

Production and Marketing of Kolli Hills

Natural Foods: There are 11 value-added products such as ragi malt, little millet rice, Italian millet rice, little millet flour, Italian millet flour, little millet upma mix, little millet bajji mix, Italian millet payasam mix, Italian millet laddu, ragi murukku and ragi flour that are being produced and marketed. During the reporting year, 12.96 tonnes of millet value-added products were sold and an overall gross income of Rs 11.41 lakhs earned.

201.4 Kolli Hills Agri-Bioresource Producer Company Limited

An FPO is nurtured in the name of Kolli Hills Agri-Bioresource Producer Company Limited

Table 2.5: *Details of millet processing, 2016–2017*

Name of millet mill	Ragi flour (kg)	Rice flour (kg)	Wheat flour (kg)	Ragi malt (mixed grains in kg)	Total (kg)
Sempuvalvu	94.5	17	110.5	–	222
Navakkadu	77	–	342	–	419
Padasolai	26	–	29	150	205
Periyakovilur	143	7	90.5	–	240.5
Puliampatti	36	121	91	–	248
Thiruppuli Orpuram	51	43	68	–	162
Thuvareppallam	147	34	214.5	–	395.5
Vendalappadi	1316	54	130	–	1500
Total	1890.5	276	1075.5	150	3392

(KHABCol) at Kolli hills with financial support from NABARD. The major objective of the FPO is to build capacity of the farmers' collectives to access financial and non-financial supports such as bank linkages, value-added products and marketing of primary products. The FPO comprises of small and marginal farm families of five village panchayats of Kolli hills. So far, 530 tribal farm households have been registered as members. The details of memberships are given in Table 2.6.

Table 2.6: **Membership of KHABCol**

Panchayat	Villages	No. of FIGs	Male	Female	Total
Alathur Nadu	8	8	46	48	94
Gundani Nadu	8	7	60	44	104
Thiruppuli Nadu	9	8	159	36	195
Gundur Nadu	14	13	121	4	125
Vazhavanthi Nadu	1	1	12	0	12
Total	38	37	398	132	530

FIGs: Farmers' Interest Groups.

Of the total farmers, small farmers are 273, marginal farmers are 220 and large farmers are 37. Each farmer has contributed Rs 1000 as share capital and so far Rs 530000 has been collected by the FPO. The Board of Directors (BoD) consists of one chairman, five directors and five executive members with equal participation of men and women members.

Major target crops are millets, fruits (jackfruit, mango, pineapple, orange, lime), cashew, pepper, coffee and pulses. The BoD and Chief Executive Officer (CEO) of the FPO prepared a business plan and strategies for

the next five years. There were 31 orientation training programmes conducted across 38 settlements covering the 530 farmers. The training sessions are focused on formation of FPO, farmers' mobilization, formation of farmers' interest groups and linking with banks, and share capital collection. Fifteen training-cum-exposure visits have been organized for BoD members and the CEO on formation of FPOs, roles and responsibilities of the CEO, farmers' mobilization, database management, share capital collection, equity grants and credit guaranty fund.

201.5 Training and Capacity-Building Programmes

The project team organized a number of on-spot and outside training and capacity-building programmes. About 164 training programmes have been organized under tribal development programmes, Farmers' Producer Company, millet cultivation and VRCs and VKCs in which 3280 tribal farmers (M: 1863; F: 1418) participated.

Sub Programme Area 202

Community Agrobiodiversity Centre, Wayanad

A notable milestone of the year was marking the twentieth anniversary of CAbC. The Department of Science and Technology, Government of India, sanctioned core-grant support for another 5 years, and a special grant from the Kerala Government also came during this year.

202.1 Food Security and Livelihood Enhancement Initiatives

Food and Nutrition Security Initiatives:

Food and nutrition security activities aimed at enhancing the nutrition security of 482 Paniya and Kattunaikka families in six hamlets in two panchayats and one municipality of Wayanad district were implemented. According to the nutrition assessment study conducted by MSSRF among the Paniya families in 2015–2016, 90 per cent of the children in the age group 6–10 are underweight, 100 per cent have deficient calorie intake and 90 per cent face deficient protein intake. More than 80 per cent children have deficient carbohydrate and 72 per cent children face deficiency of fat intake. It was noted that the rate of protein intake deficiency was increasing alarmingly in the higher age groups of 11–18, 19–40 and 41–59, which was found to be continuing throughout the life span of the person. Hence, local tuber varieties, legumes and leafy vegetables, which are rich in protein and minerals, were provided to establish “Home Nutrition Garden” in select households to reduce protein and iron deficiency. Their preference for local varieties was also taken into account during crop selection. Good quality local seeds of two tuber varieties of *Dioscorea alata*, taros, elephant foot yam, amaranthus, cow pea, bushed cow pea, winged beans and sword beans were provided along with other common vegetables. These tribal families were provided with skills training and design of a nutrition garden. Proper consumption of the produces was ensured through awareness classes for select members of the tribal households.

Orchard Development and Animal Husbandry:

Programmes for livelihood enhancement of 302 families that include 158 Kattunaikka, 135 Paniya and 9 Kuruma tribal households were completed. A total of 39211 seedlings of various crops were planted (Table 2.7).

Table 2.7: **Seedlings of various crops planted**

Species	No. of seedlings distributed	No. of families
Pepper	15573	251
Coffee	15573	251
Arecanut	5187	251
Gooseberry	1039	251
Mango	460	251
Rambuttan	460	251
Garcinia	460	251
Coconut	459	251
Total	39211	251

Dairy and goatry units were promoted to increase the income of tribal families. Now, a total of 29 families are engaged in dairying.

Production and Value Chain Development of Mushrooms:

For increasing the income and rural employment opportunities, mushroom cultivation was promoted among women belonging to socially and economically weaker sections in Puthoorvayal, Pozhuthana, Mukkilpeedika and Kolagappara villages. A total of 20 women, including 12 tribal women, were involved in the production of mushrooms. Four units produced a total of 972 kg of oyster mushrooms during the reporting period with an average production of 20 kg per month (Table 2.8). The groups are selling mushrooms at the rate of Rs 250 per kg.

Table 2.8: **Bio-inputs and mushroom produced as part of livelihood development**

Bio-inputs/ mushroom	Quantity produced (kg)	No. of farmers involved
Trichoderma	260	18
Pseudomonas	150	18
Mushroom spawn	2000	1
Mushroom	972	30

Production of Bio-inputs: Three bio-input production units were established in three villages which were also run by trained tribal women. These units produced a total of 260 kg of *Trichoderma harzianum* which was given to the farmers of respective regions during the reporting period. Basic infrastructure and space for the bio-input production units were provided by farmers of the region and respective gram panchayats.

Promotion of Pepper and Ginger Cultivation: This activity is being implemented among 280 tribal families, spread across five hamlets in Wayanad district. About 8,500 pepper vines were raised at four nurseries established in four intervention villages. Fifteen decentralized pepper nursery units were also set up in two select villages, which were run by “lead farmers.” Direct poly bag method and serpentine method were adopted for raising pepper vines in the nurseries. About 10000 pepper seedlings were also produced and distributed from these decentralized nurseries.

Soil and Water Resource Management: About 14500 sq m of earthen bunds and 1720 cubic meter of rainwater pits for 153

households and 91 beneficiaries were constructed with work participation and contribution of the farmers. As part of water resource development, two ponds measuring 20 m by 19 m by 4.5 m were dug. Renovation of five shallow wells was completed during the reporting period. A total of 56 families got access to safe drinking water due to the well renovation.

Social Mobilization and Community Leadership: Village-Level Planning Committee (VPC) of participating families was formed with eleven members (40 per cent women). A Purchase Committee (PC) comprising five representatives of the VPC is being actively engaged in the purchase of seedlings, organic manure and vegetable seeds. This committee has been registered under the Societies Registration Act.

Effort to Strengthen Grassroots Institutions: The grassroot institution (GRI) activities in Wayanad focused on promoting collective action in agrobiodiversity conservation, crop diversification in farmlands and safeguarding the interest and rights of tribal communities over agrobiodiversity.

Wayanad Tribal Development Action Council and SEEDCARE: A total of 22 groups have been formed among tribal communities at the village level to strengthen the ongoing community effort to conserve plant genetic resources at the local level in the district. These groups consist of 526 families belonging to four different ethnic groups. They mobilized Rs 568000 as capital and

started collective farming in 64 ha of land. During the reporting period, they cultivated 9 varieties of traditional rice, 26 varieties of vegetables, 17 varieties of tubers and 11 varieties of pulses. As an initiative to document the existing agrobiodiversity, community-level agrobiodiversity registers have been prepared by these groups. At the apex level, the Wayanad Tribal Development Action Council (WTDC) partnered with MSSRF in implementing the project “Adivasi Youth Skill Development Programme.” During the reporting period, 11 tribal youths found employment either with the government or in the private sector owing to the training programmes. The Community Agro-biodiversity Awards instituted by WTDC were given to *Adivasi* families during the Wayanad Community Seed Festival. This award is given every year to recognize the families engaged in the conservation of traditional rice varieties and other valuable agrobiodiversity in their region.

Wayanad Agri Marketing Producer Company Limited: The centre facilitated the formation and registration of a farmer producer company named Wayanad Agri Marketing Producer Company Limited (WAMPCo) with an authorized capital of Rs 5 lakhs. The major activities of the company include marketing of traditional varieties of rice, vegetables, coffee and pepper and providing technical support to increase the productivity and quality of traditional crop varieties having food and economic value. The company initiated marketing of organic farm produces worth Rs 1 lakh during the year.

202.2 Education, Communication and Training

Education, Communication and Training (ECT) programme of CAbC has the vision of empowering tribal and rural families in conservation with sustainable use of biodiversity and aims to work with multiple stakeholders for promoting the concept of sustainable development through knowledge, skill and technology transfer. A total of 4,596 farmers, students and Panchayat Raj Institutions (PRIs) were trained during the year.

Capacity building of PRIs: To facilitate and motivate gram panchayats in the conservation of agrobiodiversity, capacity-building programmes were initiated in six panchayats of Wayanad district. In partnership with National Institute of Rural Development and Panchayat Raj (NIRD&PR) a series of ten programmes for PRI members was organized to orient them on integrating environmental concerns in local-level planning. The 3-day-long programme covered topics related to biodiversity, agrobiodiversity, climate change, environmental issues of Kerala, sustainable agriculture, sustainable development, natural resource management and so on.

Wayanad Community Seed Fest: With the support of grassroots institutions such as WTDC and SEEDCARE, a Wayanad Seed Fest was organized to create awareness on the importance of conserving seeds of traditional crop varieties, and their medicinal and economic value. A total of 133 farmers including 43 women, representing 26 local self-

government bodies of Wayanad, Kasargod and Kannur districts of Kerala and Nilgiri and Namakkal (Kolli hills) districts of Tamil Nadu, exhibited traditional seed diversity. The Seed Fest was attended by 1700 individuals, including farmers, students and policymakers.

Retaining Youths in Agriculture: To retain tribal youths in agriculture through dissemination of innovative farming methods and value addition of farm products training programmes were organized in collaboration with the Rajiv Gandhi National Institute of Youth Development. The objective was to expose tribal youths in various farming techniques to enhance their income. A total of 688 youths benefitted from this training programme.

Training and Capacity Building for Farming Community: A total of 247 training programmes covering topics relating to food security, livelihood, crop management, livestock management, value addition, organic

farming and pepper and ginger cultivation were organized during this year. These programmes saw a participation of 4,596 tribal farmers (M: 1748; F: 2849).

Every Child A Scientist Programme:

To promote education on biodiversity and environment among children, Every Child A Scientist (ECAS) activities are implemented at CAbC, selected schools and tribal hamlets. A total of 95 students enrolled at three levels (30 at the ECAS hub centre; 30 at schools; and 35 at tribal hamlets). The activities covered regular classroom lectures, field visits and interaction, project works, making of working models, preparation of audio and print contents and so on.

Meetings/Workshops/Seminars: A total of two national-level and three state-level training programmes, which included students, farmers and scientists, were conducted in different subject areas. A programme called Bio Education Travel Package was introduced

Table 2.9: *Details of national-level and state-level meetings/workshops/seminars*

Training programme	Duration	No. of participants
“Agrobiodiversity Conservation & Sustainable Livelihoods” – national-level training workshop supported by DST	5 days	36 delegates
“Formulation of Projects under Climate Change for Funding under National and International modes” – national-level training workshop supported by BIRD, NABARD	4 days	26 delegates
“Biodiversity and Climate Change” – state-level vocation training programme supported by KSCSTE	15 days	29 students
Good food campaign of GRI programme	3 days	360 farmers
Internship/research supervision	1–3 months	17 students
Bio-Education Travel (BET) Package	34 days	509 farmers
Total		977

for training farmers in the lead farmers' fields. Details of the programme are given in the Table 2.9.

202.3 Biodiversity Conservation

Biodiversity Conservation programme focused on M S Swaminathan Botanical Garden (MSSBG) and on the conservation of RET species and crop genetic resources in farmers' fields.

Conservation of RET Plant Species of Cultural, Curative and Conservation Value:

Aimed at the conservation of medicinal plants, the *Punyavanam* programme was initiated at three sacred places, namely, Manikavu, Kootakkavu and Pazhassi tomb. A total number of 2075 saplings of 124 sacred and culturally important medicinal plant species were planted at these places with the active participation of local communities and PRIs. Environment Day in the district was observed in association with the district administration with a unique programme named "*Ormamaram*" – every new voter planting a tree sapling in memory of casting their first vote. More than one million saplings were planted in the whole district as part of this programme in which MSSRF was one of the key partners.

With the support of Kerala State Biodiversity Board and Biodiversity Management Committees, cultivation and value addition attempts were done for six species of medicinal plants at five panchayats in Wayanad. Over 100000 saplings of medicinal, RET, ornamental and horticultural species were produced and distributed during the reporting period. The awareness programme on medicinal plants

was continued with four campaigns targeting students, farmers and SHGs. Validation of one herbal formulation for the cattle disease "mastitis" had been initiated in collaboration with Kerala Veterinary and Animal Science University. As per the request of the Kerala Forest Department, floristic survey was taken up at four notified ecologically fragile land (EFL) of the scheduled properties in Wayanad, and the reports submitted. It resulted in retrieval of 51.6 ha of disputed forest land from private owners, which has been vested with the Kerala Forest Department, Government of Kerala.

The 20 different components meant for conservation of various groups of biodiversity established at MSSBG were properly maintained and augmented with 36 RET and other important species. During the reporting period 12156 visitors visited MSSBG for various purposes.

Conservation of Crop Plant Genetic Resources:

Field surveys were continued for locating, identifying and documenting traditional varieties of food crops (tubers, yams, spices, vegetable and fruit crops) in Wayanad, Kozhikode and Malappuram districts. Crop germplasm at the centre was strengthened with traditional varieties including twelve new leguminous crops, six new varieties of banana/plantain, six varieties of yams/tubers, two varieties of ginger and four varieties of other vegetable and fruit crops. Further, three community conservation plots were continued at farmers' plots for conserving twenty-two traditional varieties of cow pea at Meppady, Wayanad.

Sub Programme Area 203

Biju Patnaik Medicinal Plants Garden and Research Centre

203.1 Conservation of Biodiversity

Ex situ conservation of ethno-medicinal plants: A botanical conservation garden located within the campus of the centre garners special attraction from local plant lovers, academicians, students, scholars and local traditional healers. The garden has 384 ethno-medicinal plants including 27 RET medicinal plants. In addition, the garden demonstrated cultivation practices of 21 prioritized medicinal plants, which were promoted by the State Medicinal Plants Board of Odisha. During the year, 4423 medicinal plant seedlings of 12 species were raised in the nursery and distributed to schools, the Forest Department, NGOs, traditional healers and individual plant lovers. Seeds were harvested from medicinal and other tree species growing in the garden and supplied to the Forest Department for their nursery, which included two RET medicinal plants *Mesua ferrea* and *Saraca asoca*.

Conservation of Plant Genetic Resources: Around 140 rice landraces and 20 millet landraces were conserved, cultivated both as *in situ* conservation at MSSRF campus and via diversity blocks conservation in three cluster villages. Farmers were invited for exposure visit to conservation plots before harvest. Some of the farmers selected many varieties for cultivation in their fields for the coming

year. Seeds of selected varieties were sent to Community Seed Bank. During this year, 2.2 tonnes of paddy, 0.20 tonnes of millets and 0.35 tonnes of pulses seeds were distributed through seed banks to the farmers.

People's Biodiversity Register: People's Biodiversity Registers (PBRs) were prepared for 16 gram panchayats of Boipariguda, Jeypore and Kundura blocks of Koraput district. A total of 26 Biodiversity Management Committees (BMCs) were established in 26 gram panchayats with 182 members, of whom 33 per cent are women. In this year, an agreement was signed with the Odisha Biodiversity Board (OBB) for the preparation of two new PBRs. The documented records included information on 47 local rice varieties, 8 millet landraces, 16 tubers, 22 wild flowers, 27 wild fruits, 5 fumigating and chewing plants, 26 wild animals, 16 bird species, 17 fishes species and 21 insects species.

Ensuring Safe Drinking Water for Tribal Households: The project addressed eight communities such as Kandha, Bhumia, Paroja and Gadaba involving 848 households with a population of 3972 in 13 villages of Boipariguda and Kundura blocks. Deep bore wells were dug in each village with the installation of submersible pumps and the water was stored in overhead tanks having a capacity of 3000–6000 litres. Then, 3–13 stand posts were erected for supply of drinking water from the overhead tanks to village streets. Recharge filters of different sizes varying from 9 to 25 sq. m (as per the technology developed by CSWCRTI (Central Soil & Water

Conservation Research & Training Institute)) were constructed near the bore wells for recharging the groundwater. Water meters were installed in each tank to measure daily consumption and tap water system was ensured in all 13 villages. In the interval of every 2 months bleaching was applied for treatment as per the recommendation of rural water sanitation department (bleach 100 g: 1000 l). Before the establishment of the bore wells, the villagers used to collect drinking water from hand pumps, ponds, open wells and streams near the villages. A total of 130 community water soldiers and 13 water user groups were formed in these 13 villages to monitor the use of water, resolve conflicts and ensure sustainability.

203.2 Food and Nutrition Security through Millets

The centre actively engaged with tribal farming communities in Boipariguda and Kundura blocks of Koraput district since 2007 to conserve and promote large-scale cultivation of millets. Rice and millets are the major crops occupying maximum cultivable area. Millets form a part of the daily diet of the local communities. During kharif 2016, MSSRF initiated millet and sorghum cultivation in Jeypore with the financial and technical support of Indian Institute of Millet Research (IIMR), Hyderabad, under the Tribal Sub Plan (TSP).

A total of 41 villages in the Koraput, Boipariguda and Kundura blocks were identified for the promotion of millet cultivation. The project team conducted village-level orientation

meetings in all these villages and also collected basic socioeconomic data of tribal farming communities. The major source of income for these tribal families is agriculture and the major cropping season is kharif. More than 70 per cent of the farming communities are small and marginal farmers. The average annual income of these farmers ranges from Rs 10000 to Rs 15000. Rice and finger millets are the staple food. Multiple cropping and intercropping are the major cropping patterns in uplands and medium lands whereas solo cultivation is seen in the lowlands. Constant efforts were taken to create awareness about the importance of improved cultivars, improved method of millet cultivation, agro-input support and roles of MSSRF and IIMR in this venture. As a result, the project team identified about 647 millet-growing farmers covering 519.05 acres in 11 gram panchayats of 27 villages. Out of these more than 85 per cent are tribal farming communities.

Promotion of Improved Cultivars: In general, farmers of the selected villages use their own seeds of traditional varieties of millets and sorghum. Out of 20 traditional finger millet varieties cultivated earlier in this area, only 2 are now being cultivated. Due to the poor yield farmers lost interest in the cultivation of these millet varieties, and because of this the net millet sown area has drastically reduced. In order to revive the interest of the tribal farmers, the project introduced improved cultivars of finger millet and sorghum (GPU-66, BHARABI, CHILIKA, SUBHRA; CSH-14, CSH-16, CSH-25 respectively) by providing good quality seed materials supplied by the Odisha State Seed

Corporation, Indian Institute of Millet Research and DHAN Foundation.

Promotion of Improved Packages of Practices: The project addressed the issues of low productivity by providing a set of packages of practices such as quality seed materials, appropriate seed rate, fabricated row marker for line sowing, application of inorganic fertilizer as basal dose, space maintenance both for line sowing and row planting, nursery maintenance, application of bio-pesticides, timely sowing, thinning, weeding and harvesting.

Yield Enhancement Demonstration: Yield enhancement trial is one of the important activities taken up to help the farmer get a higher yield from millet cultivation through improved agronomic practices. Two methods of cultivation were followed in the same field for comparison: one was the direct sowing of millets by using row makers with improved packages of practices; and another was broadcasting method and following farmer practices. Simultaneously, transplanting of millet seedlings in line with proper spacing was also taken up. In all, the farmers were

Table 2.10: *Yield potential of finger millet (variety: CHILIKA)*

Method	Date of sowing	Date of harvest	Crop cutting (1 m x 1 m) Estimated yield			
			Avg. grain yield (kg)	Avg. fodder yield (kg)	Grain (kg/ha)	Fodder yield (kg/ha)
Broadcasting	12.07.16	25.11.16	231	228	2310	2280
Line sowing	22.07.16	19.11.16	370	237	3700	2370
Line transplanting	09.08.16	23.11.16	402	336	4020	3360

Table 2.11: *Yield potential of finger millet (variety: SUBHRA)*

Method	Date of sowing	Date of harvest	Crop cutting (1 m x 1 m) Estimated yield			
			Avg. grain yield (kg)	Avg. fodder yield (kg)	Grain (kg/ha)	Fodder yield (kg/ha)
Broadcasting	12.07.16	12.11.16	215	219	2150	2190
Line sowing	18.07.16	8.11.16	228	223	2280	2230
Line transplanting	05.08.16	21.11.16	317	291	3207	2910

Table 2.12: *Yield potential of finger millet (variety: GPU-66)*

Method	Date of sowing	Date of harvest	Crop cutting (1 m x 1 m) Estimated yield			
			Avg. grain yield (kg)	Avg. fodder yield (kg)	Grain (kg/ha)	Fodder yield (kg/ha)
Broadcasting	27.06.16	9.12.16	311	371	3110	3710
Line sowing	08.07.16	4.12.16	344	298	3440	2980
Line transplanting	19.08.16	12.12.16	406	316	4060	3160

Table 2.13: *Yield potential of finger millet (variety: BHARABI)*

Method	Date of sowing	Date of harvest	Crop cutting (1 m x 1 m)		Estimated yield	
			Avg. grain yield (kg) (three samples)	Avg. fodder yield (kg)	Grain (kg/ha)	Fodder yield (kg/ha)
Broadcasting	22.6.16	16.11.16	242	323	2420	3230
Line sowing	12.7.16	29.11.16	292	257	2920	2570
Line transplanting	03.08.16	22.11.16	331	308	3310	3080

exposed to the field both at vegetative stage and physiological maturity stage by organizing the farm day. Square meter crop cuttings were made from each plot in the presence of farming communities to understand the yield potential. The yield potential of improved finger millet varieties is shown in Tables 2.10–2.13.

Cost-Benefit Analysis: Data for cost-benefit analysis was collected from 320 tribal farmers who cultivated millets in about 215.5 acres. These farmers were randomly selected out of 620 farmers who cultivated millets in about 519 acres in the kharif season. It included farmers practicing broadcasting, line sowing and line transplanting. Costs of cultivation include seed cost, manure cost and labour cost, such as ploughing, sowing, weeding, thinning, harvesting and post-harvest processing. The return cost was derived from grain and straw yield. These factors were converted into money value based on current market value. Analysis of data indicated that farmers received 17.45 per cent of higher yield when using line sowing compared with farmer practices and 35.9 percent higher yield in line transplanting compared to farmer practices. The average benefit-to-cost ratio is 2:1.

Farmers' Field Day: Two farmers' field days were organized during the pre-harvest stage of the crops. Farmers from ten villages were invited to the millet-sorghum plot. They were encouraged to visit the large-scale demonstration plots of finger millet-sorghum planted using both line sowing and broadcasting. The farmers visited all the demonstration plots, measured the ear heads using their hands and counted the tillers and number of fingers. They also compared square meter yield of ear heads from broadcasting and line sowing and this provided an opportunity for them to realize that line sowing and transplanting methods produced more yield than the broadcasting method of millet cultivation.

Value-Addition Practices and Introduction of Suitable Machineries: During the baseline survey it was documented that there is no efficient technology for processing the millet grains at the village level. Such lack of technology has been forcing dependence on traditional methods of grain processing, which are tedious, time consuming and cause a lot of drudgery for women. Stone grinders are traditionally used by women for making flour

out of finger millet in villages. In the case of little millets, their dehulling by the traditional method is very tedious for women. Dehusking of this little millet is done by women using a wooden grinder. After this it is again dehusked and cleaned by a small hand pestle to get the rice. The extent of drudgery demanded from such operation is well imaginable. All these tedious post-harvest operations are performed by women. So the demand was communicated to ICAR-IIMR to install the millet huller unit to reduce the drudgery and provide quality food regularly.

Improving Livelihood Status of Marginal and Small Paddy Farmers: During this year under the tribal sub-plan – RICE (ICAR-IIRR), Hyderabad, supported a livelihood enhancement project for small and marginal tribal farmers. A total of 187 farmers were

involved in participatory demonstration trials in 13 villages covering 209 acres in low, medium and upland systems. Good Agricultural Practices (GAPs) such as summer ploughing, seed treatment, line transplanting, Integrated Nutrient Management, irrigation management (alternate wetting and drying) and Integrated Pest Management were demonstrated to farmers. The results indicate that in the lowland paddy system, the Var. 1001 recorded the highest yield (6660 kg/ha) followed by Var. 1010 (6497 kg/ha). However, the Var. Sahabhagi recorded 5811 kg/ha under upland rain-fed conditions, which was transplanted 22–30 days late compared to var. 1001 and var. 1010, which were cultivated under irrigated conditions and transplanted at the right time. The project team organized training on GAPs in paddy is shown in Table 2.14.

Table 2.14: **Organizing training/workshop/seminar/conference/others**

S.no	Name of the trainings/ workshops/etc.	Objective of the training	Date and venue	Participation		
				Male	Female	Total
1	Good agronomic practices	To impart new technologies for enhancing the yield	18 August 2016	63	21	84
			31 August 2016	61	14	75
2	Management of pests and diseases of paddy	To provide appropriate solutions for pest	27 September 2016	82	33	115
3	Management of pests and diseases of paddy	management	3 October 2016	98	27	125
4	Post-harvest technology and safe storage	To avoid post- harvest loss during storage	4 November 2016	79	36	115
			11 November 2016	100	26	126

Sub Programme Area 204

Community Gene Bank

This year, the Community Gene Bank (CGB) rejuvenated 30 stored paddy varieties. These varieties were multiplied in the experimental field at Indira Gandhi Centre for

Atomic Research (IGCAR), Kalpakkam. The rejuvenated paddy varieties were harvested and the seeds cleaned and stored in the Gene Bank. Five new saline-tolerant traditional rice varieties from Uttara Kannada District, Karnataka, namely, Kari Kagga, Bile Kagga, Mudpandya, Dasarpetta and Arya, have been added to the collection of germplasm of CGB.

BIOTECHNOLOGY

*The main focus of the programme is to develop rice varieties for abiotic stress tolerance and nutritional enhancement. A special focus is on isolating genes and understanding the molecular stress tolerance mechanism of *Oryza coarctata*. The bioprospecting programme has established lichen cultures for the biosynthesis of secondary compounds. The group has isolated a lead molecule against *Mycobacterium tuberculosis*. A large number of bacterial and archaeal strains isolated from mangrove and crop plant rhizospheres were screened for their plant growth promoting properties. The potential strains were subjected to on-farm trials to assess their impact on crops. The “Water 4 Crops” project demonstrated the reduced levels of pollutants and enhanced the water quality.*

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Sub Programme Area 301

Genetic Enhancement

301.1 Rice Biofortification with Enhanced Iron and Zinc

The 160 landraces of rice (reported earlier) were cultivated for the third season during November 2016–January 2017 at the experimental plots at Indira Gandhi Centre for Atomic Research (IGCAR), Kalpakkam. The dehusked seeds are under screening for their iron and zinc contents using energy dispersive X-ray fluorescence (ED-XRF) technique. While there is considerable variation among the 160 accessions, it has been observed that the values for polished and unpolished rice for a given genotype are comparable over the three seasons tested. This data conclusively proves the identification of select genotypes for high zinc and iron content. Detailed agronomic characteristics of all these 160 genotypes have been recorded and documented. Principal coordinate analysis of few important agro-morphological traits was done through a simple sequence repeats (SSR) marker analysis. The aim was to measure genetic diversity and its effect on agronomic traits among rice landrace genotypes. Diversity was measured using 25 microsatellite markers and 159 genotypes. Among the markers used, a total of 188 alleles were detected at 24 polymorphic SSR loci, while one locus was monomorphic. The number of alleles identified by each marker ranged from 2 to 15 with a mean of 7.52. Polymorphism information content ranged

from 0.2 to 0.686, with an average of 0.505. A dendrogram based on total microsatellite polymorphism grouped 159 genotypes into four major clusters. It can be inferred that this collection of germplasm harbours huge amount of genetic diversity and can be utilized in future breeding programs.

301.2 Studies on Genetic Diversity in *Moringa oleifera*

In the earlier years, the work on *Moringa oleifera* focused on exploration and collection of natural populations of *M. oleifera*. During this year subsequent population analyses and genetic diversity studies through SSR markers were carried out. The set of 20 SSR markers used in the study clearly explained the extent and nature of genetic diversity existing in the entire population set collected from natural population. The mean allele value, polymorphism information content (PIC) value and gene diversity indicate the wide genetic base in the collection. Results obtained from population structure analysis are in accordance with the PCoA and cluster dendrogram based on neighbour-joining tree. These samples were also subjected to inter-simple sequence repeats (ISSR) marker analyses – 39 markers were used, of which 15 primers produced reproducible and clear sharp bands. The 15 primers produced 100 bands with band sizes ranging from 0.25 to 3 kb. The percentage of polymorphic bands varied from 16.6 per cent to 88.8 per cent with an average of 54.6 per cent. Data analysis using POPGENE 32 software revealed an average observed number of alleles (N_a)

1.603 and effective number of alleles (N_e) 1.317. The mean gene diversity (H) and Shannon information index (I) were observed to be 0.188 and 0.288, respectively. Genetic variance analysis using AMOVA showed an 84 per cent variance within population and 16 per cent among the populations. The population structure analysis based on PCoA showed a maximum amount of variance in the first three axes with majority of the Tamil Nadu accessions getting clustered separately from rest of the accessions. The PCoA plot was observed to be similar to the results obtained from STRUCTURE and the maximum ad hoc measure of delta K was observed at $K = 2$. Based on the neighbour-joining tree three major clusters were observed of which majority of the accession from TN fall into clusters 1 and 3 with rest of the accessions getting clustered into cluster 2.

Leaf Iron Estimation: Considerable variation of iron content in the leaf samples were observed. About 50 mg of the dried tissue was used for estimation of iron content using Atomic Absorption Spectroscopy (AAS). The values ranged from 0.025 mg/g to 0.335 mg/g among the entire population. Sequence-related amplified polymorphism (SRAP) marker analysis is under way to identify accessions with high iron content. These results can be utilized to predict diverse genotypes for exploiting breeding programmes focusing on traits related to nutritional aspect and identifying the natural genetic variation existing in the Indian moringa population which will complement the Farming Systems for Nutrition (FSN) approaches.

301.3 Characterization of *NHX1* Antiporter Gene from *Oryza coarctata* (*OcNHX1*)

In the previous year, yeast complementation assays and effect of salinity stress on *OcNHX1* transgenic lines at the seedling stage were examined. *OcNHX1* transgenic seedlings showed a significantly elongated hypocotyl in the presence of NaCl, suggesting the ability to use Na^+ as an osmoticum for cell elongation. Subsequently, *OcNHX1* transgenic lines have been subjected to incremental salinity treatment and examined for (i) expression of *PcNHX1*, (ii) expression of endogenous transporter genes, (iii) leaf, stem and root Na^+/K^+ content, (iv) leaf chlorophyll, (v) malondialdehyde and (vi) proline content. *OcNHX1* transgenic lines show significantly lowered leaf Na^+ content, increased chlorophyll content and decreased malondialdehyde content, suggestive of enhanced performance under salinity stress.

301.4 RNA Isolation and RT-PCR Analysis of Purified Microhairs from Leaves of *O. coarctata*

About 6 g of *O. coarctata* leaves were scraped (abaxial surface), ground in suspension buffer and filtered sequentially through nylon meshes (100 μm , 70 μm , 40 μm). The pellet on the 40 μm mesh was resuspended in a fresh buffer and purified by continuous density gradient centrifugation (Percoll) using a fixed angle rotor. Microhairs present in the purified fraction were counted using a Hemocytometer. Cell viability was determined using propidium iodide staining and percentage of live cells

calculated. Total RNA was isolated from the salt glands and purified using lithium chloride. Reverse transcription-PCR (RT-PCR) analysis using gene specific (actin) primers confirmed that the RNA isolated was of transcription grade. This protocol will now be employed to study differential gene expression in microhairs of *O. coarctata* under salinity stress conditions.

301.5 Isolation of Partial HKT1;4 Genomic Sequence from *O. coarctata*

HKT1;4 transporters are involved in imparting salinity tolerance in wheat and rice. PCR-based genome walking method was employed for isolation of *O. coarctata* HKT1;4 (*OcHKT1;4*) transporter genomic sequence. The expected genomic size of *OcHKT1;4* is approximately 5.4–5.8 kb (3 exons and 2 introns). Primers designed for PCR were based on BLAST analysis of BAC end sequences *O. coarctata*/*Oryza* spp. (significant hits; sequence identity; query = HKT1;4 from *Oryza sativa*). Primers were also designed based on *O. coarctata* HKT1;4 partial sequence information. Seven PCR fragments were cloned in T-vector and sequenced. Sequence assembly was done for clones. All seven clones were examined for relatedness to reported *Oryza* genomic sequences using BLASTN (non-redundant (nr) and genome survey sequence (gss) databases). BLASTN analysis (nr) showed varying degrees of identity to *O. sativa japonica* HKT1;4 gene sequence [Accession number: AJ491853; Clone 1 (82 per cent), Clone 2 (84 per cent), Clone 4 (75 per cent), Clone 5 (75 per cent), Clone 6 (80 per cent), Clone 7 (84 per cent)]. Clone 3 did not show

any significant match with *Oryza* HKT1;4 sequences in the nr database.

301.6 Studies on Carbon Dioxide Enrichment in *Suaeda nudiflora* and *Sesuvium portulacastrum*

Halophytes withstand soil salinity and are an excellent resource for developing salt tolerance in crops. The effects of salinity (200 mM NaCl) and elevated CO₂ treatments in tandem on *S. nudiflora* and *S. portulacastrum*, which have different photosynthetic pathways, were studied: C3 and C4 are reported. The plants were grown in ambient (380 ppm) and elevated (500 ppm) concentrations of CO₂ using a mini-FACE facility. The total chlorophyll content, total soluble sugar concentration, lipid peroxidation level and electrolyte leakage were measured from fresh leaf samples collected at different time points. The results show a positive effect for elevated CO₂ concentration on salt tolerance in both C3 and C4 plants, and indicate that C4 halophytes may benefit from the rising atmospheric CO₂ concentrations. Elevated CO₂ concentration was effective in alleviating physiological damages of salinity stress in these two species. This positive effect of elevated CO₂ was more significant in C4 (*S. nudiflora*) plant on extended exposure than in *S. portulacastrum*, where the positive effects of elevated CO₂ in salt treatment was more gradual. Both plants showed negative and varying response at the 30-day (initial) time point to salt under elevated CO₂, which turned to positive and uniform at longer, extended time points. In the context of accelerated climate change, these results indicate that

prolonged atmospheric CO₂ enrichment may provide greater protection to the salt-sensitive C4 halophytes than the less-sensitive C3 halophytes. These results pave the way for better understanding of plant responses to salinity under increased atmospheric CO₂ concentrations.

301.7 Generation of CRISPR/Cas9 OsGORK Construct for Rice Transformation

Genome editing with engineered nucleases enabling site-directed sequence modifications for advanced plant breeding and crop protection has been taken up. The RNA-guided endonuclease technology based on CRISPR/Cas9 is an extremely powerful tool for plant genetic engineering. Guide RNAs have been designed for knockout of the *O. sativa* GORK gene (OsGORK) using the online tool CRISPR-P. GORK gene is a major selective outward-rectifying potassium channel of the guard cell membrane and is involved in regulation of stomatal movements according to water availability. Two guide RNA sequences (Guide RNAs 1 and 2) were independently annealed and cloned in *Bsa*I digested pRGEB31 vector (CRISPR/Cas9 binary vector). The clones were screened with colony PCR (guide RNA primer and vector sequence primer) and further sequencing. The guide RNAs were subsequently assembled into a single construct by PCR amplification of guide RNA2 and cloning in the Hind III site of the pRGEB31 carrying guide RNA1. This assembled construct carrying both OsGORK guide RNAs is being transformed

into an *indica* rice via *Agrobacterium*-mediated transformation.

301.8 RNA Transcriptome Profiling of Abiotic Stress-Tolerant Plants

In the previous years, drought as well as salt-stressed miRNA libraries of six abiotic stress-tolerant plant species (*Avicennia marina*, *Prosopis juliflora*, *Macrotyloma uniflorum*, *Chrysopogon zizanioides*, *Sorghum bicolor*, *Pennisetum typhoides*) were constructed and sequenced to generate roughly 10 million 50 bp single end reads per library. This year, the overall quality of reads was assessed and improved using several tools. Down sampling was done and length range filtering was carried out to limit minimum (16 bp) and maximum (36 bp) lengths, which were considered for further analysis. Aligned reads were extracted and checked for ncRNA (rRNA, tRNA, snRNA and snoRNA) contamination. The unaligned reads to ncRNAs were used for known miRNA prediction. Reads were made unique and hence read count profile was generated. Further, homology search of these miRNAs was done against *Viridiplantae* mature miRNA sequences retrieved from miRbase-212 database. Known miRNAs with copy number ≥10 were considered for target prediction. Statistical analysis, including count normalization and differential expression, was performed with edgeR using condition (drought/salt stressed or control) and sample (leaf and root) as factors. The stressed samples were compared to its control to identify the miRNAs. Differentially expressed microRNAs under drought and salt stress

conditions were identified and analyzed further for each of the species. Known and novel miRNAs commonly and differently responding to salt/drought stress in all the six species were identified and a list of most highly up-/down-regulated miRNAs was prepared. Target genes of the miRNAs were predicted and the metabolic pathways associated with them were analyzed.

301.9 Phenotype and Molecular Characterization of Salinity-Tolerant Kagga Paddy

During this period, the seed viability was studied by assessing the germination percentage of Kagga paddy landrace collected from the Ghazani land (salt swamps) of the Kumta region of Karnataka. The Kagga seeds were placed in petri plates containing moisturized cotton for germination after breaking the dormancy at 50°C for 5 days. The seeds germinated after 3 days in the dark at 30°C, and 90 per cent germination was observed on the sixth day. Growth parameters such as shoot and root elongation and number of leaves and leaf pigmentation were observed.

Seedlings were transferred to hypotonic solution (0.91 EC) and also to hypotonic solutions with varying EC treatments (2–12 EC) on the 31st day to assess their salinity tolerance level at the three leaves stage according to the IRRI screening of salinity-tolerant rice protocol. The plants displayed tolerance up to 6 EC for 16 days showing its moderate tolerance level. It was observed that

few plant survive even under 10 EC for upto 15 days of treatment.

Sub Programme Area 302

Bioprospecting

Lichen secondary compounds with their unique chemical profiles and established biological activity show great potential for drug discovery. MSSRF is bioprospecting many lichen compounds for their pharmaceutical significance through bioassay-guided procedures in partnership with accredited laboratories. These studies have resulted in the identification of leads against cancer, tuberculosis and multidrug-resistant bacterial pathogens.

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

MSSRF in partnership with the contemporary lichen laboratories, namely, National Botanical Research Institute (NBRI) and the Agharkar Research Institute (ARI), has established lichen mycobiont and whole thallus cultures for the biosynthesis of the secondary compounds of rich species. During the reporting period, MSSRF established lichen cultures of 15 species collected from the Western Ghats. The biosynthesized lichen compounds were isolated, purified and characterized and provided to collaborative laboratories, namely, 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* sp.1, *Diorygma* sp.1, *Glyphis cicatricosa*, *Graphis* sp.1, *Graphis* sp.2, *Phaeographis* sp. and three unidentified mycobiont cultures were generated.

Molecular Identity and Confirmation of Lichen Cultures: The subcultures of *Trypethelium eluteriae* were generated. In addition the DNA isolation protocol was standardized to confirm the molecular identity of *T. eluteriae* using its conserved Internal Transcribed Spacer (ITS) and mitochondrial small sub unit (mrSSU) primers. The confirmed sequences were submitted to NCBI.

302.3 Bioprospecting of Secondary Compounds

Isolation and Characterization of Secondary Compounds: During this year three novel compounds (MSSRF/TE/02, MSSRF/TE/09, MSSRF/TE/05) from *T. eluteriae* were isolated and characterized. The chemical data of these compounds was submitted to Cambridge Crystallographic Data Centre (CCDC).

302.4 Screening Lichen Extracts against Cancer Lines

Cancer Institute, Chennai, has screened 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). The extracts of MSSRF/L1/Ha1, MSSRF/L1/Se1, MSSRF/L5/Se1,

MSSRF/L5/Se1, MSSRF/L9/Ha1, MSSRF/L9/Se1, MSSRF/L11/Ha1/NBRI/L10/Ha1, ARI/L2A/Ha1, ARI/L3A/Ha1, ARI/L4A/Ha1, ARI/L5/Ha1, ARI/L6A/Ha1 and ARI/L5A/Se1 showed no significant anti-cancer activity.

302.5 Screening Compounds against Tuberculosis

The National Institute for Research in Tuberculosis, Chennai, has screened four promising candidate anti-tuberculosis compounds – ARI/L7/Ha1, ARI/L7/Se1, ARI/L8/Ha1 and ARI/L8/Se1 – with an MIC of 25 µg/ml and these compound are also active against Gram positive and MRSA strains. The compounds isolated from the cultures of *T. eluteriae* were further tested against non-tuberculosis mycobacterium species, and it showed activity against *M. pheli*, *M. chitae*, *M. parafortuitum*, *M. szulgai*, *M. kansasii*, *M. intracellulare* and *M. avium*.

Sub Programme Area 303

Microbial Diversity

303.1 Microbial Community Profiling of the Mangrove Ecosystem

The Obligate Halophilic Bacteria Community of Mangrove Rhizosphere: The 21 *Salinicola* strains isolated from *A. marina* rhizosphere belonged to obligate halophilic bacteria with sodium chloride requirement for growth. Taxonomic identification based on 16S rRNA BLAST analysis, the isolates MSSRFH1, MSSRFH3, MSSRFH4, MSSRFH5, MSSRFH6

and MSSRFH8, showed 99.7 per cent sequence similarity with *S. rhizosphaerae* MSSRFH1^T and *S. acroporeae* KM200719. Phylogenetic analysis of the six isolates clustered with *S. rhizosphaerae* in a single phyletic line suggesting they belonged to a single species. Further, biochemical characterizations suggested that the isolates MSSRFH9 and MSSRFH6 may be novel species in the genus *Salinicola*; this needs to be confirmed by polar lipid and DNA:DNA hybridization, which is under progress.

303.2 Biofertilization and Bioirrigation

During this year, the experimental trial on the concept of “biofertilization” and “bioirrigation” using consortia of biofertilizers was conducted in a mixed cropping system of pigeon pea (PP) and finger millet (FM) in the Kuttikiraipatty village, Valapur Nadu Panchayat, Kolli hills. The consortium of biofertilizers consists of arbuscular mycorrhizal fungi (AMF) and *Pseudomonas* sp. MSSRFD41, plant growth promoting rhizobacteria (PGPR). PP seedlings were raised in polybags with control (500 bags) and biofertilizer (1900 bags) treatment for five different experiments: (i) main experiment, (ii) plant density bioirrigation (PDB), (iii) on-farm trials (OFT), (iv) larger plot experimental trials and (v) root architecture studies.

In 2016–2017 the experimental trial with three treatments – (i) 100 per cent RDF (recommended dose of fertilizer), (ii) 50 per cent RDF and (iii) biofertilizer with 50 per cent RDF with PP direct sown and transplanted

– was tested. The randomized block design (RBD) design consisted of six treatments (T11, T12, T15, T11D, T12D and T15D) with four replicates. Treatment plots were of 3.9 m by 6.6 m dimension. In PP direct sown treatments T11D and T12D, two seeds were directly placed in the soil at 60 cm distances, and in T15D treatment, 5 g AMF was applied in the pit. The PP yield in the transplanting method was comparatively higher than in the direct sown. The results indicated that the absolute seed weight from the net plot area (3.9 m by 6.6 m) of direct sown treatments were as follows: T11D – 164 g, T12D – 118 g, and T15D – 117 g; while yields using the transplanted method were: T11 – 440 g, T12 – 317 g, and T15 – 445 g. The PP polybag seedlings showed three times higher yield than direct sown. PP seedlings established well in polybags, and were able to withstand drought.

In PDB experiment, varying PP-FM ratio was tested to understand its effect on bioirrigation. The best treatment T11 (AMF+PGPR with 50 per cent RDF) of the main experiment was chosen for this trial. The PDB plots size was 3.6 m by 7.2 m, to accommodate the PP-FM ratio. The RDB design of the PDB trial consisted of six treatments with four replicates. The six treatments consisted of monocropping (T1 and T2); mixed cropping with row planting (T3 – 8:2; and T4 – 2:4); and mosaic pattern (T5 – 2:8; T6 – 2:4). The growth and yield parameters showed that row planting provided better yield compared to mosaic pattern of PP planting. Finger millet yield was also better in

row planting compared to the mosaic pattern. Row planting of PP was found suitable for intercropping systems for better yield.

303.3 Microbes for Biotic and Abiotic Stress Attenuation

Field Testing of Plant Growth Promoting Biocontrol Strains against Fusarial Wilt in Tomato:

The trial was conducted in Pannapatti village of Dindigul district to test the efficiency of three plant growth promoting biocontrol (PGPB) strains, that is, *Bacillus* sp. MSSRFT15, *Pseudomonas chlororaphis* MSSRFC15 and *Pseudomonas* sp. MSSRFD41, against *Fusarium* wilt pathogen in tomato. Fish tonic applied plots served as control (farmers' practice). The RBD with nine treatments of individual and consortia of the three PGPB strains were maintained in triplicates. The tomato seedlings were planted as per the recommendation of Tamil Nadu Agricultural University (TNAU). The plot size was 3.75 m by 4.05 m, and tomato seedlings were planted with a distance of 45 cm between plants and 378 plants per plot. The harvesting was done in December 2016. The following biometric parameters – (i) plant fresh weight, (ii) plant dry weight, (iii) plant height, (iv) weight of ten fruits, (v) protein content of the fruit, (vi) lycopene content of the fruit, (vii) total yield and (viii) disease incidence – were recorded.

The results indicated that the disease incidence was very minimal in treatment with *P. chlororaphis* MSSRFC15 plus *Pseudomonas* sp. MSSRFD41 followed by *Bacillus* sp. MSSRFT15 alone. Maximum yield of 81 kg was

observed in *Bacillus* sp. MSSRFT15 followed by *Pseudomonas* sp. MSSRFD41 with 71 kg, whereas farmers' practice with fish tonic yielded 61 kg. All the three isolates enhanced yield and reduced disease incidence.

Bioremediation of Distillery Effluent Contaminated Sites Using Bacterial Isolates:

Melanoidin and phenolic compounds like cinnamic acid and benzoic acid derivatives are major constituents of distillery effluents and pose environmental pollution hazards due to their complex chemical nature. During this year, phenol degradation using bacterial consortia was carried out at the laboratory. About 74 phenol-degrading isolates were identified, and among them *Pseudomonas* sp. MSSRFPD2, *Alcaligenes* sp. MSSRFPD20, *Glutamicibacter* sp. MSSRFPD35, *Ralstonia* sp. MSSRFPD25, *S. maltophilia* MSSRFPD38 and *Pandoraea* sp. MSSRFPD40 used phenol as a sole carbon source in the range of 1000–1200 mg/L. Growth and phenol-degradation kinetics were studied in *Glutamicibacter nicotianae* MSSRFPD35, *Stenotrophomonas maltophilia* MSSRFPD38 and *Pandoraea* sp. MSSRFPD40 using Haldane's Kinetics model. *G. nicotianae* MSSRFPD35 was able to degrade phenol upto 1200 mg/L within 96 h. It grew on other phenol derivatives like *p*-nitrophenol, catechol, gallic acid, tannic acid, cinnamic acid, α -naphthol and 1-chloro,2,4 dinitro benzene. It also exhibited tolerance to lead (200 mg/L), zinc (600 mg/L), manganese (800 mg/L), iron (400 mg/L), chromium (100 mg/L), nickel and copper (10 mg/L). Thus *G. nicotianae* MSSRFPD35 can be used for reclamation of phenol-contaminated sites.

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

This project attempts to treat the sugar and distillery effluents of KCP Sugar and Industries Corporation Ltd. in their Lakshmipuram and Vuyyuru sites in Krishna district, Andhra Pradesh, and to reuse the water for agriculture.

Lakshmipuram Site: The water quality of raw and treated water from the constructed wetland (CWL) was measured fortnightly for its physico-chemical parameters since 2014. With each year, the outlet water quality improved significantly, which is an indication of stabilization of treatment in the system as the plants and microbes in the system are well adapted to the system's environment. With respect to the inlet and outlet concentration, the sedimentation rate is very low, which ensures longtime sustainable performance of the system. The oxygenation of wastewater is a very important part of the treatment, and it is done by (i) the removal of chemicals and biological matter that demands oxygen and (ii) supply of oxygen by diatoms, roots of Typha and free surface flow with intermittent loading (increased air/water interface). Thus the dissolved oxygen (DO) content of sugar effluent was enhanced simultaneously as the pollutant concentration decreased. The oxygen transfer rate (OTR) in the system was 1120 mg/m²d, which clearly proves the aforementioned process happening in the system.

The kinetics of pollutant removal was studied comparing the first-order, second-order and

Stover-Kin Cannon model, and it was found that the rate of removal followed second-order kinetics. The high removal rate (m) of different pollutants shows that the design features of constructed wetland substrates, including the hybrid flow pattern, govern the performance of the system. A modeling with Sub Wet 2.0 software was used to assess the performance and efficiency of CWL in treating the biochemical oxygen demand (BOD), nitrate and total phosphorus across all the seasons. Three scenarios were analyzed, namely, incremental and decremental (i) flow, (ii) BOD₅ and (iii) temperature. The results indicate that the treatment potential of the constructed wetland is appreciable across the seasons with different scenarios maintaining the treatment efficiency. Short-duration mixed cropping of brinjal, tomato, lady's finger, sweet corn, chilli, double beans and marigold was done in an area of 1040 sq. m and irrigated with bio-treated sugar effluent. Decentralized drip system was installed to increase the water use efficiency of the treated water from the fish pond. The short duration crops irrigated by drip for 125 days reduced the quantity of water used thereby contributing considerably to water saving. This excess water was supplied to the sugarcane farmer to irrigate his field. It was observed that the sugarcane yield was 45 tonnes per hectare which is 22 per cent higher compared with the harvest using water irrigated from the effluent treatment plant (ETP).

Vuyyuru Site: The sequential treatment of primary treated distillery effluent followed by the treatment through constructed wetland is

being continued in the site. The water quality data shows a stable result over 3 years, which substantiates the performance of treatment process. The sludge analysis from the aeration tank (AT) and the sedimentation tank (ST) showed that it has high nutrient value as compared to the bio-composted sludge derived from distillery waste (Table 3.1). This has good agribusiness potential for making a viable product for soil amendment.

Reuse of the bio-treated distillery water was done in cultivating halophytes (*Suaeda maritima*, *S. nudiflora*, and *S. portulacastrum*), sweet corn and moringa in 175 sq. m, 1512 sq. m and 174 sq. m respectively. The cultivation of halophytes is being carried out and monitored for their growth parameters. An increase in the height, shoot length and biomass has been observed as shown in Table 3.2.

Table 3.1: **Physico-chemical characterization of the sludge from sequential bio-treatment setup by MSSRF and the bio-composted sludge of the industry**

Parameter	Unit	Sludge from sequential bio-treatment (MSSRF)	Bio-composted sludge by KCP	Difference (%)
pH	–	7.54	7.59	
Total nitrogen (Kjeldahl)	mg/kg	29300	12300	58.02
Total phosphates as P ₂ O ₅	mg/kg	22800	11600	49.12
Potassium as K ₂ O	mg/kg	43400	22800	47.47
Magnesium as Mg	mg/kg	30783	900	97.08
Sulfur as S	mg/kg	5115	18200	-255.82
Zinc as Zn	mg/kg	574.56	0	100.00
Manganese as Mn	mg/kg	310.73	327.34	-5.35
Iron as Fe	mg/kg	19664.08	3017.42	84.66
Copper as Cu	mg/kg	100.5	36.87	63.31
Organic carbon	mg/kg	885500	388100	56.17

Table 3.2: **Growth parameters of halophytes under raw effluent and treated effluent water**

Halophytes	Height/shoot length in 120 days (cm)	
	Treated distillery effluent (T1)	Raw distillery effluent (T2)
<i>Suaeda maritima</i>	117.00	95.00
<i>Suaeda nudiflora</i>	114.10	116.80
<i>Sesuvium portulacastrum</i>	200.35	110.80
	Dry biomass in 180 days (g/sq. ft)	
	Treated distillery effluent (T1)	Raw distillery effluent (T2)
<i>Aeluropus lagopoides</i>	18.87	15.45
<i>Paspalum vaginatum</i>	44.30	33.46

In the three cycles of sweet corn studied earlier, the plots irrigated with treated water gave a good yield that was 12.7 per cent higher compared to that in fresh water (14.4 t/ha) and so a study to understand the income from sweet corn irrigated with treated water alone was done during December 2016–February 2017. The moringa PKM-2 was grown in treated, fresh and raw water with 40 plants in each plot (58 sq. m) with an area of 1.2 m by

1.2 m since September 2015. The average pods per plant in a year were 210, 223 and 103 in fresh, treated and raw water irrigated plots respectively. The average weight of pods in treated water (53.9 g/pod) was high compared to that of those in fresh water (51 g/pod) and raw water (35.9 g/pod). This shows that nutrient-rich water without melanoidin helps in increasing crop yield.

ECOTECHNOLOGY

The activities of the centre were focused on promoting sustainable farming through suitable technologies, practices and appropriate institutional mechanisms to strengthen the on-farm livelihoods of men and women farmers. Improved varieties, quality seeds, maintenance of required population and spraying of nutrient solution at the time of flowering were proved to be catalytic technologies in increasing the productivity of pulses. Participatory approaches in varietal selection, technology demonstration and exposure visits to the best practitioners proved to be useful learning and knowledge sharing practices for farmers. Use of ICT tools like voice mails, social media and websites are emerging as important platforms for learning and sharing of knowledge among small holders. The upscaling of pulse production was demonstrated through establishing partnership with the Department of Agriculture in Odisha and through farmers' networks via farmer producer organizations in Tamil Nadu. Access to irrigation for small holders in rainfed systems have proved to be a good strategy to increase and ensure the income of farmers in rainfed regions. The key learning of the grassroots institutions from the four field sites with respect to pulses, milk, organic vegetables, tamarind and other crops is that business models with horizontal integration of producers into collectives are working well in increasing farmers' income. The successful strategies were improvement in their bargaining power for better price in the market and reduction in the transaction costs due to economies of scale in production. The role change process in the management of grassroots institutions were facilitated well in two organizations and it was successfully demonstrated which provides the base for other organizations.

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Sub Programme Area 401

Coastal Regions

401.1 Puducherry State

Biovillages – Innuyir Grama Sangam:

Innuyir Grama Sangam (IGS) is a registered organization that functions with 2826 members, representing 270 self-help groups (SHGs) from 56 villages. During the reporting period 200 members were enrolled in the IGS. The total turnover during this period was Rs 575 lakhs, including members' savings, share capital and credit from banks. The repayment performance is consistently maintained at 98 per cent during the past 2 years. The role change plan was initiated during 2013–2014 and a considerable level of progress has been achieved in managerial, organizational and financial dimensions of sustainability. Now the federation is meeting out its entire administration cost and giving equal opportunities to all the members in Executive Body in taking up leadership positions on rotation. The accounting system has been computerized for better monitoring of its performance at the group, cluster and federation levels. Also it helps to ensure transparency at all levels and brings confidence to the external partners of the institution.

With regard to livelihoods, 32 training sessions on entrepreneurship were organized with field exposure, by which 301 members have taken up additional economic activities like vegetable and flower cultivation, dairy, calf rearing, and

so on. The total annual turnover of livelihood activity was Rs 78.28 lakhs which provides technical, financial and market support to the members. The federation is playing a key role in accessing quality inputs and this activity generated an annual turnover of Rs 28.24 lakhs. In line with the changes in bank policies, among the SHGs, joint liability group (JLG) approach was promoted to access credit from banks for strengthening livelihoods (dairy, goatery, backyard poultry farming, floriculture, vegetable cultivation, coir making, vermicompost etc.). In the reporting period IGS facilitated linkages with banks for 67 groups and members received Rs 137.10 lakhs as credit from various banks. Considering the higher proportion of single women members in the federation (22 per cent of total members) an exclusive association was promoted to address their specific needs and to support them in accessing their entitlements.

Sustainable Farming Systems: Under the Indo-Moroccan Food Legumes Initiative project pulses were integrated in the rice-based cropping systems and the practice of crop rotation was encouraged in the monocropping area. In 2016–2017, the main focus was to increase production and productivity of pulses, namely, blackgram, groundnut and moth bean, by enabling access to input and output market services and technical inputs to small holders. In order to identify varieties suitable to the region, six participatory varietal selection (PVS) trials were continued in blackgram using VBN 3, VBN 4, VBN 6, ADT 5, T 9, WBU 108 and Yasotha varieties. Farmers selected VBN 4, which performed well when compared

with all other varieties in terms of productivity and resistance to yellow mosaic virus (YMV). To improve the knowledge and skills of the farmers, seven farmer field schools (FFSs) were conducted and 30 farmers participated in each of the schools. The main themes covered were seed treatment, maintaining optimum plant population, use of recommended seed rate, 2 per cent di-ammonium phosphate (DAP) foliar spray at the time of flowering, cultivation of trap crops and integrated nutrient management based on soil tests. These practices resulted in an increase in the productivity of blackgram from 350 to 525 kg/acre during rabi season and from 400 to 600 kg/acre in the case of moth bean in post-rabi season (December–February). The cultivation of blackgram expanded to 550 acres in rice fallows, by horizontal expansion through producer groups.

Grassroots Institutions and Sustainable Livelihoods: The organization was registered in 2016 under Producer Company Act as

PASUMAI Farmer Producer Company Limited (PAFPCOL). A total of 549 shareholders (M: 143; F: 406) representing 31 groups in Mannadipet commune in Puducherry are the members of this company. Legal procedures were followed to appoint directors, chairman, managing officer and auditor was done as per the statutory compliances. Training and capacity building were organized for the member office bearers and directors of the company to efficiently act and function in their respective positions (Table 4.1).

During the past kharif season, the company extended support to obtain quality seeds of required varieties of groundnut, moth bean and blackgram to farmers and provided credit support to farmers for cultivation of pulses. During this year, the PAFPCOL initiated wholesale purchase of food grains and marketing, and 18 tonnes of food grain were marketed with a turnover of Rs 5.16 lakhs. The profit was distributed to shareholders as dividend of Rs 50–150 depending upon their

Table 4.1: *Training and capacity-building programmes organized to strengthen the governance of PASUMAI FPO*

Target group	Details of the programme	No. of programmes organized	No. of women and men participated
Members	Awareness on collective approach, role of members, governing structure, rules and regulations of the FPO	35	193 new members (M: 35; F: 158)
Group leaders	Organization structure, fund management, networking, decision-making and business plan for the next 5 years	16	320 (M: 132; F: 188)
Board of Directors	Legal aspects, management strategies and operational mechanisms	4	10 (M: 6; F: 4)
Staff	FPO concept, implementation process, strategy and expected outcomes	6	2 men

contribution to the business in the company. This helped them to show how shareholder participation in business is important for the company. Another activity to increase farmers' income is value addition to the produce, and this was attempted in a pilot mode for groundnut and sesame. Oil extraction, adopting the traditional technology of wooden and cold press method, and branding it as "PASUMAI" was done for marketing. Through this service 15 tonnes of groundnut were aggregated and planned for staggered processing into oil. It helped the farmer to get an additional income of 12 per cent when compared to selling the product as raw groundnut. Similarly for pulses, aggregation of blackgram was done during the past year (5 tonnes) and an attempt was made for delayed marketing which fetched an 8 per cent higher price when compared with immediate as well as individual sale.

Sub Programme Area 402

Semi-arid Regions

402.1 Kannivadi

Kulumai Producers Federation: Kulumai Producers Federation was registered under the Trust Act in the year 2007 in Dharmathupatty village of Dindigul district. Currently it has 243 women and men producer groups from 68 hamlets in Reddiarchatram block of the district. The total membership is 3450, of which 72 per cent are rural landless agricultural labourers and the rest are small and marginal farmers and other type of labourers.

Sustainable Livelihoods: Small-scale dairy and bio-inputs production are emerging as viable enterprise models for on-farm and off-farm livelihoods. It is learnt that while promoting livelihoods among small holders, institutional structures and backward, forward and lateral linkages are necessary for its sustainability. These services were institutionalized by organizing the members into Kulumai Milk Producer Company Ltd (KMPCL) in January 2016, which has 758 dairy farmers as shareholders and the total share capital mobilized so far is Rs 7.58 lakhs. The cultivation of forage grasses and leucaena species and the use of balance concentrated feeds and quality vaccines were some of the important services facilitated by the company. During the year 28 tonnes of concentrate feed were produced which reduced the feed cost by 10 per cent. In collaboration with ABT Foods Private Limited, 18 milk collection centres managed by women SHGs were established for market tie up. The facility helps dairy producers to get prices based on quality. On an average they are getting Rs 4–5 more per litre of milk when compared to the rates of local vendors. The average turnover of production is 3700 litres of milk per day.

The second emerging model is bio-inputs production for sustainable agriculture by women farmer groups. The intervention is institutionalized through an institutional structure, namely, Kulumai Rural Livelihood Foundation. They have been producing bio-inputs such as *Azospirillum*, *Phosphobacteria*, Potash mobilizing bacteria, *Arbuscular mycorrhizae*, *Trichoderma viride*,

Pseudomonas fluorescens, *Beauveria bassiana*, *Paecilomyces lilacinus* and *Bacillus subtilis*. During the past year they have produced 28 tonnes of bio-inputs with a value of Rs 18 lakhs which generated 1700 employment days in production and marketing. A capacity-building programme was organized for 700 farmers on integrated crop management through application of organic and bio-inputs. Through consistent efforts and training, 4000 farmers (35 per cent women) in this region are regularly applying bio-inputs in their fields. The enterprise model is replicated in Kolli hills, where, based on the local crops, *Pseudomonas* and Arbuscular Mycorrhizae production units were established. Women members of the Kannivadi production units trained the Kolli hills farmers by sharing the practical challenges faced by them in the process of production and marketing. With the support of FiBL, Switzerland, a partner in BIOFI project, a detailed environmental and economic assessment of ecoenterprises was carried out. Under this initiative, small-scale, low-cost vermicompost production units were tested and fine-tuned, and now five women members are engaged in production at commercial scale. Last year they produced and marketed 10 tonnes of composted manure.

Grassroots Institutions – Role Change Process: The Kulumai Producers Federation has attained its financial sustainability through the various services it provides its members. It is meeting the costs of all the field staff and the manager. District-level institutions and banks have recognized the contribution

of Kulumai Federation and are forging new partnership to reach the target groups. Last year NABARD recognized the activities of the Kulumai Federation and approved a project to form 100 new JLGs in Reddiarchatram block with necessary financial support. Till now, 87 JLGs (758 members) were formed of which 280 members are linked to bank and accessed credit to the tune of Rs 1.12 crore to strengthen their livelihoods. Also NABARD Financial Services (NABFINS) recognized the federation as CBO and extended financial access to 410 members for livelihoods such as milch animal purchase, goat rearing, agriculture and country chick rearing. The Kulumai community banking programme provided Rs 5.25 lakhs to 35 members for the construction of low-cost toilets. Recently, the district collector has recognized the federation as a training agency to create awareness in the Reddiarchatram block on water management under the government programme of drought management.

Reddiarchatram Sustainable Agriculture Producer Company Limited: The current shareholder strength of Reddiarchatram Sustainable Agriculture Producers' Company Ltd (RESAPCOL) is 1117 (M: 698; F: 419). The key function of the company is to promote collection action to access inputs, technology and knowledge, finance through bank linkage and marketing for its members. This year through the agri-input shop, RESAPCOL had a total turnover of Rs 11.86 lakhs, of which 69 per cent was from seeds sales and 20 per cent from the sale of bio-inputs. A total number of 66 farmers (M: 20; F: 46) were linked with the

commercial bank for availing dairy loans and a total sum of Rs 25.10 lakhs was mobilized.

Apart from this the institution plays a vital role in improving the knowledge of the men and women farmers and towards this the company has adopted both print and digital mode to reach the learners, supplemented by face-to-face meetings. Also, the offline mode is adopted using CDs. A total of 778 farmers (M: 317; F: 461) participated and shared experiences in agriculture, livestock and health. During the past year, 554 contents were developed on agriculture (312), veterinary (78) and corporate literacy (164) and distributed by Reddiarchatram Seed Growers Association (RSGA) to farmers through Mvayoo portal. Moreover, 334 agriculture- and veterinary-based contents were shared with IFFCO Kishan Sanchar Limited for delivering messages to IFFCO-Airtel farmers. Agriculture- and veterinary-based voice mails were heard by 766 farmers (M: 492; F: 274). With reference to web-based learning, the association (RSGA) is running a website www.l3ftn.com for the Life Long Learning Farmers in Tamil Nadu to provide locale-specific weather and market information and also technical details for crop cultivation. During this year this webpage has been viewed 29926 times by 23034 visitors. Fifty video clips on agricultural practices and experiences of farmers were uploaded to YouTube.

402.2 Pudukkottai District

Land and Water Management: During this year, this region received only 239 mm of

annual rainfall against the average of 690 mm (average 50 years). In the reporting period, 24 open wells meant for agriculture were deepened to access more ground water for irrigation. The cumulative size of the deepening works in open wells was about 3080 cubic metres, which can store about 31 lakh litres of water. Due to this, water availability in rainy season in the renovated wells increased by 89 per cent and in the summer season by 130 per cent. The total area under irrigation from open wells increased from 41.5 acres to 68.95 acres, which benefited 43 families with assured irrigation. Farmers are now cultivating paddy, groundnut, pulses and vegetables and even establishing horticulture plantations in rotations in the available land since there is assured water availability. It is estimated that the average farm income of the farmers increased from Rs 66000 to Rs 128000 due to the assured irrigation. As a follow up of the soil health analysis carried out last year, supply of 11 different kinds of organic manure was organized and delivered to the farmers to enhance soil health.

Sustainable Farming Systems: In continuation of the previous years, suitability of short-duration pigeonpea varieties was tested in Illuppur region. Five red gram varieties (ICPL-161, ICPL-20325, ICPL-88039, VBN-2 and ICPL-20338) were also tested during kharif season adopting PVS process and three varieties (ICPL-88039, ICPL-161 and ICPL-20338) performed well in terms of seasonal suitability, less incidence of pest and diseases and productivity. Four demonstrations of blackgram in 38 acres and four in groundnut

in 26.5 acres of rainfed lands were taken up, but due to severe shortage of rainfall (long dry spell after the sowing period) only 37 and 39 per cent average yield was realized. To resolve the technological issues faced by the local farmers, two field experiments were carried out in the areas of coping with water stress with Hydrogel and nutrient management by spraying dynamic nutrient provider (DNP). Results of the experiment are being analyzed.

Access to machineries to small holders was facilitated by IAPCL (farmer producer organization) on rental basis to meet the labour demand in the region. To improve the access of women farmers to these machineries, IAPCL opened “Agriculture Service Centres” leveraging panchayat buildings in six villages. They act as a centre for technology transfer by providing farm implements, bio-inputs and agriculture and market information which supported farmers for fair price realization for the farm produces. Need-based contents to cope with the drought situation was regularly prepared and disseminated through 6949 voice mails to farmers. As a contingency crop, 136 farmers resorted to small-scale cultivation of organic vegetables in an average area of 10–20 cents. The average productivity ranged from 820 to 1350 kg per 10 cents, worth approximately Rs 26000 in 4 months. This strategy of diversification created a good impact in ensuring income when the main seasonal crops failed.

Grassroots Institutions and Sustainable Livelihoods: The total membership of the IAPCL has reached 1000 shareholders with

a higher proportion of women (M: 227; W: 773). During the past year the annual turnover of the company was Rs 52 lakhs from four enterprises and Rs 4.37 lakhs was the net profit. As part of the role change process, IAPCL has established “Patikaadu Community Resource Centre” in 4.5 acres of land of their own and started work on the infrastructure. This is envisaged to provide all sorts of backward, forward and lateral linkages for the 1000 small-holding farmers in this region.

Each and every activity implemented was planned in the Board of Directors forum of the IAPCL and executed through its 71 farmer producer groups, which meet once a month. This two-tier system of management is helping the company to promote good governance and bottom-up decision-making process. Further, specific monitoring committees were placed for monitoring each and every component of the project implementation process. Similarly monitoring committees were also formed with technically qualified external persons like watershed engineer to assess the work scientifically. The company established a good partnership with Tamil Nadu Small Farmers Consortium (TNSFAC) and Department of Agribusiness through MSSRF for implementing all the government schemes through the Producer Company. Apart from this the company has developed partnership with National Pulses Research Centre, Vamban, Kalanjiam Thozhilagam Limited, Vijay Dairy and Foods, 17 organic outlets across Tamil Nadu, 3 bulk processors and traders for technical and business supports.

To diversify the income of small-holding farmers, IAPCL is facilitating four social enterprises, namely, aggregation and value addition of pulses, cultivation of organic vegetables, dairy and poultry – country chick species. Value chain approach is adopted while promoting these social enterprises and marketed under the brand name of “*Patikaadu*.” In the pulse category 11 tonnes of blackgram, 4 tonnes of greengram and 1 tonne of pigeonpea was processed and marketed. Under organic vegetables, 136 farmers were involved in cultivation. The company procured 23.5 tonnes of vegetables with 20–40 per cent premium price than the local market price and marketed to 17 organic outlets across Tamil Nadu. This strategy is evolved as a potential crop diversification method in the region. In case of dairy, due to drought 267 farmers are currently supplying milk out of the 349 during the past year. Eleven collection centers were in operation that aggregated and marketed 1.44 lakh litres of milk worth Rs 37.20 lakhs. Local sale of milk was suggested as a strategy to get more income. During this year 78 per cent of the milk produced was sold locally (12 per cent during the previous year), which resulted in an additional price of Rs 10 per litre. To meet the demand for fodder, the technology of soil-less forage production using maize seeds was tested under multi-story system. The technology was demonstrated to dairy farmers and 45 farmers adopted the technology. The main outcome of the intervention is that the concept of FPO was incorporated in the three main developmental programmes of the Government of Tamil Nadu promoted

by the World Bank. Three visits from World Bank team along with TNSFAC, IAMWARM and *Puduvazhvu* supported them to take the decisions. A total of 487 representatives belonging to 38 FPOs from various parts of Tamil Nadu and Karnataka visited the IAPCL activities at Illuppur for exposure of FPO activities. Also as parallel cross-learning process, MSSRF is providing technical inputs to ABT Dairy company to establish a collective dairy farm operated by a women’s group near Pollachi, Coimbatore district.

402.3 Villupuram District

Land and Water Management: In continuation of the previous year, 352 soil samples were collected and tested and soil health card was issued to practice Soil Test and Crop Response based fertilizer application methods to optimize the use of chemicals in maintaining soil health. From the rejuvenation of 45 open wells during the past year, it is understood that this is the best strategy to ensure minimum farm income in the rainfed conditions. However, access to credit was the main issue faced by the farmers to expand this activity. To address this, efforts were taken to establish a revolving fund system.

Sustainable Farming System: To identify the suitable varieties in blackgram and groundnut, PVS method was adopted during kharif season 2016. Five varieties of blackgram, namely, VBN 4, 5, 6, ADT-5 and MDU-1, were identified for testing in the fields. In groundnut five varieties, namely, TMV-13, TMV-7, VRI-2, ICGV86564 (Asha) and Kadiri-6, were

selected for testing. Castor and cowpea were grown as trap crops along the border. FFS and farmer scoring methods were adopted to encourage the participation of men and women farmers to evaluate and identify best-performing varieties. In blackgram, though the crop growth was affected by the poor distribution of rainfall in the growing season, varieties such as VBN 4 and 6 were found to be moderately tolerant to YMV compared to others. Groundnut, being drought tolerant, was able to cope with adverse condition especially in kharif season compared to blackgram. Among groundnut varieties, VRI-2 and TMV-13 were found to be moderately tolerant to leaf rust compared to other varieties.

Testing and Fine-Tuning Technologies to Improve Productivity: The two important technologies tested were application of DNP and Hydrogels. DNP is an enriched fertilizer consisting of biological and chemical nutrients to enhance pulse productivity and soil health, which was developed by TNAU. It is applied to soil at the time of sowing as basal application. In order to promote the adoption of this technology, five block demonstrations in blackgram and six in groundnut were done during kharif 2016. However, due to the poor monsoon, low productivity was realized in both the crops and hence the efficiency of the technology was not conclusive to the farmers. Hydrogel (Water banks) application, which is a biodegradable polymer, helps to improve the water holding capacity of soils, enhances soil permeability and aeration and promotes better plant growth. The importance

of Hydrogel and methods of application were taught to farmers in rainfed lands through three block demonstrations in blackgram and six in groundnut. It is recommended to apply 1 kg of Hydrogel per acre at the time of last ploughing which will be active in the field for a period of 5–7 years. The result showed that in one of the farmers' fields the applied field recorded 400 kg/acre of groundnut when compared to non-treated fields at 210 kg/acre.

Upscaling the Production of Pulses:

Blackgram and groundnut are major crops cultivated in both kharif and rabi seasons and moth bean in rabi season. Access to quality seeds of right variety, bio-inputs, fertilizers and credit support were facilitated through the NAFPC and banks. FFSs were organized at the village level to build farmers' capacity in using the technologies, and each FFS saw a participation of 30–35 farmers. Also the company ensured market support to its members. These concerted efforts resulted in mobilizing 213 farmers to cultivate blackgram in 316 acres and 213 farmers for groundnut in 211 acres in kharif season. As there was monsoon failure throughout kharif 2016, most of the farmers faced difficulty in providing irrigation at critical stages, especially flowering and pod setting due to water scarcity which ultimately affected the yield. In rabi season 545 farmers cultivated blackgram in 727 acres, 220 farmers cultivated groundnut in 250 acres, and 167 farmers cultivated moth bean in 201 acres. In this season also, farmers faced difficulty in realizing the full potential yield. Farmers who had access to irrigation saved the crops by

providing critical irrigation (40–45 per cent of farmers). The average yield obtained was only 189 kg/acre in blackgram, 219 kg/acre in moth bean and 704 kg/acre in groundnut. Apart from training, farmers were also regularly provided information on market and weather.

Production of Quality Seeds for Local Use:

VCN 4 blackgram variety was found most suitable to the region and hence to ensure access to quality seeds 5000 kg of seeds were procured from seed growing farmers in 2015–2016. It was processed and stored at agriculture business centre and sold to members of NAFPCCL during 2016–2017 and earned a profit of Rs 3 lakhs. This experience improved confidence among farmers on seed production as well as seed business as one of the most viable income-generating strategies. During the past year, six farmers were registered for seed production for VCN 6 in 11 acres and VCN 4 in 4 acres under Seed Certification Department, Villupuram. Around 300 kg of VCN 4 and 800 kg of VCN 6 blackgram seeds were procured from the seed growing farmers and stored for the 2017–2018 season.

Grassroots Institution and Sustainable Livelihoods:

The Board of Directors of NAFPCCL regularly meet and review the overall progress of the company's activities such as financial progress, agriculture activities, collection of share, seed business, progress of agriculture service centre and other business plans. During kharif season, NAFPCCL mobilized crop loan of an amount of Rs 50 lakhs under Kissan Credit Scheme to

support 213 farmers to cultivate blackgram in 163 acres and groundnut in 211 acres. Apart from credit, the company extended support to access machineries and quality inputs through its Agriculture Service Centre facility. In the past year, 1260 farmers purchased inputs from the shops and 670 accessed the implements. The members of NAFPCCL were also involved in the grain procurement business. A Price Fixing Committee of the NAFPCCL procured about 16 tonnes of pulses by paying Rs 300 more per quintal than the price fixed by the government.

Non-farm Livelihood: Kalamkari craft unit increased sales turnover by 45 per cent compared to the previous year. The annual turnover of the unit is Rs 622218 during this period. They have been participating in the exhibitions in Chennai and Puducherry to expand their market links. Recently, *papad* making was introduced to promote employment in the local region, and 56 women farmers were trained on blackgram *papad* making. As an initial step 10 women farmers have started making blackgram *papad* with brand name “*Mailam Papad*.”

Sub Programme Area 403

Hill Regions

403.1 Koraput District

Sustainable Farming Systems: Indo-Moroccan Food Legume Initiative was implemented in 28 villages in Boipariguda and Kundura blocks of Koraput district. Lack

of improved varieties of pulses and quality seeds, maintaining optimum plant population and nutrient management are the key issues in pulse productivity and production in the region. Evolving strategies for upscaling pulse production was the main objective in the previous year. Establishing partnership with the Department of Agriculture was adopted as a key strategy and the area was enhanced from 76 acres to 931 acres covering 820 farmers. The species were greengram, groundnut and blackgram, cultivated in rice fallows during rabi season. Pigeonpea was tried as an intercrop in both kharif and rabi seasons but the performance was poor in both the seasons compared to other pulses. With regard to the proportion of area under pulses: 400 acres under groundnut, 464 acres under greengram, 59 acres under blackgram and 9 acres under pigeonpea. The partnership with Department of Agriculture helped to ensure the supply of quality seeds and suitable improved varieties. The agronomic practices recommended for better productivity were summer ploughing, use of improved varieties, seed treatment with biofertilizer, application of balanced fertilizer, line sowing, use of optimum seed rate, application of borax and foliar spray of DAP. The rate of adoption of these technologies varied from 47 to 82 per cent depending on the resources, including labour availability. The storage pest menace is the main hindrance to store it for household use as well as for seed. The new technology of triple-layer bags resulted in reducing the losses up to 90 per cent. It helped them to store the grains and seeds for later use. By

use of the technology farmers stored the grains and ventured into delayed marketing and by this they received 20 per cent higher returns compared to sales immediately after the harvest.

Access to quality groundnut seeds is the key issue for groundnut cultivation in the rice fallows and farmers depend outside market and dependability of the seed quality was always a concern for them. Farmers used to incur more than 25 per cent of the production cost in seed alone. In order to ensure the local supply of seeds, groundnut seed was produced in 25 acres. The average productivity is 480 kg per acre. Since access to quality seeds in groundnut for rabi cultivation is a main hindering factor for both production and productivity this strategy gave an input to develop local seed systems for groundnut. Simultaneously, to reiterate the practice of improved technologies, participatory on-farm field experiments were carried out to test and build the capacity of farmers. Four packages were taken for demonstrations: seed treatment to establish good and uniform plant stand, testing the different short-duration varieties of pigeonpea (110 days) on suitable period of sowing, use of trap crops for pest management in groundnut and foliar spray of DAP in different concentrations. Farmers were involved in design, planting, flowering and harvesting stages of the growth of crops. In addition, communication products like wall hangers with information on pictorial forms, short video shows on the improved practices, sharing case stories of best farmer

practices through radio and redelivering SMS to farmers on crucial management practices were adopted to iterate the learning on new technologies and practices.

Grassroots Institutions: Vikash Maha Sangh is a (yet to be registered) farmers' federation established to support farming communities in terms of agro-input services, value addition, technology access, finance,

collective procurement, storage and delayed marketing. It has 866 members from 9 gram panchayats. During the year, 158 village meetings, 8 executive body meetings and 1 general body meeting were conducted. Apart from pulses production, value-added food products from groundnut and greengram and value addition of tamarind and mushroom cultivation were part of the company's product line for markets.

FOOD SECURITY

Food Security programme area adopted a two-pronged approach – advocacy and direct interventions – towards enhancing the food security of rural households. Advocating the concept of Farming Systems for Nutrition among different stakeholders and enhancing availability of food grains, vegetables and fruits at the household level were undertaken. Community resource persons and grassroots institutions play an important role in executing the planned interventions that covered 63 villages in the Koraput district of Odisha and 68 villages in Wardha and Yavatmal districts of Maharashtra.

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Sub Programme Area 501

Community-Based Interventions

501.1 Odisha

Mahila Kisan Sashaktikaran Pariyojana

The Mahila Kisan Sashaktikaran Pariyojana (MKSP) project aims to improve the socioeconomic status of women farmers by strengthening their livelihoods through sustainable agriculture and promotion of agri-based enterprises and covers 2552 women farmers from 45 villages across Boipariguda and Kundura blocks of Koraput district of Odisha. Nearly 72 per cent of women farmers belong to Schedule Tribes and 16 per cent to Schedule Castes. A number of capacity-building programmes including exposure visits were organized to enhance the skill and capacity of women farmers, the community resource persons (CRPs), the para-professionals and the office bearers of the grassroots institutions. The trained para professionals and the CRPs provide handholding support to the farmers. So far 11 para professionals and 45 CRPs have become trained. Odisha Livelihood Mission (OLM) has selected and empanelled six CRPs as state-level resource persons on sustainable agriculture. Table 5.1 provides details of training sessions conducted over 2016–2017. Of the women farmers who attended the various training programmes, 1837 belong to Schedule Tribes, 408 to Schedule Castes and 307 to other caste groups. The 62 producer

groups and 4 clusters of producer groups formed earlier have been brought under an apex federation. In the local body elections held in 2016, 3 women farmers were elected as sarpanch (president of village panchayat) and 12 women farmers were elected as ward members of village panchayats. The trainings and motivation provided in the programme have certainly contributed towards women farmers contesting in and winning local body elections. Facilitation to women farmers for receiving their entitlements or specific benefits of special schemes from government departments has been an important activity in the project. Setting up grassroots institutions is an important component in achieving the major goals of the project. The progress of the project was continuously assessed using the monitoring tools that are put in place. Mahila Kisan cards were regularly updated and data related to trainings and adoption of each member farmer was uploaded in the MIS.

Table 5.1: Details of training sessions organized for women farmers, 2016–2017

S.no.	Training programs	No. of training sessions
1	Sustainable agriculture practices	42
2	Non-pesticide management in paddy and vegetable cultivation	38
3	Preparation and application of bio-pesticides and bio-fertilizers	43
4	SRI in rice cultivation	08
5	Soil health and nutrient management	35
6	Seed selection, collection and post-harvesting technology	27
7	Health, hygiene and nutrition	15

S.no.	Training programs	No. of training sessions
8	Gender sensitization	12
9	Entrepreneurship development and mgt. by the producer groups	34
10	Training on book keeping and on group mgt. for the producer groups	28
11	Straw and Oyster mushroom cultivation	42
12	Women's rights	08
13	Establishment of Annadata model kitchen gardens	40
14	Mixed and intercropping in vegetable cultivation	23
15	Awareness on entitlement schemes, health, nutrition and hygiene	24

Major Outputs:

- **Promotion of Annadata model kitchen gardens and homestead kitchen gardens:** During the reporting period 116 *Annadata* model kitchen gardens and 376 backyard kitchen gardens were promoted by women farmers. So far 1149 homestead gardens including 309 *Annadata* model kitchen gardens have been promoted by women farmers. The *Annadata* model kitchen garden involves a structured garden that is designed to provide vegetables, fruits and pulses to the family round the year. Usually, the following plants are cultivated in an *Annadata* model kitchen garden – papaya, drumstick, ridge gourd, lady's finger, tomato, brinjal, chilly, beans, seasonal greens, gooseberry, pumpkin, guava, red gram and *Bahunia varigata* (a tree whose leaves are used as greens).

Farmers report increased consumption of vegetables and fruits in their households with the establishment of kitchen gardens. Sales of surplus produce from kitchen gardens have also led to additional income for the farmers.

- **Adoption of sustainable agriculture practices:** Women farmers are trained in Integrated Nutrient Management (INM), Non-Pesticide Management (NPM) and Integrated Pest Management (IPM) and are using these management practices in cultivation of paddy and vegetables. They were trained to prepare and use a variety of plant extracts, solid and liquid organic manures and mechanical traps to improve plant growth and manage pests. Some examples are: Compost, *Handikhata*, *Beejamruta*, *Jeevamrutha*, *Amritajal*, *Gomutra Hingu arka*, *Neemastra*, *Hadri*, *Peja haladi arka*, *Tulasi patra arka*, *Agneyastra*, *Brahmastra*, *cow dung and urine solution*, *chilli and garlic mix*, *Dahi nadia arka*. Pheromone trap, yellow and white trap, light trap and bird stands are also widely used to control pests. Six preparations of such inputs were tested in the laboratory, at International Crops Research Institute for the Semi-arid Tropics (ICRISAT), and their chemical composition was determined. During the reporting period 65 per cent of women farmers (1659) applied more than seven different inputs as per crop requirement in 1887 acres of cultivated area while 35 per cent (893) applied four to seven preparations as per crop requirement in 348 acres of

cultivated area. Farmers report a reduction of nearly 40 per cent in cost of cultivation. While all the member women farmers were practicing sustainable agriculture, the intensity of adoption varied. Further, women farmers adopted intercropping, mixed cropping, border crops, crop rotation, summer ploughing and mulching as pest and disease control measures. Farmers reported a considerable reduction in cost of cultivation when adopting sustainable agriculture practices – to the tune of Rs 2200 per acre.

- **Selection of good quality seeds:** Women farmers were trained in selecting good quality seeds from the field and 1647 women farmers collected and preserved pure seeds of vegetables and paddy for their own use in kharif 2017.
- **Preparation of audiovisual materials:** This year three audiovisual materials on sustainable agriculture practices were prepared with the technical guidance of Digital Green. So far 21 such audiovisual materials have been prepared and used in 1223 training/dissemination sessions at the community level.
- **Income generation activities:** Suitable micro enterprises were identified and promoted for adoption either in a group or at an individual level. The participating women farmers were also trained on marketing of the products in the local market.
- A total of 14 producer groups are involved in preparation of value-added

products from rice and millet. They sell the products in the local market and participate in village- and block-level exhibitions. Demand for their products is increasing slowly in the local market. The average profit earned by a group was in the range of Rs 12000–18000 during the reporting year. The profit gets divided equally among the group members. Further, 67 self-help groups (SHGs), formed by the state government/other agencies comprising of women farmers of MKSP, were facilitated to avail a sum of Rs 16.5 lakhs from the banks for promotion of income-generation activities and for agricultural activities.

- Women farmers found large-scale vegetable cultivation to be an economically viable activity; 276 women farmers were involved in large-scale vegetable cultivation with financial support from SHGs. They sell the vegetable produce in the local market as well as to traders.
- Cultivation of Straw and Oyster mushroom has become a profitable enterprise for the women farmers and their producer groups. A total number of 998 women farmers are engaged in this enterprise and they report to have earned a supplementary income from this during the reporting period.
- **Utilization of the Community Facility Centres:** This year three Community Facility Centres (CFCs) to access farm

implements such as weeder, spade, sprayer, sickle, diesel engine have been established in 3 villages and the total number of such centres has reached 45. Every village has a management committee that takes care of the smooth functioning of the centre, collects the rent for implements from farmers and maintains accounts. These 45 CFCs, taken together, have so far received Rs 2.3 lakhs as user fees for farm equipment.

- **Convergence:** About 907 women farmers were facilitated to submit applications at the block office for construction of vermicompost pits and cattle sheds through convergence with MNREGA. The applications were passed through the *Pali sabha* and *Gram sabha*. During the reporting period, 36 cattle sheds, 36 compost pits and 16 farm ponds were constructed through convergence with different schemes; moreover, 867 toilets were constructed under the Swachha Bharat scheme. The total value of convergence in the reporting period is to the tune of Rs 1.2 crores. Further, 436 women farmers were facilitated to get job cards under the MNREGA. Participation of women farmers in the *Pali sabha* and *Gram sabha* increased by 15 per cent in the reporting year in comparison to the previous year essentially due to the trainings and motivation provided to them.
- **Soil health card and soil nutrition management:** 216 women farmers were facilitated to send soil samples to the

Agriculture Department for soil testing and trained to use the soil health cards to understand the nutrient deficiencies in the soil and to take corrective measures and apply the recommended nutrients.

- **Awards:** Ms Raimati Ghiuria, woman farmer and a CRP, was felicitated by the Central University, Koraput, as an organic farmer on International Women's Day.

Community Grain Bank

During the year, 786 member households across 18 villages availed loan from Community Grain Banks (CGB) at different points of time to fulfil the household food requirements. The average stock of food grains (paddy and finger millet) vary across the CGBs: seven have more than 20 quintals; five have 10–15 quintals; and six have less than 10 quintals. All the 18 banks are being managed well by the respective management committees and were in a position to lend grains as per the demand of households. In these 18 villages, every month there is at least one meeting of the management committee in which detailed discussions on maintenance of store house, stock of grains, interest to be charged for the lending, issues in lending and repayment and so on take place and decisions are taken. In some villages, such as Taliaguda, the management committee is very active and has decided to bring down the annual rate of interest to 15 per cent from 20 per cent due to sufficiency in grain stock. However, in two villages the community food grain banks that were functioning till last year became dysfunctional during the reporting period.

Efforts at understanding the factors underlying the non-functioning of the two community food grain banks are ongoing and appropriate action shall be taken in the course of next year.

501.2 Maharashtra

Mahila Kisan Sashaktikaran Pariyojana

The MKSP in Maharashtra has entered its tenth year of operation and the focus on empowering women farmers, through various capacity-building measures, is slowly but steadily showing results. A total of 215 women farmers' groups have been formed into three cluster-level federations that are actively engaged in strengthening the lives and livelihoods of the 3265 member women farmers. A major development during the reporting period is the scaling up of the establishment of farm implements hiring centre (Common Facility Centre or CFC) by the Government of Maharashtra (GoM); NABARD has also extended financial support for the setting up of these centres in villages. The total cost for establishing one CFC is Rs 2 lakhs. The contribution by GoM and community is 90 per cent and 10 per cent respectively. In NABARD-supported CFC, NABARD contributed 95 per cent and the community contributed 5 per cent. Details of major outputs during the reporting period are:

- Mr Shailesh Naval, District Collector of Wardha, visited the CFC established at Lonsavali village on 25 October 2016. This CFC was established in 2012 as part of the MKSP project. Mr Naval had a discussion with the villagers and the women farmers'

committee that is managing the CFC and was convinced about the important role played by this centre in making available farm implements for small and marginal holders. He sanctioned the establishment of eight CFCs across eight villages to be managed by the women farmers' groups of MKSP. However, these groups will have to share 10 per cent of the total costs of Rs 2 lakhs, that is, Rs 20000, in establishing the centre. MSSRF is providing the technical support in establishing the eight centres. The process of setting up the centres has begun and orders for farm implements have been placed.

- NABARD sanctioned a project of Rs 10 lakhs for one of the women farmers' federations, namely, *Wardha Taluka Mahila Shetkari Kashtakari Sanstha*, to set up a CFC in Dhamangaon village and for construction of a room to store the implements of the CFC in Lonsavali village.
- About 235 member women farmers have taken loans from the federations to the tune of Rs 14.90 lakhs, amounting to an average of Rs 6300 per farmer. Majority of the members (223) availed loans to purchase agricultural inputs; 12 members availed loan to set up microenterprises such as cleaning and grading machines, noodle makers and mini CFCs; 4 availed loan to initiate enterprises that support sustainable agriculture, namely, preparation of *nimark*, vermicompost, trading in bio-fertilizer, setting up a flour mill and sericulture activity. The credit programme initiated by

the federations has been well received by the women farmers and in their perception it is an important measure in strengthening their livelihoods.

- All three federations have facilitated members to avail the benefit of various government schemes and entitlements (supply of agriculture implements, fertilizer, seed kit, LPG connections, bicycles; construction of wells, farm ponds, toilets, houses; and medical facilities) to the tune of Rs 3 crores.

Illustrations on signs of empowerment of women farmers and their federations:

- Indira Meshram, President, Ralegaon Federation, has been reselected as a member in a district-level advisory committee of Agricultural Technology Management Agency (ATMA). She has been an active participant in meetings and has raised relevant local issues on support required for farmers in the area of seed supply and irrigation.
- A team of 15 CRPs identified as best practitioners and trainers by the Maharashtra State Rural Livelihood Mission (MSRLM) conducted trainings for farmers in four villages where MKSP project is not in operation. These farmers received remuneration for their trainings from the MSRLM.
- Group members from 35 villages actively participated in *Mahila gram sabhas* held in November 2016 and raised issues related to employment under MGNREGS, provision

for *Gharkul* scheme (construction of house), installation of dustbins, construction of toilets and soak pits, digging well in the fields and supply of seeds for kitchen garden.

The results achieved during the reporting period are as follows:

- In 17 villages, gram sabhas passed resolutions for installation of meter on drinking water taps and succeeded in installing it in 7 villages; this would, it is hoped, result in judicious use of water by the villagers.
- Seventy-nine houses were constructed in 13 villages under the Gharkul scheme and 147 toilets were constructed across 17 villages.
- Group members from 6 villages received seeds for their kitchen gardens from the village panchayats.
- Purchase of seeds (pigeonpea and gram) as also bio-inputs (Rhizobium, Azotobacter, Phosphate Solubilizing Bacterias and Trichoderma sp) were undertaken by the federations to benefit 500 women farmers. Collective purchase brought down the cost of input and also ensured availability.
- Women farmers from three villages, Dahegaon, Gawande and Zaragad, organized Kharif Melawa on 21 and 27 April 2017 for gaining expert opinion on crop production related issues.
- Extent of adoption of recommended practices among women farmers is indicated in Table 5.2.

Table 5.2: *Details on adoption of recommended practices, 2016–2017*

Component	Practices adopted	No. of women farmers
Soil and water conservation practices	Sowing across the slope	2039
	Farm bunding	211
	Early summer ploughing	2431
Seed management practices	Seed germination test	2083
	Seed treatment	1931
Integrated nutrient management	Soil test based nutrient management	2008
	Application of organic manure	2168
	Mixed/multicropping system	2144
	Bio-fertilizer/Jeevamrut application	1540
	Crop rotation	2301
Integrated pest management	Cultivation of trap crops for plant protection	1778
	Yellow sticky trap	1851
Harvesting and post-harvest	Cleaning and grading of agriculture produce	2444

Other major outputs during 2016–2017 are:

- A total of 13 libraries have been set up in 13 villages for the benefit of women farmers and other villagers. These are small-scale libraries operating from the residence of a woman farmer and have magazines on agriculture and Panchayati Raj and local newspapers. The libraries have been set up because of the collective efforts of women farmers. All the arrangements like space and infrastructure have been made by them.
- A total of 76 community kitchen gardens (CKGs) were developed by 258 women farmers in 52 villages. In addition to sharing the produce from the gardens, women farmers also supplied vegetables for the preparation of mid-day meals to 52 village schools.
- Of 3265 women farmer households, 2017 members (about 62 per cent) have kitchen gardens that ensure access to pesticide-free, fresh vegetables and fruits.
- Households of 28 women farmers, across 5 villages, managed to receive their ration cards after persistent follow up by office bearers of the women farmers' groups.
- The health insurance by Mahatma Gandhi Institute of Medical Sciences, Sewagram, covered 1096 women farmers (with 4498 family members) across 37 villages.
- Four women farmers received awards and recognition during the reporting period: Asha Debare, Deoli, received an award from the Zilla Parishad as the second best accredited social health activist (ASHA) worker in Wardha district; Ratna Borkar, Wardha, received an award titled

“Vasudha Smruti Puraskar – 2017” by a Nagpur-based NGO for her contribution in village development as a sarpanch; Sadhana Nikhade, Wardha, received an award from the Reliance Foundation for her kitchen garden activities; and Sandhya Manikpure’s name has been proposed as a member in Scientific Advisory Committee by Krishi Vigyan Kendra (KVK), Selsura.

An Initiative to Address Zero Hunger Challenge

This project targeted households with pregnant women, lactating women and children less than 2 years of age, across 13 villages of Wardha district, Maharashtra, addressing the problem of child malnutrition through nutrition literacy programmes and other focused interventions. The project created a cadre of CRPs who worked with ASHAs belonging to the National Rural Health Mission, the Auxiliary Nursing Midwives (ANMs) and the Village Health, Nutrition and Sanitation Committee (VHNSC) members provided to facilitate access to the numerous nutrition and health support schemes of the Central and State Governments. The target households across 13 villages identified were 397 families comprising of 334 children and 85 pregnant and 93 lactating mothers. A major result of the project relates to the enhanced awareness levels of the target group at the end of the project period, in comparison with the baseline, pertaining to crucial aspects such as balanced diet, feeding practices, immunization, sanitation, hygiene, health and government entitlements. Further,

the knowledge and skill levels of CRPs had improved during the project term as a result of structured trainings, and they had rendered appreciable help to the government health department. Anganwadi Sevikas of target villages remarked that as a result of the project initiatives the level of participation in Anganwadi programmes improved and there was increased level of awareness about health of newborn babies and lactating mothers. An important learning was that it is necessary to go beyond the defined target group and include other caregivers – older women in the households, such as mothers-in-law, and husbands – in the village-level trainings to improve adoption of recommended practices.

Sub Programme Area 502

Advocacy

Farming Systems for Nutrition: A Pathway for Addressing Malnutrition in India

Farming Systems for Nutrition (FSN) approach is being demonstrated in the states of Odisha and Maharashtra, by the MSSRF, as part of a research programme on Leveraging Agriculture for Nutrition in South Asia (LANSA). Given the importance of the FSN approach in dealing with persistent malnutrition among rural households, a project with a time frame of 18 months was initiated in February 2017, with two core objectives: (1) to advocate the concept of “Farming Systems for Nutrition” across different stakeholders, in four selected states of India, namely, Andhra Pradesh, Bihar, Maharashtra and Odisha; (2) to provide

policy recommendations for strengthening agriculture-nutrition linkages in these four states. FSN, a farmer-led strategy, is defined by M. S. Swaminathan as, “The introduction of agricultural remedies to the nutritional maladies prevailing in an area through mainstreaming nutritional criteria in the selection of the components of a farming system involving crops, farm animals and wherever feasible, fish.” Diversified food production system has the potential to expand the consumption basket of farm families and is a basic principle underlying the concept of FSN. The FSN model is a location-specific, inclusive model, based on the resource endowments and specific environment, to address the nutritional needs of families.

Three consultations have been organized so far, at the block level, in collaboration with the LANSA team, to disseminate the concept of FSN and to share the experiences of farmers who are practitioners of the approach. The first consultation was organized in Boipariguda block of Koraput district, Odisha, on 27 April 2017, where 135 members participated. The second and third consultations were organized in Karanja and Arvi blocks of Wardha district, Maharashtra, on 9 and 12 May 2017, respectively. The total number of participants were 128 in Karanja and 110 in Arvi. Government officials at the block level

representing departments of agriculture fishery, forestry, administration and ICDS, Panchayati Raj functionaries, farmers and NGO representatives participated in the consultations. In all the three consultations detailed deliberations on the FSN concept, the need for this approach, the constraints in adopting FSN and the benefits of FSN were held. Some progressive farmers shared their experiences of improved access to different types of pulses, millets and fruits and vegetables due to adoption of this approach. The officials expressed their support for the concept of FSN and the ongoing work of MSSRF. While some farmers mentioned lack of availability of required seeds as a constraint for adopting FSN, many other stakeholders enlisted the benefits as follows:

- Enhanced availability of nutritious grains at the household level
- Enhanced access to fresh vegetables and fruits by the ICDS centres and schools
- Enhanced soil fertility and soil health

A Technical Advisory Committee (TAC), comprising of domain experts, has been constituted under the chairmanship of Prof. M S Swaminathan to provide guidance to the project team. The first meeting of the TAC was held in April 2017.

Programme Area 600

INFORMATION, EDUCATION AND COMMUNICATION

The Information, Education and Communication (IEC) programme helped the resource-poor farming and fishing communities in the states of Tamil Nadu, Andhra Pradesh, Puducherry, Kerala, Telangana, Maharashtra and Odisha to get locale-specific, demand-driven and scientific information for timely decision-making. The Village Resource Centre (VRC) and Village Knowledge Centre (VKC) programme advanced its reach to 15980 with 38.12 per cent being women, besides the headway it has made in sustainability of VKCs. The PAN India Fisher Friend Mobile Application (FFMA), a multilingual application supporting nine languages in India, witnessed optimistic leads from the state governments of Kerala, Andhra Pradesh, Puducherry and Tamil Nadu for its scaling-up efforts. The implementation of an e-learning course for public library professionals through International Network of Emerging Library Innovators (INELI) has grown to cover nine South Asian countries, and it has enabled the 46-member Indian cohort to get resource support for implementing the learning gained through the online course.

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Sub Programme Area 601

Jamsetji Tata National Virtual Academy for Rural Prosperity

The Jamsetji Tata National Virtual Academy for Rural Prosperity programme comprises National Virtual Academy (NVA), Jamsetji Tata Training School, Village Resource Centre (VRCs), Village Knowledge Centre (V KCs) and Grameen Gyan Abhiyan (GGA). The overall aim of this programme is to link science with society through knowledge empowerment among rural community on agriculture, fisheries, health and nutrition.

601.1 National Virtual Academy

As of 2016, the NVA has inducted 1800 national-level NVA fellows from 24 states in India and this is shown in Figure 6.1. These grassroots academicians contribute immensely to the process of knowledge transformation on their own with their neighboring villages for addressing real-time issues, providing solutions and thereby creating a knowledge revolution movement across India. During this year, 62 potential NVA fellows were selected by the three Regional Peer Review Committees from 97 nominations received from 7 states through 23 partner organizations. The newly selected fellows' expertise extends to the fields of agriculture, health, education, micro enterprises, women empowerment and government schemes. Together 58 NVA fellows (M: 35; F: 23) from 18 states have been identified for their integration with the public libraries for knowledge dissemination.

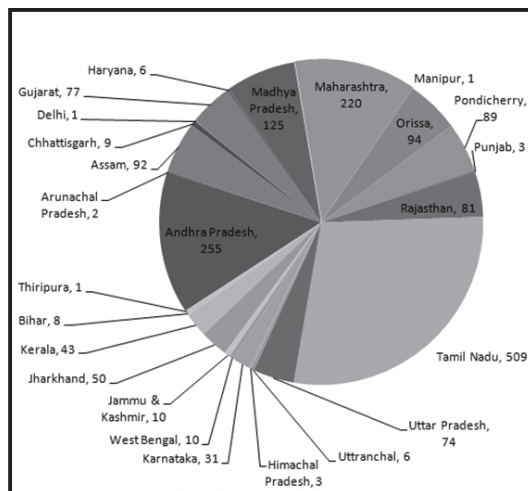


Figure 6.1: NVA fellows across the states.

601.2 Jamsetji Tata Training School

Online Capacity Building of International Network of Emerging Library Innovators, India and South Asia

Public libraries shall be the future knowledge and learning hubs, wherein societies shall stay connected beyond books. This unfolds via the leadership and innovation programme of International Network of Emerging Library Innovators (INELI), India and South Asia, that began with 26 library professionals in Cohort I. With Cohort II, the network of librarians has now expanded to 46 public librarians from 24 states of India as part of the Indian Public Library Movement (IPLM). A rigorous process was followed with mentors as experts from the field of libraries, having a vision of redefining their libraries as Knowledge and Learning Centre (KLC). The Massive Open Online Course (MOOC) platform engages every librarian through online forums. For effective knowledge sharing, seven mentors offer online

and offline guidance, besides the support given by two online learning coordinators from IEC.

Outputs:

- Selected 21 librarians (M: 14; F: 7) in Cohort II from across the 24 states
- Cohort I members completed four modules while Cohort II began the first module
- A total of 35 members participated in the First National Convening I of Cohort II, organized in Kerala between 6 and 8 February 2017, and gained an understanding of INELI programme
- A total of 49 members, including INELI Oceania Innovators, participated in the First International Convening II of Cohort I for cross-learning and regional networking with INELI Oceania from 7 to 11 March 2017, in Melbourne, Australia
- 20 Librarians virtually celebrated the National Librarian Day of India on 12 August 2016 and were connected globally with members of IFLA, BMGF and TASCHA
- The course writers completed six e-learning modules

Knowledge and Learning Centres

The learnings from years of experience with hub and spokes model of the VKCs and VRCs for enhancing the lives and livelihoods of the rural community have been applied in strengthening the public libraries as KLCs. The INELI librarians are given an opportunity to strengthen the capacities of the identified

library staff to introduce need-based, ICT-enabled knowledge services for communities in collaboration with IPLM. They are also given tools to map effective functioning of their libraries and communicate this to the state- and national-level stakeholders for policy advocacy. All the 46 librarians were oriented on IPLM and the objectives of the KLC.

601.3 Village Resource Centres and Village Knowledge Centres

The ICT-based VRCs and VKCs promote knowledge empowerment among the rural community on agriculture, animal husbandry fisheries, health and education in Tamil Nadu, Puducherry, Andhra Pradesh, Telangana and Odisha. In addition to the hub and spokes model, knowledge-based interventions on fisheries using virtual mode have been expanded to the states of Kerala, West Bengal and Karnataka. Together 6 VRCs and 29 VKCs continue to provide need-based and location-specific information and knowledge to reduce the gap between experts and community, promote cross-learning, build digital skills among rural community besides minimizing risks and maximizing economic benefit. During this reporting period, the programme catered to 159980 members, including 98989 men and 60991 women in rural area, ensuring a 38.12 per cent participation of women (Table 6.1).

The VRC facilitates ICT action platforms such as voice messages, phone-in programmes, helpline services, audio-video conferencing and WhatsApp advisories through which fisherfolk and farmers continue to communicate with expert for solutions.

Table 6.1: *Reach of VRC/VKC*

Themes	Male	Female	Total
Agriculture	31222	26272	57494
Fisheries	49810	423	50233
Health education	10895	25490	36385
General	1261	479	1740
Government scheme	3473	6327	14128
Grand Total	98989	60991	159980

Sustainability of Village Knowledge Centres

Efforts have been made to promote ownership among the communities toward the VKCs. A sustainability framework of VKC incorporating five pillars, such as Social, Human, Psychical, Financial and Institutional parameters, has been evolved and applied. Further, appropriate orientation and training has been given to the key stakeholders at the community level. The integration of Common Service Centres (CSC) provides incremental advancement to the financial sustainability and government entitlement. The VKCs were connected with line department officials for content support on a regular basis. The key results achieved are:

- 5 VKCs mobilized Rs 3.30 lakhs including community membership for sustainability,
- increased confidence among VKC management committee members and knowledge workers to manage the VKC independently and
- 25 VKCs obtained CSC status to offer government schemes and e-services.

601.4 Farmer Friend Programme

The entire ICT action platform mentioned earlier has been effectively used in this

programme to address queries related to the season, crop, region and the variety to take care of and manage for maximizing the yield. This programme also includes information on soil nutrient management through sample testing and fertilizer advisory, onsite training and demonstrations, helpline and the latest WhatsApp services. These services have helped to reach 46961 farmers with timely information across Tamil Nadu, Puducherry, Maharashtra, Andhra Pradesh and Telangana. Statistical analysis indicates that 54 per cent of men farmers and 46 per cent of women farmers participated in the agro advisory services.

Interactive voice recorder (IVR) allows farmers to replay the messages even when they are missed by them. The farmers utilize the phone-in programme for immediate solutions to problems related to land, seed, crop, weed, diseases and pests as also harvest and post-harvest processes. Audio-video conference is arranged in locations for the experts to review crop samples before providing online solutions. Helpline services provide instant solutions to manage the crops. WhatsApp helps farmers post queries and photos on pests and diseases for getting advisories.

Soil Health Management: A soil and irrigation water testing mobile laboratory in Tamil Nadu and two soil testing laboratories in Wardha and Yavatmal districts in the Vidarbha region of Maharashtra have focused on awareness creation on the importance of soil testing, correct method of soil sample collection and following the advisory of correct doses

of inputs to the crops. Subsequently, the soil testing was done and the farmers were provided with soil health cards where the agri-experts explained the general features of the soil in the village and the remedial measures to enhance nutrients and answered queries of the individual farmers related to soil status, treatments and nutrient requirements. The problems identified through soil testing and the recommendations provided are presented in Table 6.2.

Farm School: Farm schools facilitates farmer-to-farmer learning and capacity building. Farm schools in Odisha have also taken up activities such as tamarind processing, preparation of rice value-added products and so on besides training 25 community resource persons (CRPs) every month. Moreover, five exposure visits from different organizations have been done. Training programmes conducted in farm schools in Maharashtra, Odisha and Tamil Nadu are shown in Table 6.3.

Table 6.2: *Soil health problems*

Type of soils	Problems	Remedial measures
Low and low-to-medium	Sandy and sandy-loamy soils with poor organic matter	Application of organic and green manures such as Sunhemp, Daincha and mixing of microorganisms
Nitrogen, phosphorous and potash	Temperate climate of Thanjavur and Pudukkottai	such as Pseudomonas, Azatobacter and Sugarcane wash slurry
Alkaline	Alkaline soils of pH from 8 to 9 are observed in parts of Thanjavur and Puducherry	Use of gypsum at the rate of 500 kg per acre for the pH range of 8–9 and 1000 kg for 9–10
Saline	Saline soils are very rare in the areas where soil samples are tested	Washing by fresh water and application of organic/green manure. In addition, farmers are advised to select saline-resistant paddy varieties such as Trichy 1 or 3 and Co43. Further, they are advised to grow other crops such as cotton, chilli, sunflower or onion
Observed calcareous nodules in some soils in Thanjavur and Pudukkottai areas	pH ranging from 7.5 to 8.5	Calcareous soils are recovered by recommending the application of sulfur at the rate of 8 kg per acre and further treatment by the application of farmyard and green manure
Acidic	pH less than 6	Application of CaCo ₃ at the rate of 500 kg per acre along with press mud from sugarcane factories at the rate of 5 tonnes per acre

Table 6.3: *Farm schools*

State	Male	Female	Total	Focus of the training
Maharashtra	84	16	100	Kharif and rabi crop preparation and management
Odisha	483	157	640	Good agronomic practices, management of pests and diseases of paddy, post-harvest technology and safe storage
Tamil Nadu – Thanjavur district	122	126	248	Agronomic practices, seed treatment, soil health and pest and disease management
Total	689	299	988	

E-Plant Clinics

MSSRF-CABI collaboration in Plant Wise programme continued for the fourth year with expanded Plant Clinic sessions in the Tamil Nadu, Puducherry, Maharashtra and Andhra Pradesh. It facilitates the diagnosis of affected crop samples and provides expert recommendations that are economically and ecologically viable.

Farm-Valley – Video-Based Learning: Video-based learning of farmers in agriculture is a new venture between Access Agriculture (AA) and MSSRF. The reference of collaboration is to use the existing and newly created video-based learning modules in agriculture to translate into regional languages for the knowledge benefit of farmers. The AA team trained eight MSSRF staff in the video production. Following this, they translated six videos and produced three new videos.

Outputs:

- A total of 57494 farmers, including 26272 women and 31222 men, have benefitted from the agricultural services.
- A data analysis shows that farmers prefer

agro-advisories through ICTs in general and their access to different technology choices include voice messages (33 per cent), audio-video conferences (20 per cent), helpline services (19 per cent) and phone-in programmes (14 per cent).

- A total of 392 plant clinic sessions were conducted in 60 villages, in which 5438 men and 910 women farmers participated and analyzed 5689 sick plant samples and got advisories on diseases and pest control measures.
- Ten fact sheets containing generic advisories on diseases and pests were generated and 22 Pest Management Decision Guide (PMDG) was recorded.
- A total of 350 farmers (196 in Tamil Nadu and 154 in Maharashtra) joined the WhatsApp group and it facilitates 10 information sharing pieces on an average per day.
- A total of 999 farmers tested 1104 soil and 202 water samples from 200 villages in 16 districts.
- A Village-Level Fertility Index (VLFI) map for Pullanviduthi village in Pudukottai

district was developed for spatial analysis and further recommendation.

- Soil reclamation practices have been imparted to 48 farmers (M: 41; F: 7) from 20 villages where the soil was found to be acidic and alkaline in nature with the soil scientist from Soil and Water Management Research Institute (SAWMRI), Thanjavur.

Outcome:

- About 36 per cent of the farmers who visited plant clinics changed their practices to apply bio-inputs and green and yellow chemicals, which reduced economic losses.
- A total of 14505 farmers, including 1957 women, received timely and suitable recommendations for their problems and thus saved 45 per cent of the crop yield loss.
- Of the farmers who received voice messages, 83 per cent followed the recommendations; of these 67 per cent realized an increased income between Rs 8000 and Rs 10000 per acre.
- A farmer who precisely followed soil testing consistently for 3 years and applied recommendation got an additional 500 kg of paddy per acre.
- Minor millets were cultivated in 22 ha by 223 small-holding farmers for the first time in the Trichy region.
- A total of 102 farmers who used good agricultural practices gained an additional income of Rs 45 lakhs in Tamil Nadu, Andhra Pradesh and Telangana.

601.5 Fisher Friend Programme

This programme aids fisherfolk across Tamil Nadu, Andhra Pradesh, Odisha, Kerala and Puducherry to get timely information on varied aspects related to their traditional practices including (a) early warning such as cyclone, high wave and other disaster alerts, weather and Ocean State Forecasts (OSF); (b) Potential Fishing Zone (PFZ) and Tuna Forecasts; (c) sustainable fisheries and marine resource conservation; (d) market information; and (e) government schemes. Multipronged communication strategies are integrated for empowering the communities through ICT action platforms such as Fisher Friend Mobile application (FFMA), voice messages, 24/7 helpline services, WhatsApp groups, phone-in programmes and training and awareness.

PAN India Fisher Friend Mobile Application:

The pioneering effort of MSSRF has culminated in the development of multilingual PAN India Fisher Friend Mobile Application that provides 16 information services besides acting as a navigation aid. A multilingual portal that currently supports nine national languages – Bengali, Gujarati, Kannada, Marathi, Malayalam, Tamil, Telugu, Odiya and English – has gone through 13 revisions based on the feedback of fisherfolk. To ensure continuous flow of information through the application to the larger users, the PFZ information has been auto-ported and the OSF information from Indian National Centre for Oceanographic information Services (INCOIS) is under process. Now, it has been made available in the Google Play Store for

wider reach and benefit. The Google analytics is in-built in the application currently having a user base of 9689 with total screen views of 1019377. The top information services accessed by the fisherfolk are OSF, GPS, PFZ, Weather, Harbor, PFZ map, and Compass and government schemes.

Scaling up: The PAN India FFMA laid a ground to undertake policy advocacy with central and state governments. As a result, the state governments of Andhra Pradesh, Kerala, Puducherry and Tamil Nadu have showed greater interest in taking it forward. Partnership has been established with CMFRI, Mangalore, in Karnataka, and REDC in West Bengal for the scaling up of FFMA in the respective states.

Key Results

Outputs:

- 41865 fisherfolk from 330 villages of 29 coastal districts across 5 states received marine fishery advisories on a daily basis through multiple ICT applications
- Availability of a PAN India FFMA in nine Indian languages in the Google Play Store for public access
- 11500 fisherfolk accessed INCOIS–MSSRF 24/7 helpline facility, hosted in four languages
- 969 callers approached Helpline during NADA and VARDHAH cyclones
- Traced four lost boats and saved the lives of 16 fisherfolk through 24/7 helpline, Tamil Nadu
- The overall screen view of FFMA during the year was 1019377 with average screen views of 1500 in a day.
- Commissioned a market study taking a sample size of 100 users besides collecting individual feedback from 846 fisherfolk to understand their experiences on the accuracy of PFZ, Tuna Species Specific forecast and OSF information services and its benefits.

Outcomes:

- More than 80 per cent of fisherfolk use PFZ information for informed decisions and fishing.
- PFZ advisory enabled fisherfolk of Gilakaladindi village in Andhra Pradesh to change their fishing practice from bottom trawling to pelagic. Trawler fisherfolk caught a minimum of 500 kg of tuna in one haul and realized doublefold income of Rs 15000–20000 after expenses besides reducing 600 litres of diesel per trip and benefit sharing to their fishing crew.
- Fisherfolk realized 11 tonnes of increased tuna catch per trip, valued at Rs 25 lakhs besides reduction of 6–10 fishing days on sea.
- The small craft fisherfolk move beyond their traditional fishing ground due to PFZ advisory and saved time, energy and fuel.
- Users of FFMA indicated an economic gain of Rs 2393800 besides recording many instances where their livelihood assets and lives got saved.

601.6 Health Education

An effort has been taken in collaboration with the departments of State Planning Commission, District Rural Development Agency and *Pudhu Vazhvu Thittam* to improve health, hygiene and nutritional practices among the community. Using both ICT- and non-ICT-based communication strategies such as video-based educative sessions, audio messages, expert discussion and so on, a shift in the knowledge, attitudes and practices of the community on sanitation and nutrition has been brought about in Pudukottai district. Consensus building was done among 43 village panchayats in a block to achieve “open defecation free” (ODF) status for the villages, as poor sanitation is a major impediment to achieving nutrition among human being, particularly women and children. A systematic approach is being followed to promote nutrition literacy and ensure its practice among adolescent girls, children and pregnant women. The below listed changes have been brought about in the community through this programme:

- 30928 villagers (M: 8329; F: 22599) gained knowledge on health and sanitation.
- A total of 18 panchayats have been declared as ODF zones besides complete elimination of open air defecation in 83 locations and partial elimination in 117 locations.
- 2123 households have begun to use household latrines.

- 3140 new latrines have been constructed by the community of which 270 were constructed without government subsidy.
- 7500 students (boys: 3149; girls: 4351) follow the practice of handwashing and 90 per cent follow clean habits such as cutting nails and wearing chappals.
- 42 households laid out the nutri garden in 8 villages and 165 households follow recommended balanced diet schedules.

Sub Programme Area 602

Informatics Division

This division accomplished the following results during the year:

Development of PAN India Fisher Friend Mobile Application – FFMA: FFMA Android application developed in the year 2015 has been strengthened as a PAN India Application by the addition of five more languages such as Odiya, Bengali, Marathi, Kannada and Gujarati with a size decline from 8.20 MB to 6.20 MB and additional features.

Capacity Building of Librarians – Online Learning Management System: A provision has been made in the existing MOODLE platform to enable Cohort II members to learn. Also a networking space has been created to facilitate interaction between two cohorts and mentors. INELI India logo has been strengthened and incorporated besides the improvement of INELI India website with facilities to post blogs, events, news and videos.

m-ICE – Mobile application for Information Community Empowerment:

m-ICE is an Android application developed for the rural community to receive timely information on agriculture, animal husbandry, fisheries, health, employment, government schemes and district news. A special feature of helpline contacts to agriculture and fisheries experts in the region is built into the application for instantaneous interaction. There is a facility for the user to provide feedback to improve contents and technology.

Knowledge Management Systems

Programme Level Knowledge Management Systems (KMS):

KMS web-portal is an effort to pool all the knowledge resources together onto a common web-portal. Nearly 780 contents under various thematic heads have been uploaded to the existing pool of 2594 contents.

ClimaAdapt KMS: The exclusive KMS designed for the ClimaAdapt programme aimed at improving the adaptive capacity and water use efficiency of the farmers in the states of Andhra Pradesh, Telangana and Tamil Nadu was regularly updated with relevant contents. Around 270 contents have been uploaded to the existing resource pool of 737 contents.

MSSRF Website: In order to make MSSRF website more attractive, user-friendly and easy to navigate, it has been redesigned with relevant features. The new features of latest information about the programme events have led to a significant increase in the number of

visitors. According to the Google analytics report, 69479 visitors have visited the website.

Website for LANSa Project: Improvement was done in the LANSa website with eight new features. This website yielded 35006 page views from 6682 users from different countries.

Website for ENERGIA Project: A new website for ENERGIA project was developed and launched. An Android-based application was developed to undertake household survey with facilities like off-line data saving and porting to the server through the connectivity. The application works on tablets.

Hardware Infrastructure

- Enabled IVR to the voice message application to help registered users hear/rehear the broadcasted message;
- configured FTP server for auto-porting of PFZ and OSF data from INCOIS to FFMA server;
- audio-conferencing facility for international projects such as LANSa improved by connecting to voice message-IVR portal, and
- prototype communication model developed for data recording of pH, humidity, soil moisture, nitrogen, phosphorous and potash in the soils using sensors for monitoring and advisory.

Rural Knowledge Movement (Grameen Gyan Abhiyan): The GGA facilitated network with the Common Service Centres and integrated it into the VKCs for disseminating government entitlements and other e-services.

Further it facilitated the connect with the partners to nominate potential candidates for the NVA Fellowship.

Sub Programme Area 603

Youth in Development

Eighth Indian Youth Science Congress

The Eighth Indian Youth Science Congress was held in Mumbai University from 16 to 18 February 2017. There were technical panel discussions on Climate Change: Adaptations and Mitigation, Forestry, Biodiversity and Climate Change, Coastal Zone and Climate Change; and two plenary sessions on Food and Nutrition Security: Agrarian Distress in the context of Climate Change and Role of Media in Communicating Scientific advances. A galaxy of eminent scientists and young, budding participants addressed various aspects in the rich deliberations throughout the day.

In total, 1200 students registered from various colleges and educational institutes from all over India and participated actively in the proceedings with over 600 posters and 20 oral presentations. More than 30 judges assessed the posters which were categorized into five subthemes – Genetic Resources and Climate Changes, Early Warning: Traditional Wisdom and Modern Science, Carbon Sequestration, Natural Resources Management and Traditional Wisdom, and Other Topics related to Science and Technology – with 24 prizes awarded based on innovation and communication. A documentary film produced

by Mr Dinesh Lakhanpal was telecast for the benefit of students on the central theme of the conference – Food for All. It highlighted the work done by Prof. Swaminathan and was produced under his guidance for World Food Programme.

The valedictory session had few star young innovators – Mr Karan Chaphekar, who created the first 3-D printer in India; and the team from IIT-Mumbai led by Mr. Aditya Singhal, which was instrumental in successfully launching “Pratham” Indian satellite – who shared their experiences.

Sub Programme Area 604

Every Child A Scientist

The major objective of this programme is to create awareness on science, nutrition, health and hygiene, environment, biodiversity and bio-resources. The two-week programme has a combination of lectures and related documentary films. During the reporting year, the Every Child A Scientist (ECAS) centre developed new resource materials and other hands-on practical experiments. Resource materials include Significance of Biodiversity, Ecosystem Services, Pollution and Its Control, Global Warming and Climate Change, Innovation in Science and Technology, Biographies of Famous Scientists, Natural Resources Management, Ozone and Its Depletion, Food and Nutrition, Health and Hygiene, Microbes in Human Welfare, and Human Health and Diseases. During the academic year, approximately 180 students

benefited from this programme. Making compost pits and sensor-based practical experiments are the new upgrades this year.

Sub Programme Area 605

The Hindu Media Resource Centre, MSSRF

Regular updates and sharing of information is facilitated by *The Hindu Media Resource Centre* (THMRC) through the website, social media platforms, e-newsletter and print newsletter. Articles, press releases, publication updates, videos and photographs maintain regular connect with society. During 2016–2017, the Foundation website underwent a revamp, with updated design and development.

- The Foundation website reached 242231 page views during the year with a number of new and regular users. The website also served as a contact point for enquiries from media, students, development practitioners, farmers, academics, international agencies and members of the public.
- “Latest News,” “MSSRF in the News” and social media posts are updated regularly on the website.
- MSSRF’s social media engagement was through the platforms Twitter and Facebook. During the reporting period on Twitter, MSSRF achieved total impressions of 179900 or an average of around 15000 reads every month. The interactions on Twitter with government departments, donor agencies, influencers and media

persons helped build a greater rapport with them. The number of followers for the Foundation’s Twitter @mssrf handle as of March 2017 was 1543.

- On Facebook, the Foundation has a reach of over 20000 people every month, with regular posts, campaigns and event updates shared here. A total of 4800 people “like” the MSSRF page and receive updates on a regular basis.
- Prof. M. S. Swaminathan, who is on Twitter, has been consistently engaging on this platform with over 2032800 impressions during the year and 169400 impressions each month for his messages. He has over 13700 followers on Twitter.
- MSSRF’s e-newsletter called “e-Synergy” reaches over 1450 internal and external stakeholders including media persons, scientific, academic and student communities. There were 23 e-newsletters sent out during the year, in addition to invitations. The MSSRF print newsletter “Synergy” was continued with three issues brought out.
- In addition to news clippings, social media updates and publications, over 203 event and content updates were posted on the website during the year.
- All of these updates provided a regular connect with external stakeholders and brought in regular feedback and engagement with them.

Media Outreach: THMRC reaches out to journalists regularly through press releases,

story ideas and event invitations. Media persons also reach out to the centre for inputs or to discuss stories.

- MSSRF impacted over 448 news stories, in mainstream English newspapers and web editions.
- A total of 27 press releases were issued to journalists for events, updates and statements on behalf of the Foundation.
- Interviews and media coverage were facilitated for various occasions and journalists also regularly contacted THMRC centre on their own. There were over 73 requests from media persons for interviews, stories, quotes and information.

Advocacy Partnership: A knowledge partnership for nutrition alliance in Tamil Nadu for advocacy and networking stakeholders in the state was initiated in partnership with UNICEF. The year-long programme aims to create a knowledge sharing network, initiate and manage a portal of resources and advocate for strengthening nutrition initiatives among various stakeholders in the state. A partnership was formalized in March 2017 with head THMRC as the nodal person from the MSSRF side to facilitate the advocacy and knowledge process.

Capacity Building: Capacity building for a writing workshop was facilitated for staff members of the IEC team. VRC coordinators from the agriculture cluster of the IEC programme participated in the two-and-a-half day training and submitted various stories as inputs for the website and news updates.

Millennium Lectures: THMRC provided support and coordination for Foundation events and across Programme Areas for enhanced public and media outreach and impact on these themes. There were two Millennium Lectures organized by the centre during the year: by Mauritius President Gurib Fakim and the IRRI Director-General Matthew Morell. Several seminars and events were supported by THMRC, the details of which can be found in Section 705 of this report.

Sub Programme Area 606

Library and Information Services

MSSRF Library has 18591 books of which 110 were included during this year. In addition it also holds 565 CDs, 140 journals, 102 newspapers clippings for the year 2016–2017 and 4535 bound journals. The existing collection of books was further enriched by adding more current, important scientific and technical books. Besides, the library has a precious collection of technical reports, and annual reports from various institutions.

The web-based MSSRF Open Access Archives (OAA) has been initiated for benefit of the research community globally and India Stat, EPWRF, JSTOR, SAGE have been successfully renewed this year. The library provides assistance through CABI Abstracts to the research students working in the areas of Agricultural Sciences, Biotechnology and Life Sciences. During the past year around 200 students from various universities located in national and international level used this facility.

CROSS-CUTTING THEMES

Gender, grassroots institutions and climate change are the cross-cutting themes that work towards reiterating the mandate of the Foundation with other programme areas through planning the activities in pro-poor, pro-nature and pro-women dimensions. Two specific projects directly addressing gender issues are: economic empowerment of single women farmers and studying the gender factor in political economy of energy sectors particularly in agriculture and related enterprises and use of clean cooking fuels at the household level. The other projects are interdisciplinary in nature and efforts were taken to integrate social and gender issues at the activity level, and the themes are technologies for climate change adaptation, bio-fertilizer production and use in intercropping systems and climate information services. Support services to grassroots institutions (GRIs) in following the legal compliances and design were provided to improve their functioning and support extended in role change process especially for the newly formed producer organizations.

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Sub Programme Area 701

Gender

701.1 Gender Integration and Mainstreaming

Gender mainstreaming efforts have been strategically addressed by ensuring integration at the proposal development stage itself. The proposals submitted by the different programme areas are screened by the Project Screening Committee for their level and scope of integration of gender and given specific inputs for integration. The best case studies and articles relating to the work of Gender Integration and Mainstreaming (GIM) members were shared to improve their perspectives of gender integration in their respective project activities. Four case studies were developed with video documentation, portraying how technologies and practices helped them to address the challenges of social norms in breaking gender stereotypes. The leadership of the GIM group as well as its members was revisited with new terms of reference. Greater focus is now being given to document results from the field reflecting the changes in gender relations at individual, household and community levels.

Gender Impact Studies: The Information, Education and Communication (IEC) programme conducted an impact study on FFMA in which the gender perspectives were integrated; the study results show that the intervention is specifically focused on livelihoods that are men specific. However,

issues relating to processing and market information for women emerged as a key concern; these will be considered in forthcoming interventions in the programme.

701.2 Interdisciplinary Research Initiatives

Activities were focused on empowerment of single women farmers on their rights to productive resources and livelihoods technologies and climate information and collective action through institution building.

Empowerment of Farm Widows and Single Women Farmers in Vidarbha Region: The current membership of the Single Women Federation is 856 members organized into 84 producer groups spread across 54 villages in Wardha and Deoli blocks of Wardha district. The groups have been formed into 9 clusters. Of the total members, 85 per cent are widows, 11 per cent are abandoned, 2 per cent are divorced and the remaining 2 per cent are unmarried. In terms of occupation, 20 per cent of them are involved in on-farm livelihoods, 44 per cent in off-farm livelihoods and the remaining 36 per cent in non-farm activities. Three main strategies focusing on building the social, human and finance capital base were adopted to empower single women farmers. These were: (i) institution building (formation of producer groups, clusters and their federation) to bring collective power; (ii) building technical knowledge and skill to access and control the productive services and assets related to on-farm, non-farm and off-farm livelihood activities; and (iii) expanding institutional linkages with mainstream institutions

such as banks, District Rural Development Agency (DRDA), Social Welfare Department, Agricultural Technology Management Agency, *Maharashtra Agricultural Competitiveness Project* and social security service providers.

Access to credit is the main constraint for the single women to improve or strengthen their livelihoods. The women depend largely on informal moneylenders in the village for credit at high rates of interest and become vulnerable if the repayment is delayed; hence, access to credit emerged as a primary need during the initial needs assessment meetings. To start with, the groups were linked with banks and savings activity promoted. This helped the groups to stay together and start discussion on their economic activities. Training and capacity-building activities were organized regularly to improve their knowledge and skills on economic enterprise activities. A total of 60 members were trained in goat rearing, de-worming and feed management and 50 received training in backyard poultry farming activity; 5 of them have started poultry units with 25 birds, with support from the Krishi Vigyan Kendra (KVK). Fifty members underwent training in backyard vegetable cultivation and cultivated crops like sweet potato and lady's finger and marketed them within the village. The members are organized into groups at the village level, clusters at the panchayat level and as a federation at the block level. The group members regularly meet once in a month and discuss the issues related to livelihood activities, training programmes they participated in, access to credit and other institutional linkages. As single women, they otherwise have very limited opportunity at the

village level to discuss these issues due to prevailing social norms. Five of the members underwent training to be paralegal workers with the support of Working Group for Women and Land Ownership, an Ahmadabad-based organization; they now provide necessary legal aid services on land-related issues to all the members, linking the federation with Chetana Vikas, a civil society organization working in the region on agriculture development and providing free legal aid and counseling services to women. Access to services and entitlements by members of the producer groups improved during the year through cluster-level intervention. Twenty members received widow pension, seven received new ration cards and another seven got their disputes on land-related issues settled. All the 856 women members have become members of the National Forum for Single Women; and the executive committee shared their progress, issues, challenges as well as new initiatives on various on-farm and off-farm livelihoods at the grassroot level, with members from 18 other states organized by National Forum for Single Women at New Delhi.

Bio-fertilization and "Bioirrigation" for Sustainable Mixed Cropping of Pigeonpea and Finger Millet (BIOFI): The Foundation is the socioeconomic research lead in this research consortium. It is involved in socioeconomic baseline assessment, testing technology adoption through on-farm trials (OFTs) in collaboration with School of Agricultural, Forest and Food Sciences, Bern University of Applied Sciences, and economic and environmental studies with Research Institute of Organic Agriculture (FiBL) on the

BIOFI package as well as eco-enterprises. The baseline study on socioeconomic factors was completed in Kolli hills (Namakkal district, Tamil Nadu) and Malavalli taluk (Mandya district, Karnataka). The enabling and disabling factors of adoption of BIOFI technology were analyzed in detail for both the field sites by School of Agricultural, Forest and Food Sciences (HAFL) in consultation with the MSSRF team. The analysis indicated the need for simplifying the complex BIOFI package into three subcomponents such as assessment of bio-fertilizer technology, intercropping of finger millet (FM) with pigeonpea (PP) in different ratios and patterns of sowing and line sowing versus transplanting of PP seedlings.

With regard to evaluating the technology, based on the results and experiences of the first year's OFTs, farmers feedback and external reviewers' inputs, three different types of field experiments were conducted during the year: (i) OFT as conducted during the previous year to test the BIOFI practice in comparison with farmers' practice with varying practice levels in Kolli hills; (ii) larger demonstration plots in Kolli hills to show the performance of bio-fertilizers (AMF, PGPR and Rhizobium) in sole and intercropping systems under direct sowing as well as seedling transplantation in case of PP; and (iii) demonstration of the entire BIOFI package for comparing with existing farmers' practice in cultivation of FM under rainfed conditions in Krishnagiri and Dharmapuri districts, two predominantly FM-growing regions in Tamil Nadu.

In case of OFTs, eight field trials were completed with the participation of men and women farmers in four villages: Padasolai, Naduvaluvu,

Semputhuvalavu and Thuvarapallam in Thirupuli Nadu panchayat of Kolli hills. The components of the selected technology are: intercropping pattern with eight rows of FM and two rows of transplanted PP (40-day-old seedlings raised in polybags) treated with bio-fertilizers, namely, AMF for PP (*Glomus leptotocum*) and PGPR (*Pseudomonas* sp.) MSSRFD41 in comparison with farmers' existing practice and direct sowing of PP seeds in rows. The primary objective of the OFT in different farmers' fields is to strengthen our understanding of men and women farmers' perspectives, their challenges in adopting mixed cropping systems and potential drivers and barriers in using bio-fertilizers. Preparatory data on the OFT field conditions, data at trial establishment stage, details of the farmers' agronomic practices, socioeconomic status of participating farmers and biometric and yield parameters were collected and are being analyzed. In a larger demonstration experiment in Kolli hills, an attempt was made to evaluate the different components of BIOFI technology in Keeraikaadu village, Guntani Nadu, under rainfed conditions. The experiment was a "randomized block design" on a plot size of 71.28 sq. m (6.6 m by 10.8 m), with eight treatments and three replicates, to compare the performances of sole cropping versus intercropping, application of bio-fertilizer versus control, and transplanting of PP seedlings versus direct sowing. The demonstration trials were carried out in Anchetty village in Krishnagiri district and Varthalmalai in Dharmapuri district. Eight farmers' (M: 6; W: 2) fields were identified to demonstrate the BIOFI package for comparison with their existing practice of FM

cultivation. Considering the field locations and farmers interest, 5 farmers were selected for field demonstrations. Both Anchetty and Varthalmalai villages are on hilly terrain and farmers regularly cultivate over large areas. The plot size of each demonstration unit was 71.28 sq. m (6.6 m by 10.8 m). In all the field trials, long duration PP variety SRG-1 and local FM variety (medium duration) were preferred by the farmers.

The feedback from both the OFTs in Kolli hills and demonstration plots in two major millet-growing regions of Tamil Nadu indicates that BIOFI package is labour intensive and time consuming, from raising PP seedlings in polybags, drilling the soil for pit making, transportation of seedlings and planting especially when the soil moisture is available for a limited period of time, they would like to complete the sowing practice at the earliest possible. Also farmers explained the complexity and difficulty involved in applying three different kinds of bio-fertilizers (two species of AMF, PGPR and Rhizobium) to the crops. Here the complexity is Rhizobium is applicable only to PP, PGPR only to FM and one strain of AMF to FM and the other species to PP.

The project took an effort to produce these bio-fertilizers in Kolli hills itself to enable its easy access, price and time. Kolli Hills Agro Biodiversity Conservers Federation (KABCOFED), the grassroots institution, is trained to mass multiply these bio-fertilizers. The mass production process was fine-tuned in both *Pseudomonas* and AMF production and the detailed production process was documented. The registration application

for the AMF production unit with State Fertilizer Controller through district-level joint directorate of agriculture at Namakkal was submitted. The main point which needs closer attention is getting the necessary permission to commercialize use of the strains of *G. leptotocum* and *Glomus faciculatum*. Necessary Material Transfer Agreement to use the strain received from the Centre for Natural Biological Resources and Community Development, *Bangalore*, was obtained. However, permission from State Biodiversity Board of Karnataka is essential to use the strain for mass multiplication and commercial use in Tamil Nadu. The process towards this has been initiated. Simple learning material in local language on the use of *Pseudomonas* sp. through seed treatment, soil application and foliar spraying was prepared and shared with millet-growing farmers who are also part of the agro forestry programme in Thirupuli and Guntani Nadu promoted by MSSRF. In-depth discussion was held with the farmers involved in AMF production on the steps as well as resources and cost involved; it proved to be an excellent learning opportunity for them to recall, reflect on and analyze the challenges involved in the production process. The economic and environmental assessment of BIOFI package as well as eco-enterprises was carried out in collaboration with FiBL. The detailed cost of cultivation in nursery for poly bag seedling preparation, different methods of planting/sowing, bio-fertilizer application and intercultural operations were collected and analyzed for feasibility. Details regarding the quantity of inputs used and the energy and labour involved in different activities were collected and fed into a model to understand

the economic and environmental dimensions of this BIOFI package and eco-enterprises. The results indicate that to attain economic viability, the units have to either increase the scale of production or increase the cost of product; the environmental assessment is under process.

The Gender Factor in Political Economy of Energy Sector Dynamics:

The main objective of the project is to build the evidence base for improving equitable energy access by influencing policies. This 4-year research programme was started in 2015 and a scoping study was completed. Based on the issues identified in the scoping phase, the main research work was started under which a detailed study was undertaken in four field sites (Koraput and Mayurbanj in Odisha, Wayanad in Kerala, and Dindigul in Tamil Nadu) at micro, meso and macro levels. This field-level study is using quantitative and qualitative methods to collect data in the spheres of productive and social reproductive work of men and women. It is trying to explore the ways in which women's use of modern energy (broadly, electricity, LPG and diesel) is related to their empowerment. There can be two ways in which energy and empowerment of women relate to each other. Use of energy may lead to empowerment, or empowerment of women may lead to a change in the use of energy, for example, shifting from household-polluting solid biomass to non-household-polluting LPG or use of machineries in agriculture operations. In the productive sphere, extent of use of energy in different agriculture operations by men and women and the related policies are being studied in all the field sites. The preliminary study findings

indicate that access to technologies, finance, machineries, knowledge and skills, scale of the technologies, institutional linkage, levels of mobility and prevailing social norms are important factors in facilitating women's access to energy and use in agricultural operations. In case of social reproduction, deeper analysis is in progress to understand consumption of energy at the household level vis-a-vis value of women's work in the productive sphere. The study analyzes the impact of the capital subsidy policy in providing access to clean cooking fuel in less and more commercially developed rural areas of India. The main finding is that capital subsidies have promoted fuel switching where women are substantially involved in income-earning activities. But in poorly developed areas there is fuel stacking rather than fuel switching. The research shows that mere access to clean energy is not adequate. To turn access into use, there is need for promotion of women's increased participation in economic activities to increase the value of work. The study also compares the energy policies of India and Nepal with those of South Africa on gender integration and its enabling and constraining factors in practice at the macro and meso levels.

Social and Ecological Rationale for Conservation of Paddy Land and Wetlands in Kerala:

Conversion of paddy lands has social and environmental implications. On the social side, conversion leads to loss of employment for women, since more than 70 per cent of the field operations are carried out by women when compared to banana and betel nut; the competing land uses hardly employ less than 5 per cent of women

labourers. This research project aims to estimate the ecological loss or gain due to conversion of paddy lands to competing land uses and is under way in Wayanad district of Kerala since April 2015. The competing land uses considered are banana and betel nut. Conversion to banana from paddy is considered a reversible conversion, while conversion to betel nut is considered an irreversible conversion. The ecological indicators studied are abundance of frogs and diversity and soil organic carbon sequestration capacity, which is measured in terms of organic carbon content in the soil.

Paddy fields support the highest abundance as well as diversity of frogs among the land uses. The least abundance and species diversity was observed in banana fields. Frog species diversity was also observed to be the highest in the paddy lands followed by betel nut and the least diversity is observed in banana fields. Frogs use paddy wetlands largely for breeding, calling and foraging, while they use banana and betel nut fields for calling and foraging. From the analysis it follows that shifting from paddy to banana and betel nut can negate the impact on key ecological factors. The impact is more pronounced on frog abundance and frog species diversity. In the case of soil organic carbon content, the impact is more indirect with the extent of pesticide use influencing soil organic carbon content. Thus shifting out of paddy to banana and betel nut is bound to result in ecological losses. This result adds credence to the ecological argument underlying the Kerala Wetland and Paddy Land Conservation and Protection Act, 2008. But paddy farming is considered

less economically viable compared to cash crops like banana and betel nut. The main conclusion of the research study is that the state should adequately compensate paddy farmers by providing “ecological incentives” for continuing to cultivate paddy, at the risk of personal economic losses, for the larger societal benefit. The “ecological incentive” should ideally be over and above the existing production subsidies for paddy farmers.

Sub Programme Area 702

Grassroots Institutions

Foundation has been taking efforts to institutionalize developmental interventions through Grassroots Institutions (GRIs). Needs-based support has been given to GRIs across programme area and field sites. Technical inputs and guidance was provided to develop a draft trust deed for the women farmers’ federations in Jeypore. Processes and steps in organizing annual general body meetings were provided to five organizations: two in Jeypore, two in Wayanad and one in Kolli hills. The books of accounts were verified and internal auditing processes for SEED Care, Wayanad Tribal Development Action Council (WTDAC) and Innuyir Grama Sangam (IGS) completed. According to the Indian Chartered Accounts norms, the balance sheet was finalized. Capacity-building programmes were organized for the Board of Directors of Puducherry, Mailam and Kolli hills and EC members of WTDAC, SEED Care, Panchabati Grama Unnayan Samiti and Vikas Maha Sangh by facilitating the process of meetings at different levels.

Farmer Producer Organizations and Collective Action:

Foundation is recognized as one of the Producer Organization Promoting Institution (POPI) by National Bank for Agricultural and Rural Development (NABARD). Three FPOs are formed in field sites, namely, Kolli hills, Mailam and Puducherry, with focus on small millets and spices in Kolli hills and pulses and vegetables in Mailam and Puducherry. All of the three organizations have been registered under Producer Company's Act 2013 and facilitated to adopt procedures as per legal compliances. Technical support for designing accounting books format for FPC in Mailam, Kolli hills and Puducherry was completed. Besides, capacity-building programme over 2 days was organized to educate Farmers Producer Company, FPO leaders and managers on statutory compliances and preparation of business plans. Detailed business plans were prepared based on focus crop. The implementation process will commence forthcoming cropping season in June 2017. Details of activities taken up by these GRIs are given under Programme Area 400 Ecotechnology.

Sub Programme Area 703

Climate Change

Clima Adapt

MSSRF is one of the consortia partners involved in the design and implementation of the 4-year project Clima Adapt: An Integrated Science–Stakeholder Approach to Develop Adaptation Framework for Water

and Agricultural Sectors in Andhra Pradesh, Telangana and Tamil Nadu States. The Clima Adapt project is in its final phase of completion. Given the focus of enhancing water use efficiency among farming community in the context of climate change through consortia approach, Village Knowledge Centres (VKCs) were established in eight locations of these three states and they played significant role in knowledge empowerment. Information and knowledge in connection to climate variability, climate smart agriculture and water management techniques, agro advisories, care and management of livestock and climate literacy have been the part of the knowledge empowerment. Gender mainstreaming across the project cycle was given much emphasis by all partner organizations to ensure gender equality and equity in the project process and progress besides bringing gender sensitization among different stakeholders.

Multiple ICTs have been used to extend locale-specific knowledge to the farmers. Farmers, both men and women, recognized plant clinics, which is one of the ICT-enabled services offered for timely diagnosis and recommendations to address pest and disease of their crops. The following are the key results of the project:

- 17360 farmers, including 11438 men and 5922 women, received information and knowledge in relation to climate smart agricultural and water management practices through multiple ICTs and VKCs.
- 389 farmers (M: 237; W: 152) participated in the different climate literacy programmes and discussions related to adaption and water use efficiency techniques.

- 424 farmers (M: 287; F: 137) contacted the helpline for addressing their real-time knowledge needs on agriculture.
- The timely information and knowledge on various aspects such as water management, seed treatment, pest and disease management, and nutrient management enabled 432 farmers to gain additional income of Rs 16.25 lakhs in addition to the benefit of risk reduction.

The summary of knowledge services offered to the community through VKC is given in Table 7.1.

Another important theme of gender mainstreaming across the project cycle was given much emphasis by all partner organizations to ensure gender equity in the project process and progress besides bringing gender sensitization among different stakeholders. As a gender node in the consortium with multidisciplinary partners and institutions, inputs were given to design the impact evaluation study integrating gender

perspectives and developing the policy brief for all the three states. The upscaling process in the three states was fine-tuned with the integration of gender issues. The process of capacity building has resulted in mainstreaming gender perspectives at the organization level at Water and Land Management Training and Research Institute, Hyderabad, in its activities related to capacity building and revisiting the policies related to Water Users' Association. In Tamil Nadu, based on the experiences in the Kalingarayan canal and Ponanaiyar basin, the issue of lack of gender sensitivity in Water Users' Association at the membership level was discussed with Water Resources Organization, to make necessary changes in policy.

Experts from Norwegian Agency for Development Cooperation (NORAD), Norway, and The Royal Norwegian Embassy, New Delhi, performed a summative appraisal of the project in November 2016. As part of this assessment, discussions were held with

Table 7.1: *ICT-enabled services offered through VKCs*

Name of the programme	No. of programmes	No. of participants		
		Male	Female	Total
Direct users to VKCs	0	3959	2111	6070
Training and awareness on VKC, agriculture and livestock	44	1437	995	2432
Audio advisory	0	4913	2102	7015
Audio conference	38	307	272	579
Phone-in programme	44	168	236	404
Video conference	46	446	148	594
Plant clinic	19	208	58	266
Total	191	11438	5922	17360

implementing partners and key stakeholders in the public departments and with community members. The evaluation team appreciated the efforts taken by the partners in working towards an approach that delivered meaningful changes. Both VKC and gender efforts have gained special mention of appreciation.

Climate Information to Enhance the Adaptive Risk of Men and Women Farmers:

The Foundation in partnership with the GRI, Reddiarchatram Seed Growers Association, is managing a “B” type weather station in Kannivadi which is recognized as one of the Agro Meteorological Field Units (AMFU) under the network of Indian Meteorological Department (IMD) for South Zone of Tamil Nadu. It provides agro advisories to farmers based on the forecast given by IMD on medium range weather (3–5 days in advance) and extended range forecast (15 days–1 month). Due to prevailing gender roles and associated social norms, climate information is not equally accessed by women and men. In the context of increasing women’s role in agriculture efforts are taken to create an access to forecast and agro advisories for women farmers through awareness creation, building their capacity to use the agro advisories, working women members based producer organizations and so on. During 2016–2017, 624 weather forecast and weather-based agro advisory bulletins (both in Tamil and English) were developed and issued to six adjacent southern districts (Dindigul, Madurai, Pudukotai, Ramanathapuram, Sivagangai and Theni) of Tamil Nadu. About 59500 Agromet advisory SMS were sent to men and women farmers

on every Tuesday and Friday through mKisan Portal. Partnerships were established with NGOs like Reliance Foundation and Vidiyal for wider dissemination. Vidiyal receives forecast messages from MSSRF and disseminates them to 2300 (M: 600; F: 1700) farmers in 27 villages in Theni district; Reliance Foundation receives and disseminates messages to 1500 men and women farmers in Dindigul district. A “Weather and Agriculture” WhatsApp-based group was created with 100 farmers and agriculture experts and bi-weekly weather forecast and agromet advisories were shared and discussed in the group. Needs assessment and feedback meetings are regularly conducted with men and women farmers to understand the risk-related issues in farming operations including livestock in the prevailing conditions of erratic monsoon.

Sub Programme Area 704

Institutional Initiatives

Social Science Unit

Data Management: During the year 2016–2017, the main effort was to update MSSRF’s database on community-based interventions pertaining to March 2016. Collection and compilation of this database from different programme areas is ongoing. A preliminary analysis revealed that MSSRF has a presence in 33 districts across eight states – Andhra Pradesh, Karnataka, Kerala, Maharashtra, Odisha, Puducherry, Tamil Nadu and Telangana. The Management Information System (MIS) that was developed

to store this database was revised to include additional features wherein programme-wise details across location and overtime could be accessed. So far, detailed profiles for 31 districts and 113 revenue villages have been prepared and uploaded in the web portal. Further, templates for collection of household and village-level information have been uploaded.

Evaluation of Community-Based Interventions

Alleviating Poverty and Malnutrition in Agrobiodiversity Hotspots: A post-project evaluation of the Alleviating Poverty and Malnutrition in Agrobiodiversity Hotspots project (APM) was carried out during April–June 2016. The APM project was implemented for a period of 42 months, during 2011–2014, covering 3845 households, across three project sites – Kolli hills, Koraput and Wayanad. The project worked with the objectives of enhancing farm productivity and food and nutrition security and strengthening livelihoods. The post-project evaluation relied largely on primary survey of participant households and assessed the performance of major interventions implemented in the project. The evaluation found that almost all the interventions that were taken up in the project were very well received by the community participants across the three project sites. Further, the target households were from the most marginalized sections, predominantly belonging to tribal and scheduled caste communities, either small and marginal holders

or landless households. The successful and sustainable interventions of the project, namely, kitchen garden, backyard poultry, vermicompost production, yield enhancing cultivation practices, custom hiring centres for farm tools and few income-generating group activities, have had a positive impact on dietary diversification and income of households. The evaluation noted that there was scope to improve the sustainability of interventions by strengthening their input-output linkages and by building the management capacity of grassroot institutions.

Cost-Benefit Analysis of Integrated Fish Farming System, Poompuhar: A cost-benefit study of Integrated Fish Farming System (IFFS) is under way in collaboration with the Fish for All Centre. A total of 25 farmers in Poompuhar, Nagapattinam district, have been surveyed with a structured questionnaire

Education Support Programme

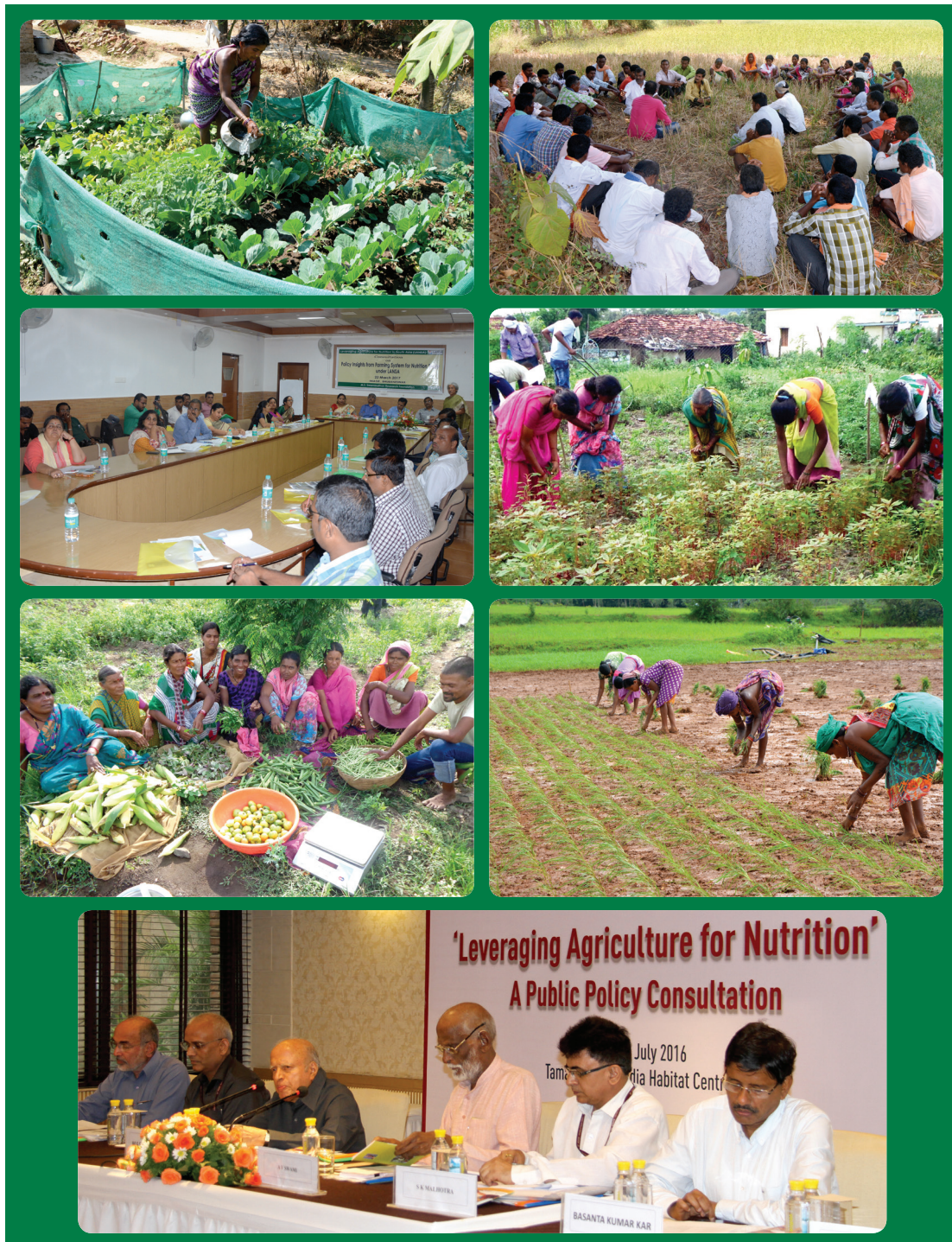
Education Support Programme in Wardha supported 29 students – 12 girls and 17 boys – across 21 villages during the academic year 2016–2017. The students covered in this programme are those whose fathers have committed suicide due to the agrarian crisis. They require continuous counseling, motivation and guidance which are provided by the staff of MSSRF. Career guidance was also arranged for students who completed their tenth and twelfth standards. Because of the facilitation of MSSRF two children could get the support of Rs 25000 for their higher education from two donors.

SPECIAL PROJECTS

Emerging evidence from ongoing studies under LANSA (Leveraging Agriculture for Nutrition in South Asia) was presented at national-, state-, district- and block-level consultations for policy uptake. Sustainability measures are being put in place under the ongoing Farming System for Nutrition Study in Koraput and Wardha. Endline surveys have commenced to examine the impact and replicability of the approach. An animation film titled South Asia: Women in Agriculture – The Nutrition Connection, conceived and developed by the LANSA Research Uptake team, was launched globally on 8 March, International Women’s Day.

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Sub Programme Area 801

Leveraging Agriculture for Nutrition in South Asia

The research and Research Uptake (RU) teams worked closely during the year to present emerging evidences from ongoing studies to policymakers and policy influencers. Five Policy Briefs based on Leveraging Agriculture for Nutrition in South Asia (LANSA) research in India were prepared and submitted to key officials in the Ministries of Agriculture and Farmers' Welfare and Women and Child Development, and Niti Aayog.

Research

Two research briefs on agriculture–nutrition linkage and on gender and child undernutrition were developed drawing on the research published under the research theme of enabling environment for agriculture-nutrition. Under the theme of increasing the nutrition impact of agriculture policies and strategies, a study to assess the feasibility and challenges of introducing millets in the Public Distribution System (PDS) in Karnataka state was completed. The report was presented to officials at a meeting convened by the Development Commissioner, Government of Karnataka, on 22 June. Another study on the operation of the PDS in Tamil Nadu examined the impact of PDS on consumption and household savings across different sections of population, in rural and urban areas of the state, using survey data from

the National Sample Survey Organization (NSSO) data and data from a primary study conducted in 2015. The paper demonstrates a significant, positive contribution of PDS to cereal/calorie consumption and savings across all sections of the population in Tamil Nadu, with greater benefit to the poorer sections of the population compared to others. The paper has been finalized for publication. A third study on situation analysis of pulse production and consumption in the country is under preparation. The analysis of findings from the study were presented at the 24th Annual Conference of the Agricultural Economics Research Association (India) in December 2016 and in a conference on “Sustainable Development Goals: Preparedness and Role of Indian Agriculture” organized by the International Food Policy Research Institute (IFPRI) and Trust for Advancement of Agricultural Sciences (TAAS) in May 2017. This paper on pulses is now being finalized for publication. A fourth paper examining the rollout of the National Food Security Act in the country has been published as a LANSA Working Paper and is being developed into a paper for journal publication.

Under research on agri-food value chains and their potential for impact on nutrition status of poor households, the review of agri-food value chain interventions in the country aimed at enhancing consumption of nutritious food by the poor completed in 2015 was finalized and published as a LANSA Working Paper. Three case studies shortlisted for study following the country review – on the Supplementary Nutrition Programme

(SNP) of the Integrated Child Development Services (ICDS), Amulspray and Tiger brand of Britannia biscuits – were conducted using the conceptual framework developed by LANSA for analysis. While the SNP under ICDS is an example of a food distribution agri-food value chain, both Amulspray and Britannia are business-led agri-food value chains. While Amulspray particularly examined the potential for business to improve nutrition outcomes, the Tiger biscuit case study examined food fortification as a route for addressing undernutrition in poor households. The case study of SNP under ICDS examined the two different models in operation in Tamil Nadu and Telangana, the former a state-private sector cooperative model and the latter a state enterprise led model and the benefits of each. The study was presented at the annual conference of the Agriculture Nutrition and Health Academy in *Addis Ababa, Ethiopia, in June 2016*. Quantitative impact assessment of Amulspray was undertaken in Odisha. Regional Centre for Development Cooperation (RCDC), an NGO with operations in Odisha, was engaged to conduct the field survey. The data collected has been cleaned and is being analyzed. Both the business case studies highlight the importance of the state's role in giving necessary direction for business to have a nutrition focus. Two blogs based on the case studies were published in the "Practitioner Hub for Inclusive Business" website in December 2016. All three case studies are being developed into LANSA Working Papers. Two papers based on the case studies are being written to form part of

a special issue of the IDS Bulletin based on LANSA research on agri-food value chains.

Farming System for Nutrition

The Farming System for Nutrition (FSN) study under the theme of nutrition-sensitive agriculture is ongoing in Koraput and Wardha districts in Odisha and Maharashtra respectively. Details of activities taken up during the year and results obtained are described below.

Koraput

Subsistence farming is the main source of livelihood among the indigenous population of Koraput district. During the 4 years since the commencement of the FSN study in seven core villages in Boipariguda block, the focus has been on better cultivation practices for improving the yields of nutritious crops as well as to develop location-specific FSN models comprising crop, nutrition garden and animal components. During this year, two major interventions, that is, intercropping of maize with pigeonpea in kharif and cultivation of finger millet in rabi, were demonstrated, and they were well received by the local community.

Crop Intervention: In kharif 2016, 238 farmers from 21 villages, including the 7 core villages under the study, cultivated finger millet (variety GPU-67 and Bhairabi) in 66 acres; both the varieties, GPU-67, a variety selected through a participatory varietal selection (PVS) programme in Koraput district, under an earlier project led by MSSRF, and Bhairabi,

a short-duration variety recommended for the region by Orissa University of Agricultural Technology (OUAT), had been tested under crop trial demonstrations during 2014–2015. The recorded yield was 2513 kg ha⁻¹, which was 56 per cent higher than the yield of local varieties at 1614 kg ha⁻¹. Similarly, maize and pigeonpea intercropping in a 1:1 ratio was done in 36 acres by 276 farmers from across the 21 villages. Average production of maize green cob was 4905 kg ha⁻¹, which was 38 per cent higher than local varieties (3565 kg ha⁻¹).

About 25 per cent of the total produce was utilized for household consumption, 9 per cent for distribution to neighbours and relatives and 66 per cent was sold at the rate of Rs 10 per kg. Pigeonpea intercrop was considered as an additional yield with production of 627 and 329 kg ha⁻¹ of green pods and mature pods, respectively. The harvested green pod was utilized thus: 44 per cent household consumption, 6 per cent distribution and 50 per cent sale at the rate of Rs 20 per kg; the mature pod has been threshed, dried and kept for household consumption. Orange flesh sweet potato (OFSP) was cultivated in 8 villages by 88 farmers covering 5 acres and the yield was 6.3 t ha⁻¹. In rabi 2016, finger millet was cultivated by 84 farmers in 30 acres in three villages. The households having no suitable area for growing finger millet in kharif were encouraged to go for the short-duration variety Bhairabi in rice fallows, provided irrigation facilities were also available. Green gram variety SML 668 was cultivated by 54 farmers in 21 acres and blackgram variety TK

94-2 was grown by 124 farmers in 33 acres. Both the rabi pulses are being harvested and the finger millet is in standing stage.

Nutrition Garden: During kharif 2016, 206 households with members having anaemia or vitamin A deficiency (VAD) or both were supported with seed kits comprising different leafy, fruit and root vegetables such as red amaranthus, Indian spinach (*poi*), coriander, ridge gourd, pumpkin, cowpea, lady's finger and OFSP cuttings. Similarly, during rabi 2016, seeds of seasonal vegetables such as dolichos bean, french bean, pumpkin, cucumber, ridge gourd, cluster bean, red amaranthus, multi-cut green amaranthus, spinach and *poi* were provided to the selected households. Households were also encouraged to save the seeds for the next cropping season. It was found that 70–80 per cent of the produce is consumed indicating their contribution to improving household food and nutrition security; the surplus was either sold in the local market or distributed to neighbours and relatives. In addition, nutrition gardens have been established in the premises of government schools in four villages and ICDS centres in two villages. Produce from the gardens is used for the midday meal provided to children at the school and ICDS centres.

Freshwater Aquaculture: Fish farming activities covered 131 farmers managing 64 ponds (56 individual, 6 groups and 2 community ponds) and in these ponds 68000 fingerlings of *catla*, *rohu* and silver carp were introduced. The first round of harvest is under way.

Capacity Building: A Farmer's Field Day was organized in Chikima village of Boipariguda block of Koraput district in March 2017. The main objective of the programme was to get farmers' feedback on millet cultivation in rabi season. About 207 farmers (M: 153; F: 54) across 19 FSN villages from Boipariguda block participated in the programme. Besides 6 schoolteachers from Chikima High School, 4 field volunteers, 14 MSSRF staff and 3 resource persons from Swayam Shakti Agri Foundation, Hyderabad, also participated in the meeting. Farmers shared their experience on how they used to depend on the market earlier for finger millet as they do not possess upland to grow the crop in kharif; cultivating finger millet in rabi is now meeting their family food requirements and has reduced their dependence on the market. A 2-day workshop on root and tuber cultivation and its value addition was organized in July 2016 for staff and farmers in the core study villages. Technical experts from CTCRI, Bhubaneswar, presented the package and practices and value-addition processes and demonstrated their plantation methods. A similar workshop was organized in Wardha in October.

Wardha

The prevalence of cash crop based cropping system of cotton and soybean in the area is well known. In order to improve the availability of nutrient-rich crops to farm families, the focus of crop interventions was on suitable and location-specific crops such as pulses (red gram, gram, green gram), millets (sorghum) and cereals (biofortified wheat).

Crop Intervention: Pulses are generally grown as an intercrop with cotton in the region; however, considering pulses are a nutrient-dense, climate-resilient, nitrogen-fixing crop, farmers were encouraged to go for sole cropping too. Farmers were reached in 29 villages, including the 5 core villages under the study. In kharif 2016, red gram varieties PKV-Tara recommended for the region by Panjabrao Deshmukh Krishi Vidyapith (PDKV), Akola, and Durga, from Nirmal Seeds, both selected through varietal trial demonstrations under the study during 2014–2015, were grown by 228 farmers covering an area of 200 acres including sole cropping by 135 farmers in 143 acres. The results indicated that the yields of Durga and PKV-Tara were 2077 and 1544 kg ha⁻¹, respectively, with Durga having 22 per cent higher yield than regular farmers' varieties (1696 kg ha⁻¹). Further, due to early maturity of Durga and PKV-Tara, the surplus after meeting the family requirement and retention for seed purpose can catch the early market thereby providing good economic return to the farmers. An additional merit observed in Durga variety is that it comes early at pod maturity stage. The tender pods are consumed as vegetable and also fetch good price in the market. Further, in case of delayed monsoon the yield potential of pigeonpea can be sustained compared to other popular varieties. As per feedback from farmers, the cooking quality and market acceptability of the variety is also equivalent to other popular varieties. Even though green gram is normally not cultivated as an intercrop and following the trial with 25 farmers in 2015, this year, it (variety Naval) was grown by 119

farmers in 65 acres including 38 farmers having sole cropping in 37 acres; a seed yield of 505 kg ha⁻¹ was recorded which was 32 per cent higher than local varieties (383 kg ha⁻¹) due to the combined effect of both improved varieties and improved agronomic practices such as timely agricultural operations, recommended fertilizer application and required disease pest management.

Since the yield from sorghum variety CSV-20 was 33 per cent lower than that from the popular farmers' hybrids in kharif 2015, CSH-14, another variety recommended for the area by PDKV, was introduced and cultivated by 145 farmers in 200 acres. Even though crops in some areas were damaged by birds and wild animals, there was an average grain yield of 2 t ha⁻¹.

In rabi 2016, the micronutrient-dense improved varieties of wheat, namely, AKAW-4210, NIAW-1415 (both rich in iron and zinc) and *Abhay* (rich in zinc), were grown by 30 farmers in 17.5 acres using their own seeds saved from the previous years' trials. Similarly, the wilt-resistant chickpea variety JAKI 9218 was cultivated by 48 farmers in 24 acres in the five core study villages. Besides, some farmers from three neighbouring villages also expressed interest to cultivate the micronutrient-dense wheat and wilt-resistant chickpea varieties and AKAW-4210 was cultivated in 1 acre by four farmers and JAKI 9218 in 2.4 acres by five farmers. The crops have been harvested and data compilation is under way.

Poultry Intervention: Backyard poultry was initiated in January 2016 with 25 households with no land and/or with incidence of anaemia. For each household, a poultry unit comprising low-cost iron cage, 25 kg starter feed and 16 chicks of *Giriraj*, *Vanraj*, *Swarnadhara* and Rhode Island Red breeds were provided. Veterinary support was provided by the Maharashtra Animal and Fishery Sciences University (MAFSU), Nagpur. Each household had an average production of 50 eggs and 26 kg meat over a period of six months (June–December 2016). Around 50 per cent of the total egg and meat produced was consumed at the household level and rest was sold either in the village or local market, providing some additional income to the farm families. Out of 25 participants, 8 households have already started collecting and brooding the eggs for chicks. Considering the first year's result and interest evinced by other farmers in the study villages, the project is working towards establishing the linkage between proactive entrepreneurs and certified chick supplier units in the locality.

Nutrition Garden: Households with backyard area and with incidence of anaemia and VAD were particularly targeted for cultivating nutrient-rich vegetables and fruits. During kharif 2016, 363 seed kits of leafy vegetables such as *rajgira* (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 246 households from the five core villages and

117 from neighbouring villages. Saplings of papaya, lemon, curry leaves, *moringa*, *karonda* (*Carissa carandas*), *amla*, wood apple, tamarind, guava and jamun were also distributed to the households. Out of the 246 households in the five core villages, 17 cultivated vegetables in their backyard, 175 in the field and 54 both in the backyard and in the field. 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 chilli, cauliflower and tomato were distributed to 212 households in the five core villages and 50 households in neighbouring villages.

Community nutrition gardens of about 0.1 acre area on common land or land leased without rent have been operating in Saheli, Heti and Borgaon Gondi villages since late 2013. They are maintained by a group of women in each village and the produce shared by them. Leafy vegetables such as spinach, amaranth (*rajgira* and *chavalai*), fenugreek, coriander and cabbage; roots and tubers such as carrot, radish, beetroot and garlic; other vegetables such as chilli, 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 garden is in operation on land within the school in three villages. In 2016, seeds of leafy vegetables such as *rajgira*, *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 schoolchildren, teachers, cook and the village volunteers. The genetic garden established in Heti village in early 2016 is being nurtured and developed as a model for awareness generation and for providing planting material.

Capacity Building: Farmers' field days were conducted for training on integrated pest management in red gram against pod borer in December 2016 and in chickpea against pod borer and wilt in January 2017. In February 2017, a team comprising officials from Agricultural Technology Management Agency (ATMA) and KVK (Selsura) visited chickpea and wheat fields, backyard and community nutrition gardens, genetic garden, school nutrition gardens, the Farmers' Knowledge Centre (FKC) at Saheli and poultry units. The objective of their visit was to understand ongoing activities under the FSN study so that the opportunities to work together through convergence can be identified. Following the visit, farmers are being organized to form groups that will be linked to ATMA. The FKC plays an important role in disseminating knowledge and information to the farmers. The major objectives are to: (i) facilitate agricultural, livestock and nutrition knowledge to the community along with allied enterprises; (ii) promote nutrition-sensitive and low-cost technology for small and marginal farmers to encourage them for adoption of cost-effective farming system and better agronomical

package of practices; and (iii) provide advisory services to the farmers on agriculture, nutrition and allied aspects. Based on the available resources, the FKC is equipped with a library and is being actively utilized as a platform to organize various capacity-building programmes for villagers. Following the response to the FKC established in Saheli village, an FKC was started in Borgaon (Gondi) last year in space and infrastructure made available by the village.

Staff members and 22 farmers attended a 2-day workshop on linseed cultivation in February 2017 to get an idea on improved package and practices of this important oilseed crop as well as the nutritional and health benefits of linseed consumption. This was followed by an exposure visit of farmers and staff to farmers' linseed fields in Chikhalapar in Nagpur district, for experience sharing on linseed cultivation, especially on harvesting and post-harvest handling of the crop. An exposure visit was organized in March 2017 to see the work of two NGOs, SEARCH (Shodhgram) and Amhi Apalya Arogyasathi (Kurkheda), in Gadchiroli district in order to know about their activities related to nutrition, health and hygiene in the community. The team comprised 20 members (M: 11; F: 9), including community resource persons (CRPs), selected proactive community members from the FSN study villages and staff members.

Nutrition Awareness Activities in Both Locations

Linking agriculture to nutrition has to be complemented with nutrition awareness

for better understanding on why and how leveraging agriculture can help address undernutrition. Various programmes like exposure visits, trainings on improved agriculture practices, pest management and trainings requested by the community people like mushroom cultivation were conducted in Koraput. In Wardha, special lectures to specific population like pregnant and lactating women and adolescent girls on dietary requirements, exhibition on pulses and food groups, cooking demonstration and exposure visit were conducted. Follow up of the nutrition calendars was done in both locations to assess its impact by organizing a skit conceived and enacted by schoolchildren.

Community Resource Person Approach: A workshop was conducted at Chennai for staff members working on the FSN study in May 2016, under the guidance of a nutrition expert Dr Rama Narayanan, for better understanding on how to link agriculture to nutrition. As a measure of fostering sustainability of the initiative at the community level, it was decided to build the capacity of selected individuals from the core study villages as CRP, following the approach developed by Dr Rama Narayanan when piloting the Community Hunger Fighter initiative at MSSRF earlier. CRPs were selected from the community by organizing meetings in the villages in both Koraput and Wardha by the participatory approach. The criteria was that a maximum of 5 CRPs and a minimum of 2–3 CRPs has to be selected from each of the core study villages in Koraput and Wardha, respectively, with representation from each caste and gender. Based on the above

criteria, 25 CRPs (M: 13; F: 12) were selected in Koraput and 15 (M: 8; F: 7) in Wardha. Three-day residential training workshops were conducted in August at Koraput and in October at Wardha for the selected CRPs. The objective was to enable them to understand their own nutritional status, diet patterns, entitlements related to agriculture and nutrition, the basics of balanced diet and nutrition and how they could access this from the surrounding environment.

Follow up of the residential training was conducted on the tenth, twentieth and thirtieth day after each programme in order to understand the sharing and adoption of the nutrition messages in the community. It was observed that the CRPs adopted some of the nutrition messages themselves and shared with their own family members. It was also observed that the messages were shared with the community both formally by conducting village meetings and informally in common places like tea shops, festival gathering, evening gossip time, while engaging in agricultural activities, travelling and transporting produce from field to processing area. Messages on the concept of balanced diet, healthy food, good dietary practices, food and nutrition care during different stages of life and on livelihood and social issues were also shared.

In Koraput, nutrition messages were shared with 178 people in FSN villages by male resource persons and 84 people by female resource persons during September–November 2016. In Wardha, male resource

persons shared messages with 125 people and female resource persons with 99 people during October–December 2016. It was reported that the messages were shared with relatives from other villages also.

A follow-up workshop was conducted to train the CRPs on linking agriculture to nutrition in October 2016 at Koraput and in December 2016 at Wardha. The CRPs who were not able to attend nominated other interested persons to attend the training. Four new CRPs in Koraput and three new CRPs in Wardha attended the training programme. This process is enlarging the pool of members of the community being capacitated at the grassroots level. The baseline nutrition status assessment in 2014 had revealed that the daily diet was predominantly cereal based and only two food groups, mainly cereals and vegetables, were consumed daily in Koraput and three food groups, that is, cereals, pulses and vegetables, in Wardha. This came to light even during the group work by the trainees. During the training programme in Koraput, the participants agreed that it was possible to achieve dietary diversity with all six food groups, that is, cereals, pulses, oilseeds, vegetables, fruits and animal source food (fish) from all three types of land: upland, medium land and low land, with a landholding of 0.5 acre each. Similarly, five food groups could be obtained from a combination of any two types of land with a landholding of less than 0.5 acre each. In Wardha, it emerged that with proper planning, good agriculture practices and availability irrigation facility, five to six food groups could be obtained from 2 acres of land

regardless of soil type and extend scope for long time production and its availability round the year. In both the locations, it emerged that the forest can be a source for seasonal fruits and vegetables. Knowledge on entitlements under different government programmes and schemes was enriched with special lectures by the Block Development Officer in Koraput, District Immunization Officer in Wardha and the Agriculture Officers in both locations.

Further training needs which will help link agriculture to nutrition were assessed and training sessions are being organized at the village level. The trained CRPs act as resource person to share messages related to nutrition and diet. By way of recognition and also to earn respect in the community, certificates of participation in training have been issued to the CRPs who have undergone training. This will help the community members to know whom to approach in the village for the relevant information. Feedback on the training programmes conducted at village level is in progress in both locations.

A workshop was conducted at Chennai in March 2017 for staff members from Koraput and Wardha on monitoring and evaluation of the nutrition awareness initiative and performance of the CRPs. The monitoring is being done at the village level to understand the sustainability of the CRP approach.

Sustainability Measures

For the sustainability of the programme, it was strategically planned to create linkage between the village community and technology

stakeholders and governments departments for convergence. In this context, several workshops and training programs have been conducted at both the study locations on seed management, integrated nutrient management, integrated pest management and improved package and practices of location-specific nutritious crops where officials from government departments or research organizations acted as key resource persons. In terms of inputs, especially of seeds, several measures such as distribution of triple-layered polythene bag for safe seed storage, community seed banks in Koraput, village-wise seed enterprises, scope of seed production with progressive farmers and community seed bank exclusively for nutrition gardens in Wardha are being explored and initiated. To encourage the consumption of pulses, possibilities of installing community pulse processing units at both the study locations are being worked out. In addition, the insights emerging from the FSN study are being shared and discussed at several scientific forums as well as at block-, district-, state- and national-level consultation meetings. A national consultation “From Research to Policy” was organized in Delhi in July 2016. Policy briefs finalized following the deliberations were subsequently submitted to officials at Niti Aayog and in the ministries of Agriculture and Women & Child Development. A state consultation on policy insights from the FSN study and recommendations based on gendered research in Koraput specifically targeting the Odisha State Policy for Girls and Women 2014 was held in Bhubaneswar in March 2017. Block-level consultations were

conducted in Boipariguda in Koraput and Karanja and Arvi in Wardha in April–May 2017. Farm men and women shared their experience under FSN with other farmers and block- and panchayat-level functionaries. See section on Workshops and Conferences for further details.

A series of endline surveys have commenced at both locations. These will be compared with the findings of the baseline survey undertaken in 2014 on commencement of the study, to examine the changes if any and assess feasibility of the initiative.

Research Uptake

MSSRF began leading RU for the LANSa consortium from 2015 with formative evaluation methodologies that have helped design and deliver tailor-made RU strategies for the four focus countries, namely, India, Pakistan, Bangladesh and Afghanistan. Insights feed into a carefully constructed strategy with objectives that determined the usefulness of the initiative, alongside a step-by-step plan providing space for risks and unintended consequences. Process documentation and analysis is finally reported on the LANSa website or as a reflective practice story, and presented in the annual report to DFID every year.

Knowledge translation is an ongoing process under RU to encourage easy access to LANSa evidence. Research findings are translated in simple language and produced in formats to suit the audience or reader, for example, blogs, presentations, discussion posts, policy briefs,

documentary film, research briefs, animation clips, summary reports and social media posts. In 2016, RU undertook to translate RU products in country languages (dialects in some cases), keeping messaging clear and easy-to-understand for local governance and community-level stakeholders. In India, MSSRF used participatory tools/audio and visual aids in local languages for effective communication with the target stakeholder community.

The RU lead at MSSRF coordinated LANSa's hosting of online discussions and social media campaigns in partnership with international organizations. An online discussion in collaboration with FAO FSN forum in July 2016 focused on how gender relations in agriculture can be transformed by recognizing women's work and its implications for her well-being and that of her children. The discussion from 26 June to 15 July attracted 94 contributions from across 16 countries. In April 2017, a 2-day online discussion on “public and private actions for strengthening the impacts of agri-food value chains on nutrition” was facilitated by MSSRF and Institute of Development Studies (IDS) in the United Kingdom, using the D-group platform hosted by IDS. Having built good relationships with well-established agriculture-nutrition platforms such as FAO FSN forum, Secure Nutrition and HarvestPlus, RU efforts showcased LANSa research for regional and global recognition. National press (English and country language media) coverage (print, online, radio and TV) in all LANSa focus countries have given LANSa

research an extra vigour. Most media attention was received as a result of RU stakeholder events organized at country level with LANSa partners taking the lead. In 2016 alone, 27 news items on LANSa work were published in English, Bangla, Odiya, Marathi and also in Dari/Pashto languages in Afghanistan. An animation film titled *South Asia: Women in Agriculture – The Nutrition Connection* was conceived and developed by the LANSa RU team across the consortium. The film was launched globally on International Women's Day – 8 March 2017 – and received 100 views on day 1 itself.

Highlights a few key indicators of RU outreach in 2016

- Upper bound of 465369 followers for LANSa research shared on social media; Twitter Impressions and Facebook reach is 273716
- LANSa RU strategies presented at What Works Global Summit in London, September 2016
- Uptake participation in FAO e-agriculture Forum in Nonthaburi led to several key government stakeholders from all LANSa focus countries receiving introduction to LANSa evidence
- LANSa research findings and plans presented at 128 district, provincial, national, regional and global conferences, workshops, seminars and meetings
- 22 blogs with a total of 3106 blog hits; an average of 147 hits per blog 2016

- 27 news items published in English, Bangla and Dari/Pashto languages (Afghanistan)
- LANSa FAO FSN e-discussion sees 94 contributions from 16 countries

In India, key stakeholder engagement events included: (i) a policy consultation in New Delhi on 29 July where the FSN study was presented and farmers from Odisha and Maharashtra shared their experiences; (ii) a session on WASH and agriculture nutrition linkage at the Odisha Environment Congress in December 2016; (iii) a seminar to observe Women's Day in March 2017; and (iv) a consultation to share policy insights from the FSN study in Bhubaneswar in March 2017. Details of these events are available in the section on Workshops and Conferences.

Capacity Strengthening: As part of building RU capacity for researchers at MSSRF, a half-day workshop was organized in August on learning to use software to visualize data in interactive ways using infographic tools and on how to use a camera for still photography as well as videography to capture ongoing research in the field. A total of 25 researchers participated. A majority (86 per cent) of the participants expressed that the session had equipped them to communicate their research better, and 71 per cent requested follow-up support. The workshop proved effective, and researchers began using infographic tools to communicate their data at conferences. Some field staff have also begun shooting stakeholder interviews of community members at the village level to support documentation on the LANSa website.

Coordination

The LANSA Consortium Advisory Group, Steering Group and Annual Partners' meeting were held at the International Water Management Institute (IWMI), Colombo, in October. A 1-day meeting was also held during this time to discuss seven ongoing formative and feasibility studies on nutrition-sensitive agriculture under the LANSA responsive window grant. With the programme due to end in mid-2018, the LANSA synthesis strategy was finalized during the year and work on consolidation of the research undertaken has commenced.

Sub Programme Area 802

International Projects

Rice Biopark

The Governments of India and Myanmar entered into an agreement for establishing a Rice Biopark at Myanmar with the full financial assistance of the Government of India with an understanding to strengthen Myanmar's agricultural sector. Appreciating the centrality of rice in the Myanmar agricultural economy Rice Biopark aims at improving food security and income security of small families and producing value-added and market-driven rice and rice-related products. It is being established in Nay Pyi Taw, about 350 km north of Yangon, with the participation and support of the Department of Agricultural Research, Ministry of Agriculture and Irrigation, Government of Myanmar.

The Rice Biopark consists of (i) ultramodern rice mill for cleaning, hulling, polishing, grading, sortexing, weighing and packing of rice; and (ii) small-scale units for producing various marketable commodities by using every part of the rice plant for producing (a) improved livestock feed by increasing the nutrient content of rice straw, cattle and poultry feed using specialized formulations, (b) oyster mushroom culture from paddy straw, (c) stabilized bran, (d) vermiculture using rice straw and husk, (e) Spirulina, (f) hand-made paper using rice straw and (g) for improving the nutrient up-gradation of local ethnic foods from rice. These facilities will be used for commercial production as well as to train farmers, scientists and other stakeholders.

M.S. Swaminathan Research Foundation is the knowledge provider for the establishment of this Biopark. Based on the Business Plan prepared, the following works were completed this year.

Rice mill shed was constructed and mill machinery and other equipment were shipped from India to Myanmar. All rice mill machinery, including colour sorter, bran sifter, bowl roaster and de-stoner for broken brown rice and packing machines, had been established. The edge runner for preparing flaked rice had also been erected and commissioned. Equipment and machinery relating to paper making from paddy straw had been erected and tested. Establishment of ethnic food laboratory was completed and required laboratory equipment were procured, tested and installed.

The training schedule for Myanmar scientists has been prepared. The training in value addition to rice and paddy biomass is being imparted to nine scientists and technical staff of the Department of Agricultural Research, Myanmar, with the support of various expert institutions in India (Table 8.1). The training for rice mill engineers will be imparted later.

Afghanistan Agro-Biodiversity Genetic Garden

Afghanistan's landscapes of mountains, deserts, open woodlands and forests are home to a vast range of species existing in a multitude of ecological conditions. It is estimated that 20–30 per cent of 3500–4000 species of plants are endemic in Afghanistan.

Table 8.1: **Details of training provided to scientists and technical staff of Rice Biopark, Myanmar**

Training subject	Name of the institute providing training
• Training on treatment of rice straw • Training on nutritious rice straw block making • Training on azolla culture and vermiculture	Institute of Animal Nutrition, Krishi Vigyan Kendra, Kattupakkam, Tamil Nadu Veterinary and Animal Sciences University
• Training on Spirulina culture • Training on value-added products (handicrafts)	SHARANA, Puducherry Aurobindo Ashram, Puducherry
• Training on chamber construction for preparing black ash from rice husk • Training on preparation of bio-fertilizer from rice husk black ash • Training on preparation of flaked rice and expanded rice	Indian Institute of Crop Processing Technology, Thanjavur
• Training on mushroom culture using rice straw • Training on bio-fertilizer (Rhizobium) unit • Training on vermiculture unit	MSSRF, Dindigul
• Training on hand-made paper unit	Jothi Speciality Papers, Erode
• Training on preparation of rice-based diets	Mysore University
• Training on edge runner • Training on preparation of popped rice, expanded rice and flaked rice	Central Food Technological Research Institute, Mysore Cottage Industries, Mysore and Devenagare
• Training on preparation of beaten rice	

More than 85 per cent of the population of Afghanistan is dependent on agriculture and related activities for livelihood. A sizable portion of the agriculture and agriculture-related biodiversity in the country has been devastated by internal conflicts and 3-year prolonged drought from 1999 to 2002. Prior to the conflicts, Afghanistan had a world renowned crop seed collection, which has been destroyed during the era of conflicts. The destroyed seed collection included varieties descended from many wild ancestors, representing a very rich genetic diversity that may have contained rare traits, such as disease and pest resistance and drought tolerance. However, how many of these plants are still in use is not known as very limited information is available on Afghanistan's crop species diversity.

The advisory panel set up by the Ministry of External Affairs, Government of India, in 2014, under the chairmanship of Prof. M. S. Swaminathan, recommended two programmes in order to safeguard the future of the food, health and livelihood security of people of Afghanistan: (i) establishment of an agricultural university in Kandahar; and (ii) establishment of a genetic garden in the premises of that university to conserve and safeguard Afghanistan's remaining agrobiodiversity giving focus on intra-species variability and also provide opportunities for the further evolution of distinct genetic strains. The committee also suggested the setting apart of 400 acres of land at the Tarnak Farm in Kandahar for the purpose of the

genetic garden. The agricultural university is being established by the name Afghanistan National Agricultural Science and Technology University (ANASTU).

Considering the fact that Afghanistan has already undergone severe genetic erosion due to conflicts, Professor Swaminathan emphasized "the need for *in situ* – on-farm conservation of perennial plants of economic value, as well as *ex-situ* live and cryogenic gene banks to conserve for posterity a sample of existing genetic diversity, and a database that maintain the record of the agrobiodiversity resources of Afghanistan." He proposed the genetic garden to "concentrate on collection and preservation of intra-specific variability; for example, in a botanical garden of rice, there may be about 20 distinct species, but in a genetic garden there could be thousands of varieties of rice. In fact in the world as a whole there are about 150,000 varieties of rice. What is important in Afghanistan is to maintain intra-species variability and also provide opportunities for the further evolution of distinct genetic strains." By establishing the Afghanistan Agro-Biodiversity Genetic Garden (AAGG), ANASTU will play an important role in preserving for posterity the remaining genetic diversity in major plants of significance to food, health, livelihood and climate security. Besides this, live collections of bio-fortified plants, which may provide horticultural remedies for nutritional deficiencies, should also be a part of this garden.

As a follow up, ANASTU has identified a large area on its campus for the establishment of

AAGG, and begun the initial steps needed for establishing the genetic garden with the help of Indian Agricultural Research Institute (IARI), M. S. Swaminathan Research Foundation (MSSRF) and National Bureau of Plant Genetic Resources, New Delhi.

The goal of AAGG is to promote integrated conservation of the vanishing genetic diversity of crop plants and other plant genetic resources of Afghanistan for food, health, livelihood and environmental security.

Major Objectives

- Develop plan for the establishment of AAGG to function as an *ex-situ* agro-biodiversity gene bank conserving the valuable genetic diversity of agricultural crops, especially those having economic and cultural value and thereby safeguarding the future of agriculture in Afghanistan.
- Capacity building for efficient implementation and sustainability of the AAGG:
 - 1 Workshops of scientists participating in the establishment of AAGG.
 - 2 Training of ANASTU faculty in collection, characterization and conservation of agro-biodiversity.
 - 3 Training of technical faculty of ANASTU for maintenance of equipment and facilities to be developed for the conservation of genetic diversity
 - 4 Training the trainers for creating public awareness and developing a cadre of village-level workers to support activities of AAGG in collection and *in situ* conservation of agro-biodiversity.
- Development of infrastructure for effective utilization of agro-biodiversity.
- Development of database for “Biological Diversity of Afghanistan.”

Development of strategy for sustainable maintenance and utilization of biodiversity, giving emphasis to the genetic resources for which Afghanistan as the centre of origin, as envisaged in “Environment Law” of Afghanistan (2007), will be prepared with the participation of stakeholders including scientists, academicians, NGOs and the farming community.

Workshops and Conferences

Trainers' Training Centre inauguration at Community Agrobiodiversity Centre, Wayanad, 11 June 2016

A training centre of international standards was inaugurated at the Community Agrobiodiversity Centre of M. S. Swaminathan Research Foundation, Wayanad in Kerala on June 11, 2016. The Trainers' Training Centre was formally inaugurated by Mr N. Ram, Chairman Kasturi & Sons Ltd and Trustee, MSSRF in presence of Panchayat leaders and various other dignitaries. Mr N Ram said "If Kerala can mainstream biodiversity, agrobiodiversity and climate change into development plans of local self Governments, Kerala can set a model for India in achieving sustainable development." Ms T. Ushakumari, President, District Panchayat in her Presidential Address while appreciating the efforts of CAbC MSSRF for supporting farming and tribal communities in the district, said, the training centre had the potential to further boost development efforts in the region. Dr Madhura Swaminathan Chairperson MSSRF, in her address said the centre filled a much-needed gap with hands-on training, expert discussions, exposure visits and on-farm trainings all in one place. The training Centre will focus specifically on local bodies in Kerala in its initial period, but also plans capacity development of other government and non-government institutions. Located in a biodiversity hotspot, it will provide facilities and

expertise for the trainings along with hands-on training.

Regional Consultation on Pulses for Addressing Food and Nutrition Security, Chennai, 7 – 9 August 2016

"A combination of Scientific Skill, Political Will and Farmer's Participation in pulses production can help achieve Zero Hunger" said Prof M S Swaminathan at the inauguration of the Consultation on Pulses for addressing Food and Nutrition Security. This thought was echoed by speakers and experts from across the globe as they spoke on the worrying situation of malnutrition in India and how pulses can help overcome this situation. The consultation was part of a 3-day event organization to explore the ways to bridge the pulses gap, as part of the activities, in UN declared International Year of Pulses and brings together farmers from India and scientists, development practitioners from around the world to discuss methods to increase pulses production. Speaking of the importance of a farmer-led approach for a malnutrition-free India, many speakers stressed that it could not be business as usual when it came to the issue of malnutrition. The consultation also stressed the need for setting up "Seed Villages" to ensure the availability of quality seed with farmers. The meeting also recommended setting up "Pulse Panchayats" like the one that had been set up by MSSRF to ensure commitment of farmers and local bodies. A Memorandum of Understanding between MSSRF and Indian Institute of Crop Processing Industries, Government of India for establishing Pulse Bio-Parks on the occasion.

National Librarians' Day, Chennai, 12 August 2016

Linking Coimbatore to Washington and Government school children to scientists, the National Librarian's Day celebration in Chennai attempted to bring out the importance of librarians in empowering society. The programme was hosted as part of the INELI India initiative that works with public librarians. The National Librarian Day is on the birth anniversary of Dr S R Ranganathan, considered the father of Library Science in India. Recalling his contribution Prof M S Swaminathan said, "Dr Ranganathan transformed the Delhi University library from a collection of books to a collection of knowledge. Representatives from four libraries from across India and professionals working for knowledge empowerment through libraries from United States spoke through a webinar as part of the event. A total of 15 librarians from across the world participated at the webinar through video conferencing. A group of school students from Chennai, who had participated in a nutrition awareness initiative held at the MSSRF library, and had displayed their artwork, were present on the occasion.

Launch of the Indo-Australian Rice Partnership between M S Swaminathan Research Foundation and the University of Tasmania (UTAS), Chennai, 1 September 2016

Scientists from India and Australia initiated a collaborative research towards developing rice that is tolerant to salt water. An agreement

was signed between M S Swaminathan Research Foundation and the University of Tasmania (UTAS) in Chennai for a project supported by the Australia-India Strategic Research Fund (AISRF). The three-year project will conduct research on salt tolerant rice varieties identified from wild species using biotechnology approaches in India and in Australia. AISRF project awarded to UTAS and MSSRF through a highly competitive bidding process, will explore the use of a halophytic, wild rice relative (*Oryza coarctata*) that occurs as a mangrove associate in the inter-tidal mangrove swamps along the coasts of India.

CRSARD Annual General body Meeting, Chennai, 20 September 2016

The 29th Annual General Body Meeting of the Centre for Research on Sustainable Agricultural and Rural Development (CRSARD) was held at MSSRF, Chennai on September 20, 2016. The meeting began with a minute of silence to Dr S Rajagopalan, who had earlier been Secretary of CRSARD. Prof M S Swaminathan, welcomed the gathering. The meeting confirmed the minutes of the 28th AGM held on September 15, 2015. The meeting also recorded its appreciation to Dr Ajay Parida, former ED of MSSRF and currently Senior Fellow at the Foundation for his services. Mr G Venkataramani, Secretary CRSARD and Dr V Selvam, Executive Director, MSSRF presented the highlights of the activities of MSSRF during 2015 – 16 who emphasized the mission of the Foundation in developing models for large-scale adoption. He shared the key initiatives taken up across all programme areas.

Approaches for a Hunger-Free India: National Nutrition Week, Chennai, 21 September 2016

Efforts towards a malnutrition-free Tamil Nadu took centre-stage as Government, non-governmental, academic, community and private organizations came together for a programme on “Approaches for a Hunger-Free India” was organised. The programme held to take forward the National Nutrition Week agenda of the Government of India called for setting up a platform of different stakeholders for convergent action on nutrition across the state. Prof M S Swaminathan, called for a 3-pronged approach involving Methods, Material and Monitoring towards achieving Zero Hunger. “No other country has legislated Right to Food. With Tamil Nadu’s track record of being the first state to start ICDS and the mid-day meal scheme, we hope there will be co-ordinated action towards facilitating a Malnutrition-Free Tamil Nadu.” Mr Job Zachariah, Chief of Office, UNICEF, Tamil Nadu and Kerala said that nutrition had to take centre stage. “The destiny of India is dependent on the first 1000 days of a child as there is enough and more research to prove that nutrition determines not only the health and mental ability but also economic development.”

Remembering a Legend: M S Subbulakshmi Centenary Concert by T M Krishna, Chennai, 26 September 2016

Music that can break barriers was the thought that echoed through the special programme

on the occasion of legendary musician M S Subbulakshmi on her birth centenary. Shri T M Krishna, a renowned Carnatic musician praised M S Subbulakshmi’s music and said it had the unique quality to break barriers. Prof M S Swaminathan, recalled how she had always shown concern and interest in the working of the Foundation and had readily sung at the institution when requested to do so.

Millennium Lecture on Technology and resources need to be equitably shared with Small Island Developing States, Chennai, 18 November 2016

“Climate Change is not a buzzword any more, it is a reality,” said Mrs Ameenah Gurib-Fakim, President of the Republic of Mauritius on the occasion of the Millennium Lecture organized at M S Swaminathan Research Foundation on 18th November 2017. Speaking on the topic, “Challenges and Opportunities for Mauritius through the lens of a Changing Climate”, Mrs Gurib-Fakim who is a scientist and the first woman President of her country dwelt at length on the various efforts being taken by island nations such as Mauritius that are highly vulnerable to adverse effects of climate change. A genetic garden of halophytes – naturally occurring salt-tolerant plants – established by MSSRF in Vedaranyam, Tamil Nadu was inaugurated through video conference by Mrs Gurib-Fakim. Plants such as these are especially important in the context of increasing salinization of land, one of the adverse effects of climate change. Introducing the garden, Dr V Selvam, Executive Director, MSSRF said the potential of halophyte for food

for people, fodder for livestock, bio fuel and for ornamental purposes was being explored and all of these could reap rich rewards in anticipatory research for climate change. “This is probably the first such garden in the world and could be called a global garden – very important in the aspect of anticipatory research.

Millennium Lecture on Climate Ready Rice Varieties ready for new challenges, Chennai, 10 February 2017

“The International Rice Research Institute has ‘Climate Change Ready Varieties’ of rice that can help provide additional resilience to the farmers” said Dr Matthew Morell, Director General, International Rice Research Institute (IRRI). Dr Morell emphasized the importance of rice for consumption and for farmers. The climate-ready varieties could face adverse conditions of stress such as salinity, drought, flooding and heat. IRRI located in Philippines, has over 127,000 accessions of wild rice in its genebank but only 5% of them have been used for breeding he said. Referring to rice as the ‘engine of food security’, he said it feeds 4 billion people and supports over 144 million farm families across the world and will continue to be important in the future as well. Speaking on the occasion, Prof M S Swaminathan referred to the Govt of India’s announcement that they would double farmers’ income in five years. “Apart from productivity and sustainability small and marginal land holding farmers can greatly benefit from using every part of rice biomass in farming practices. Dr Madhura Swaminathan, Chairperson,

MSSRF who chaired the session, said that while many institutions were working on varieties to withstand climate change, it was interesting that IRRI had ‘Climate Ready Varieties’.

Clima Adapt Meeting, Chennai, 13 February 2017

“Collaboration in agriculture and food security is crucial to deal with climate change”, said Mr Jon Georg Dale, Minister for Agriculture and Food Security, Norway. Speaking at M S Swaminathan Research Foundation at a consultation on climate change, he said “Food security is top of the global agenda and the Sustainable Development Goals. Agriculture must be at the heart of development and we must use water and other resources sustainably.” The minister announced that Norway was committed to reducing its GHG emissions by 40% by 2030 compared to 1990 levels and was taking several initiatives to meet this target. The meeting was held to share impact of the ‘Clima Adapt’ project that reached out to over 41,000 farm families in Tamil Nadu, Andhra Pradesh and Telangana. Prof M S Swaminathan, spoke of the Svalbard global seed vault with 800,000 accessions from across the world referred to as “Noah’s Ark” by National Geographic in Norway. Dr Nils Vagstad, Director General, NIBIO Norway emphasized on need for co-operation to face up to climate change challenges. “No one can solve it all alone. We need international co-operation, to share ideas. We are proud of this long-lasting co-operation between India and Norway.”

Indian Public Library Movement, Chennai, 28 February 2017

MSSRF and the Indian Public Library Movement (IPLM) in association with NASSCOM Foundation, signed a MoU on February 28, 2017. This partnership aims to strengthen public libraries across India as knowledge and learning centres. This meeting stressed that there is need for libraries to be knowledge hubs and provide need-based information to specific communities and collaboration between partner institutions, to make the initiatives more effective.

Women's Day events, Chennai and Wayanad, 10 March 2017

MSSRF commemorated International Women's day through events at Chennai and at Wayanad centres. The event at the Community Agro-Biodiversity Centre, Wayanad focused on empowerment. A seminar on March 8, 2017 observed that lack of support from society dissuaded women from seeking justice. The event organized by Wayanad Adivasi Vikasana Samithi included community members, police, legal, and scientist participants.

In Chennai, this day was observed on the theme "Will you #BeBoldForChange?" on March 10, 2017. Speakers included Director, Social Welfare Department Dr V Amuthavalli, IAS, Dr Farhat Saiyed, UNICEF, Dr Prakash V Shetty, CEO-LANSA Consortium, Dr Nitya Rao, University of East Anglia & Gender Lead LANSA, and others spoke during the function. An animation film on women and

agriculture was screened on the occasion and ongoing research by LANSA was presented by Dr Nitya Rao.

Inauguration of Community Seed Bank in 2 villages of Kumta, Uttara Kannada, Karnataka, 25 March 2017

M S Swaminathan Research Foundation (MSSRF) is implementing a project entitled "Reclamation of coastal saline soils of Karnataka: An integrated approach towards biosaline agriculture" in the coastal districts of Karnataka. One of the key objectives is to conserve and popularize the traditional saline and submerge tolerant paddy Kagga, extensively cultivated in the Ghazani land (brackish water) in the Aghanashini estuary of Uttara Kannada District. However, only few farmers are cultivating this paddy variety due to less productivity, poor market demand and conversion of Ghazani lands to prawn farms. The small and marginal farmers expressed the non-availability of quality seeds of Kagga during the meetings with them. Therefore, the inauguration of seed bank in 2 villages was organised on 25th March 2017 in Kumta, Karnataka. Dr. Narayan G. Hegde, Trustee, MSSRF inaugurated the Community Seed Bank. About 500 farmers participated in the inaugural meeting and expressed their interest in Kagga cultivation..

State-level stakeholder workshop on Marine Advisory Services, Chennai, 28 March 2017

Tamil Nadu has set up fisheries information centres across the state to support life and

livelihood of fisher folk said Dr Beela Rajesh, IAS, Commissioner of Fisheries, Government of Tamil Nadu. She was speaking at the state-level stakeholder workshop on marine advisory services organized by MSSRF and INCOIS. The workshop was attended by representatives from fishing communities from 8 districts of Tamil Nadu and Puducherry. "Fishing is the 2nd most dangerous profession in the world. Life is most important and the government cares for fisher folks safety and security." Hence saving the life of fishermen and providing information

on sustainable fishing, stop using banned nets and maintain hygienic conditions are essential get a remunerative price. Representatives from Department of Fisheries, Tamil Nadu and Puducherry, from academic institutions, besides scientists from INCOIS and MSSRF participated in the discussions. The fish landing centres are located in Chennai, Cuddalore, Thoothukudy, Nagapattinam, Kanyakumari and Rameshwaram. MSSRF has been extending technical support for these information centres.

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Gnanaprakasam, R. Training on Equity Grants FPOs. Small Farmers Agribusiness Consortium and NABARD, Namakkal. 25 January 2017.

Gnanaprakasam, R. Training on Business Plan Development and Legal Compliances. KVK-Santhiyur, Salem. 8 March 2017.

Hariharan, G. N. National Conference on Genomics and Proteomics in Bioprospecting - Role in Healthcare Development. Dr. NGP Arts and Science College, Coimbatore. 21 December 2016.

Hariharan, G. N. Brainstorming Session. CSIR, National Botanical Research Institute, Lucknow. 12 February 2017.

Jaganath Naik. Workshop on Development through Data: How to Benefit from Data in the Digital Age. Centre for Science and Environment, New Delhi. 29 November to 1 December 2016.

Janakiraman, A. International Conference on Digital Libraries (ICDL-2016). India Habitat Centre, New Delhi. 14-16 December 2016.

Jayashree, B. Popularizing Millets Workshop. ICRISAT, Hyderabad. 19 August 2016.

Jayashree, B. Regional Media Workshop. Economics of Ecosystems and Biodiversity, GIZ, Chennai. 5 October 2016.

Jayashree, B. Social and Behaviour Change Communication Training. UNICEF-New Concept, New Delhi. 1-2 March 2017.

Jegan, S. 16th International Symposium on Microbial Ecology. International Society for Microbial Ecology, Montreal, Canada. 21-26 August 2016.

Jegan, S. Workshop on NGS (Next Generation Sequencing) DNA Sequencing Hands-on Data Analysis. Bionivid Technology Private Limited, Bangalore. 23-25 January 2017.

King, E. D. Israel Oliver. National Conference on Embracing Millets back to Life & Millet Gala. Bioversity International, Bhopal. 21 May 2016.

King, E. D. Israel Oliver. Design and Planning Workshop. McGill Centre for the Convergence of Health and Economics, NIFTEM, Tata-Cornell Agriculture and Nutrition Initiative, International Food Policy Research Institute and INCLIN Trust. Jaypee Siddharth Hotel, New Delhi. 2-3 June 2016.

King, E. D. Israel Oliver. Workshop on Popularizing Millets through Product Development and Branding Karnataka Ragi.

Government of Karnataka and ICRISAT, Hyderabad. 19 August 2016.

King, E. D. Israel Oliver. Brainstorming Workshop on Harmonization of Regulations on Access to Biological Resources and Seed Movement under the Biological Diversity Act, 2002. Crops Life Asia, CABI and National Biodiversity Authority, Chennai. 22 September 2016.

King, E. D. Israel Oliver. Writeshop on Proposal Formulation for Green Climate Fund. Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) and NABARD, Chennai. 25-27 October 2016.

King, E. D. Israel Oliver. Millet Awareness Campaign. Department of Botany, Government Arts College, Krishnagiri. 6 March 2017.

Kumar, N. National Conference on Indian Association for Women's Studies. Department of Women Studies, University of Madras, Chennai. 24 January 2017.

Kumar, N. Training on Equity Grants FPOs. Small Farmers Agribusiness Consortium and NABARD, Namakkal. 25 January 2017.

Kumar, N. National Workshop on Agro-forestry Strategies for Climate Change Mitigation and Adaptation. Department of Agro-Forestry, Forest College and Research Institute, Mettupalayam, Coimbatore. 21-22 March 2017.

Lakshmanan, P. National Forum for Single Women, New Delhi. 17-18 November 2016.

Lakshmanan, P. Women Leaders in Finance: Building an Economy of Nurturance, Consultation and Confluence. Friends of World Women, Ahmedabad. 24-26 November 2016.

Lenka, K. C. Workshop on Shifting Cultivation in Odisha State - Status & Issues. Central Soil & Water Conservation Research Training Institute, Koraput. 10 November 2016.

Manjula, M. Research and Training Workshop on Environmental Economics. South Asian Network for Development and Environmental Economics, Nigombu, Sri Lanka. 10-15 June 2016.

Manjula, M. Workshop on Economic Valuation of Agro-Ecosystems. Centre of Excellence for Climate Change, Kerala Agricultural University, Thrissur, Kerala. 6-8 January 2017.

Manjula, M. Workshop on Research Methods on Impact Evaluation of Climate Change on Agriculture. Institute of Economic Growth and Indian National Society for Ecological Economics, New Delhi. 6-10 February 2017.

Manjula, M. Winter School on Research Methods in Environmental Economics cum Write Workshop. South Asian Network for Development and Environmental Economics, Kathmandu, Nepal. 26 March - 2 April 2017.

Nagarajan, R. Geospatial World Forum-2017. Novotel Convention Centre, Hyderabad. 23-25 January 2017.

Neeranjan Gouda. Training on Agro-Meteorological Observatory. ICRISAT, Hyderabad. 28 July 2016.

Nithya, D. J. Certificate Course on Social and Behavioural Change Communication. New Concept Innovation Pvt Ltd and UNICEF, Indian Social Institute, New Delhi. 1-2 March 2017.

Parasuraman, N. 9th Global Agriculture Leadership Summit. Indian Council of Food and Agriculture, New Delhi. 8-9 September 2016.

Parasuraman, N. Borlaug Dialogue International Symposium - Let Food Be Thy Medicine. Des Moines, Iowa, USA. 12-14 October 2016.

Parasuraman, N. 1st International Agrobiodiversity Congress. Indian Society of Plant Genetic Resources, New Delhi. 6-9 November 2016.

Parasuraman, N. 7th Indian Horticulture Congress. Horticultural Society of India, New Delhi. 15-18 November 2016.

Prabavathy, V. R. Workshop on Sustaining Botanical Pesticides through Innovation and Enterprise Development. Indian Institute of Management, Ahmadabad. 24-25 May 2016.

Priya, R. Workshop on Value Chains. Centre for the Study of Social Change, Mumbai. 28 June 2016.

Punitha, S. Geospatial World Forum-2017. Novotel Convention Center, Hyderabad. 23-25 January 2017.

Rajalakshmi, S. Institutional Biosafety Committee Meeting. SRM University, Kattankulathur, Chennai. 26 December 2016.

Raju, S. and Jaganath Naik. Workshop on Development through Data: How to Benefit from Data in the Digital Age. Centre for Science and Environment, New Delhi. 29 November - 1 December 2016.

Ramasubramanian, R. Research Advisory Committee Meeting for Conservation of Coastal, Estuarine and Marine Ecosystems in the EGREE Region. GoI-UNDP-GEF-GoAP, Aranya Bhavan, Hyderabad. 6 June 2016.

Ramasubramanian, R. Science Writing Workshop. Current Science Association, Indian Academy of Sciences, Bangalore. 20-25 June 2016.

Ramasubramanian, R. Asia – Pacific Readiness Workshop in India. Adaptation Fund and NABARD, Hotel Trident, Mumbai. 23-25 August 2016.

Ramasubramanian, R. Workshop on Climate Change, Adaptation and Mitigation. NABARD, Vijayawada. 5-9 September 2016.

Ramasubramanian, R. Eighteenth Meeting of the National Coordination Body for the IUCN. IUCN, New Delhi. 29 September 2016.

Ramasubramanian, R. Writeshop on Climate Change Project Development. Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) and NABARD, Vijayawada. 6-8 October 2016.

Ravinder Reddy, Ch. 48th Annual National Conference of the Nutrition Society of India. St. John's Research Institute, Bangalore. 4-5 November 2016.

Rengalakshmi, R. Social Enterprise and Women's Empowerment. Department of Management Studies, Indian Institute of Technology Madras, Chennai. 4 April 2017.

Samantray, P. C., A. K. Sahu, M. K. Nayak and R. Behera. Training on Neuro Linguistic Programming. Balavikasa People Development Training Centre, Warangal, Telangana. 27 August 2016.

Sangeetha, R. E-Agriculture Solutions Forum. FAO-ITU, Bangkok. 29 August - 2 September 2016.

Sangeetha, R. What Works Global Summit. London International Development Centre, London. 26-28 September 2016.

Seenivasan, R. Financial Inclusion and Equitable Development. Bankers Institute for Rural Development, Mangalore. 13-15 December 2016.

Selvam, V. Enhancement of Coastal and Marine Resources Policy Dialogue on Mainstreaming Biodiversity into Fisheries Sector National Biodiversity Authority, Chennai. 25 November 2016

Selvamukilan, B. Workshop on Project Proposal Writing. Balavikasa People Development Training Centre, Warangal, Telangana. 3-5 November 2016.

Sivakumar, K. Training on Preparation of Business Plan and Legal Compliances. Centre for Indigenous Knowledge System, Chennai. 26-30 September 2016.

Sivakumar, K. Training on Equity Grants FPOs. Small Farmers Agribusiness Consortium and NABARD, Namakkal. 25 January 2017.

Sivakumar, M. N. Millet Awareness Campaign. Chennai Science Festival. Queen Mary's College, Chennai. 9-12 February 2017.

Srinath, J. International Conference on Climate Change, Water, Agriculture and Food Security. NIBIO and ICRISAT, Hyderabad. 2-3 November 2016.

Srinath, J. National Workshop on Mainstreaming Climate Change and Adaptation in Agriculture and Allied Sectors. MANAGE, Hyderabad. 20-21 November 2016.

Srinivasan, R. International Conference on Climate Change, Water, Agriculture and Food Security. NIBIO and ICRISAT, Hyderabad. 2-3 November 2016.

Srinivasan, R. International Conference on Digital Libraries (ICDL-2016). India Habitat Centre, New Delhi. 14-16 December 2016.

Sudhakar, G. International Conference on Climate Change, Water, Agriculture and Food Security. NIBIO and ICRISAT, Hyderabad. 2-3 November 2016.

Thachinamurthy, K. Market Opportunities and Challenges of FPOs. Centre for Social Innovation and Entrepreneurship. Indian Institute of Technology Madras, Chennai. 24 September 2016.

Thachinamurthy, K. Farmer Producer Organization's Institution Building and

Establishment of Enterprises. National Institute of Rural Development and Tamil Nadu Agricultural University, Coimbatore. 14 November 2016.

Thachinamurthy, K. Strategizing Deployment of Solar Irrigation Pumps in India. Ministry of New and Renewable Energy and Council on Energy, Environment and Water, Government of India, New Delhi. 19 December 2016.

Thachinamurthy, K. Institutional Ethics and Market Challenges of FPOs. NABARD and Covenant Centre for Development, Madurai. 25 January 2017.

Tusar Ranjan Nayak. Training on Lab Testing of the Organic Fertilizer and Organic Pesticides. ICRISAT, Hyderabad. 24-28 July 2016.

Velvizhi, S. Consultation on Biodiversity beyond National Jurisdiction. Centre for Marine Living Resources and Ecology, Cochin. 22 July 2016.

Velvizhi, S. Workshop on Climate Change, SDGs and Coastal Habitats in India. Indian National Centre for Ocean Information Services, Hyderabad. 20-30 August 2016.

Velvizhi, S. Stakeholders Workshop on Dissemination Strategy for Marine and Weather Services of MoES. Indian National Centre for Ocean Information Services, Hyderabad. 28 September 2016.

Velvizhi, S. State Level User Interaction Workshop on Marine Advisory Services. Mangalore. 4 November 2016.

Awards/Honours

Individual

Anabel, Nancy J. 2016. Executive Member. Centre of Excellence on Digital Government and Knowledge Societies, National e-Governance Division, Ministry of Electronics and Information Technology, Government of India, New Delhi.

Bhilal, M. 2016. Best Performer Award. District Collectorate, Pudukkottai.

Bhilal, M. 2016. Executive Member. District Level Sanitation Committee, District Rural Development Agency, Pudukkottai.

Hariharan, G. N. 2017. Member. Board of Studies in Botany, University of Madras, Chennai.

Jegan, S. 2017. Exchange Fellowship. Indo-Swiss Collaboration in Biotechnology in Plant Physiology, University of Basel, Switzerland.

Jenifer, J. 2016. EMBO Short-term Fellowship. Università Cattolica del Sacro Cuore, Milano, Italy.

Parasuraman, N. 2017. Senate Member. Bharathiyar University, Coimbatore.

Prabavathy, V. R. 2016. Fellow. Academy of Sciences, Chennai.

Pranali, H., D. Arati, M. Vikas and Anjali. 2017. Second Prize for poster presentation. 8th Indian Youth Science Congress, University of Mumbai, Mumbai.

Selvam, V. 2016. Honoured with the Emblem of the Her Royal Highness Princess Maha Chakri Srinidhorn of Thailand for his work on mangrove conservation and management, International Conference on Climate Change, Biodiversity and Ecosystem Services, Thailand.

Selvam, V. 2017. Member. Expert Review Committee of Department of Biotechnology, Government of India, Port Blair.

Selvam, V. 2017. Member. Evaluation Committee on Sustainable Management of

Natural Resources to review Central Sector Schemes and Centrally Sponsored Scheme of Ministry of Environment, Forest and Climate Change, Government of India.

Swaminathan, M.S. 2016. Honorary Doctorate, McGill University, Canada.

Swaminathan, M.S. 2017. Honorary Doctorate, University of Mumbai, Mumbai.

Swaminathan, M.S. 2017. Honorary Doctorate, Indian Institute of Technology, Kanpur.

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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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National Mission Manager – Livelihoods
National Rural Livelihoods Mission
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State Coordinator (Livelihoods)
Maharashtra State Rural Livelihood Mission
Navi Mumbai

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 Mr. R. Gnanaprakasam, *Technical Assistant*
 Mr. M. Joseph Arutselvan, *Technical Assistant*
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 Mr. A. Annadurai, *Field Assistant*
 Mr. K. Sivakumar, *Field Assistant*

Biju Patnaik Medicinal Plants Garden & Research Centre, Jeypore, Odisha

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 Mr. Prashanta Kumar Parida, *Senior Scientist*
 Mr. Kartik Charan Lenka, *Scientist*
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 Ms. Sulochana Padhi, *Assistant (Administration)*
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 Mr. Ranjit Kumar Dalai, *Field Assistant*
 Mr. Govinda Chandra Nag, *Field Assistant*
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Mr. R. Kalaimani, *Scientist*

Puducherry

Ms. P. Pakkialatchoumy, *Project Associate*

Karnataka

Mr. Vinayak Edke, *SRF*

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New Delhi

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Mr. Govind Kumar Jha, *Project Assistant*

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Ms. J. Gowri, *Technical Assistant**

Mr. C. Senthilnathan, *Field Assistant**

Villupuram

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Ms. G. Valli, *Technical Assistant**

Mr. K. Rajasegaran,

*Accounts & Admin Assistant**

Ms. G. Viji, *Field Assistant**

Jeypore

Mr. S.V. Ramana, *Principal Scientist**

Ms. Mary Dayabati Kiro, *Scientist**

Mr. Neerajan Gauda, *Technical Assistant**

Mr. Pratap Chandra Jena, *Technical Assistant*

Mr. Pramod Sahu, *Technical Assistant*

GENDER & GRASSROOTS INSTITUTIONS

Chennai

Ms. Manjula Menon, *Principal Scientist*

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Dr. R. Kathiravan, *Research Associate*

Ms. S. Geetha, *Assistant Manager*

Wardha

Ms. Manda Bhondawe, *Scientist*

Ms. Yamini Gajpure, *Project Associate**

Ms. Smita Someshwer Nakshine,
Field Assistant

Kannivadi

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 Ms. Manjusha Bhagat, *Project Assistant*
 Mr. Atul Narayan Naik, *Project Assistant*
 Mr. H. Gajanan Meshra, *Project Assistant**
 Mr. Pravin R Kumbhalkar,
Asst. Manager (Accounts)

Jeypore

Mr. Tusar Ranjan Nayak, *Sr. Scientist**
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 Mr. Purna Chandra Samantray, *Field Assistant*
 Mr. Malaya Kumar Nayak, *Field Assistant*
 Mr. Rajdeep Behera, *Field Assistant*
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 Mr. M. Srikanth, *Field Assistant**

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Tiruchirappalli

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Puri

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 Mr. Suryakanta Behera, *Field Assistant*

Andhra Pradesh

Mr. T. Omkar Vinaykumar, *Project Associate**
 Mr. B. Janakiramulu, *Project Associate*
 Mr. N. Veerabhadra Rao, *Technical Assistant*
 Mr. Karri Dhanaraju, *Technical Assistant*
 Mr. Srinivasarao Divisam, *Research Intern*

Kerala

Mr. A. Sahaya Pradeep, *JRF*
 Mr. S. Kumar, *Project Associate*
 Mr. E. Edison, *Field Assistant*

Vidarbha

Mr. J. Srinath, *Principal Scientist*
 Mr. Nilesh G Patkar, *Scientist*
 Mr. Vijay S. Thokre, *Scientist**
 Mr. Dildarkhan Pathan, *Sr. Technical Assistant*
 Ms. Vaishali V Londase, *Technical Assistant**
 Mr. Irfan Turabkhan Pathan, *Field Assistant*
 Ms. Sushma Sanjay Pistulkar, *Field Assistant*
 Ms. Durga P. Pote, *Field Assistant**
 Mr. Dnyaneshwar M. Ghawade, *Field Assistant*
 Mr. Pankaj Dnyaneshwarrao Nikhar, *Driver**

LEVERAGING AGRICULTURE FOR NUTRITION IN SOUTH ASIA

Dr. R.V. Bhavani

Project and Outreach Manager

Chennai

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 Ms. Priya Rampal, *Post Doctoral Fellow*
 Dr. D.J. Nithya, *Scientist*
 Dr. A.V. Vijaya Bhaskar, *Agronomist**
 Mr. Rohit Parasar, *SRF*
 Mr. S. Raju, *SRF*
 Ms. Pritha Banerjee, *Research Uptake Assistant**
 Ms. R. Surya, *Research Uptake Assistant*
 Ms. M. Usha Priyadarshini, *Secretary*

*left during the year

Jeypore

Mr. Akshaya Kumar Panda, *Sr. Scientist*
Mr. Naresh Chandra Patro, *Technical Assistant*
Mr. Jaganath Naik, *Technical Assistant*
Mr. Santosh Raj Benia, *Field Assistant*
Mr. Balaji Mohanty, *Field Assistant*
Ms. Rajalaxmi Lenka, *Project Assistant**
Mr. Max Aurthor Gill, *Project Assistant*
Mr. Ghasi Takri, *Project Assistant*
Mr. Susanta Kumar Mishra, *Project Assistant*
Ms. Anurakta Beuria, *Project Assistant**
Ms. Menaka Choudhury, *Project Assistant*

Wardha

Mr. Prashant Laxman Deokar,
Coordinator, FSN Study
Mr. Mahesh R Maske, *Research Associate**
Ms. Rupal D Wagh, *Research Associate*
Mr. Manoj Sayre, *Sr. Technical Assistant*
Mr. Mahesh V Sadatpure, *Technical Assistant*
Ms. Pranali Sharadrao Halge, *Project Assistant*
Ms. Pranali Prakash Mete, *Project Assistant**
Mr. Vikas Parashram Meshram,
Project Assistant
Ms. Anjali Gajananrao Baraee,
Project Assistant
Ms. Arati P Deshmukh, *Technical Assistant**
Mr. Prakash Polkade, *Assistant Accounts*
Mr. Rahul Yedkar, *Office Assistant*

Bhubaneswar

Dr. Aliza Pradhan,
Coordinator, FSN Study under LANSa

RICE BIOPARK

Myanmar

Dr. Hameeda Banu N. Itagi,
Project Manager (Technical)

CLIMATE CHANGE PROGRAMME

Dr. A. Saleem Khan, *Sr. Scientist*

TRAINING & CAPACITY BUILDING

Ms. B. Raghini, *Sr. Scientist**

THE HINDU MEDIA RESOURCE CENTRE

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Ms. Aparna Narayanan, *Media Associate*

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Mr. G. Suresh Kumar, *Sr. Technical Assistant*

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Ms. Reena Eappen, Head – Administration

Mr. C.V. Parthasarathy, *Manager*
Ms. R. Malathy, *Executive Secretary*
Mr. B. Anandakumar, *Assistant Manager - Estate*
Ms. R. Nalini, *Assistant Manager*
Ms. Y. Dilhara Begum, *Sr. Secretary*
Ms. A. Uma, *Secretary*
Mr. K. Suresh, *Assistant*
Ms. A. Syed Habi Banu Begum, *Receptionist*

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ACCOUNTS

Mr. S. Nandakumar, *Manager (Finance)*

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

SUPPORT SERVICE

Mr. P. Muthukumar, *Electrician*
 Mr. B. Sivakumar, *Electrician*
 Mr. E. Thiruvengadam, *Electrician*
 Mr. T. Krishnamoorthy, *Guest House, Caretaker*
 Mr. S. Gopalakrishnan, *Driver**
 Mr. P. Balaji, *Driver*
 Mr. C.H. Venkateshwaralu, *Attendant*
 Mr. G. Niyas, *Attendant*
 Ms. V. Vijaya Lakshmi, *Attendant*
 Ms. S. Santhi, *Attendant*
 Ms. S. Soundari, *Attendant*

Ms. M. Kousalya, *Attendant*
 Ms. B. Lakshmi, *Attendant*
 Ms. G. Prabavathy, *Gardener**
 Ms. G. Jayasudha, *Gardener*

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Distinguished Chair - Gender and Development

Professor P.C. Kesavan
Distinguished Fellow

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Dr. P. Pillaiyar
 Dr. G.N.V. Brahman
 Dr. Ajay Parida*
 Dr. L. Vedavalli
 Dr. K. Balakrishnan*
 Dr. A. Thiagarajan
 Mr. P. Senthilkumar
 Mr. M.K. Pavithran
 Ms. Priyanka Mohan

World Food Prize Intern

Mr. Nicholas W Grandstaff

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Institutional Donors – National

Department of Science and Technology, Government of India

Diana World Travels Pvt Ltd, Chennai

Bajaj Capital Ltd

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Prof. P.C. Kesavan, Chennai

Mrs. Amiya Kesavan, Chennai

Mr. S. Nandakumar, Chennai

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Dr. Bruce Alberts, USA

Sources of Project Support

Programme Area 100: Coastal Systems Research

National

Society of Integrated Coastal Management,
Ministry of Environment, Forests and Climate
Change, Government of India, New Delhi

Institute of Tropical Meteorology, Ministry of
Earth Sciences, Government of India, Pune

Charities Aid Foundation (CAF) India

Tata Power Co Ltd., Mumbai

National Bank for Agriculture and Rural
Development, Mumbai.

G.B. Pant Institute of Himalayan Environment
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Reliance Industries Ltd., Kakinada

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Karnataka, Bengaluru

International

Mitsubishi Corporation, Japan

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Programme Area 200: Biodiversity

Department of Science and Technology,
Government of India, New Delhi

National Bank for Agriculture and Rural
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State Medicinal Plants Board, Kerala

Rajiv Gandhi National Institute of Youth
Development, Ministry of Human Resources
Development Government of India,
Sriperumbudur

Department of Biotechnology, Government of
India, New Delhi

International Fund for Agricultural
Development, Rome

European Union

Mitsubishi Corporation, Japan

Food and Agriculture Organization, Rome

International Plant Genetic Resources Institute
(IPGRI), Rome

Rainwater for Humanity, USA

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Kerala, Trivandrum

Kerala State Biodiversity Board, Government
of Kerala, Trivandrum

India Meteorological Department, Ministry of
Earth Sciences, Government of India, New
Delhi

Indian Council of Agricultural Research,
Ministry of Agriculture, Government of India,
New Delhi

Ministry of Rural Development, Government
of India, New Delhi

Odisha Livelihoods Mission, Government of
Odisha, Bhubaneswar

Small Farmers Agribusiness Consortium, New
Delhi

Programme Area 300: Biotechnology

Department of Biotechnology, Government of
India, New Delhi

Department of Science and Technology,
Government of India, New Delhi

Council of Scientific and Industrial Research,
Government of India, New Delhi

SAB Miller India Private Ltd, Karnataka

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International

Programme Area 400: Ecotechnology

Hindustan Petroleum Corporation Limited,
Mumbai

OCP Foundation, Morocco

Asia Initiatives, USA

National Bank for Agriculture and Rural
Development, Chennai

VA Tech Wabag Ltd., Chennai

Bank of India, Chennai

Programme Area 500: Food Security

Ministry of Rural Development, Department
of Rural Development, Government of India,
New Delhi

Maharashtra State Rural Livelihood Mission,
Government of Maharashtra, Mumbai

Odisha State Rural Livelihood Mission,
Government of Odisha, Bhubaneswar

H T Parekh Foundation, Mumbai

Tata Trusts, Mumbai

Programme Area 600: Information, Education and Communication

Indian National Centre for Ocean Information
Service (INCOIS), Ministry of Earth Sciences,
Government of India, Hyderabad

CABI, New Delhi

Qualcomm, USA

State Planning Commission, Government of
Tamil Nadu, Chennai

Bill & Melinda Gates Foundation, USA

International Rice Research Institution,
Philippines

National

International

Programme Area 700: Cross-Cutting Programmes and Institutional Initiatives

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Department of Biotechnology, Government of India, New Delhi (Through Indo-Swiss Collaboration on Biotechnology)

ETC Foundation, The Netherlands

South Asian Network for Development and Environmental Economics (SANDEE), Nepal

Ministry of Foreign Affairs, Norway through The Royal Norwegian Embassy, New Delhi

Norwegian Institute for Agricultural and Environmental Research (BIOFORSK)-NIBIO, Norway

Programme Area 800: Special Projects

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

Indian Meteorological Department, Ministry of Earth Sciences, Government of India, New Delhi

Department for International Development (DFID), UK

South Asian Network for Development and Environmental Economics (SANDEE), Nepal

National

International

Workshops and Conferences

Bank of India, Chennai

Department of Science & Technology,
Government of India, New Delhi

ICRISAT, Hyderabad

Indian Agricultural Research Institute, New
Delhi

Kerala State Biodiversity Board, Kerala

Nirmal Seeds, Maharashtra

Odisha Biodiversity Board, Bhubaneswar

Rajiv Gandhi National Institute of Youth
Development, Sriperumbudur

SBI Life Insurance Co. Ltd., Mumbai

SICOM – ICZM, Ministry of Environment and
Forests, Government of India, New Delhi

SRM University, Chennai

State Bank of India, Youth Development
Programme, Mumbai

VA Tech Wabag Limited, Chennai

World Food Programme, New Delhi

Centre for Development Innovation,
Wageningen, The Netherlands

Food and Agriculture Organization of the
United Nations, Bangkok, Thailand

HarvestPlus, USA

World Food Programme, Rome

FINANCIAL STATEMENT 2016-17

M.S.SWAMINATHAN RESEARCH FOUNDATION

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

BALANCE SHEET AS AT 31st MARCH 2017

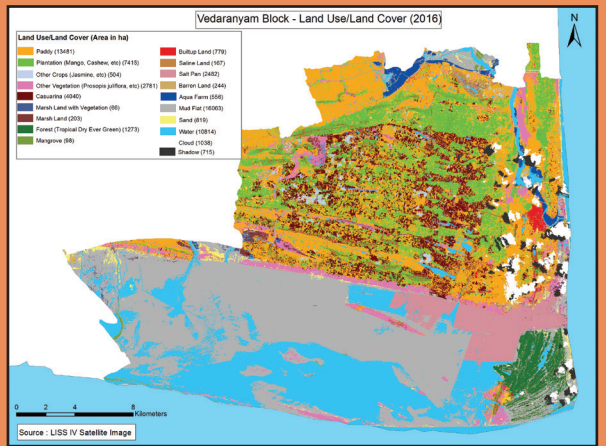
FOUNDATION					Rupees in Lakhs	
LIABILITIES	Sch. No.	2016-2017 Rs.	2015-2016 Rs.	ASSETS	Sch. No.	2016-2017 Rs.
OWN FUNDS						
OWN ASSETS						
CORPUS FUNDS	1	159.20	157.90	FIXED ASSETS	4	561.60
GENERAL FUND & OTHER FUNDS	2	3263.76	3415.61	INVESTMENTS	5	6095.60
ENDOWMENT FUNDS	3	4663.01	4613.83	CURRENT ASSETS		
CURRENT LIABILITIES	10	1161.21	771.90	CASH & BANK BALANCES	7	760.11
				ADVANCES	8	1829.87
TOTAL [A]		9247.18	8959.24	TOTAL [A]		9247.18
						8959.24

PROJECTS					Rupees in Lakhs	
LIABILITIES	Sch. No.	2016-2017 Rs.	2015-2016 Rs.	ASSETS	Sch. No.	2016-2017 Rs.
PROJECT FUNDS & OBLIGATIONS	4	1825.90	1603.17	PROJECTS RECEIVABLES	9	630.02
CURRENT LIABILITIES	10	840.62	861.88	ADVANCES	8	284.84
				BANK BALANCES	7	1751.66
TOTAL [B]		2666.52	2465.05	TOTAL [B]		2666.52
GRAND TOTAL [A]+[B]		11913.70	11424.29	GRAND TOTAL [A]+[B]		11913.70
<i>Provisional (Unaudited)</i>						
						10807.83

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

FOUNDATION

Provisional (Unaudited)



Address:
M. S. Swaminathan
Research Foundation
III Cross Road
Institutional Area
Taramani
Chennai 600 113, India