25 MSSRF
Harnessing Science for Sustainable Development

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– The MSSRF Experience

M. S. SWAMINATHAN RESEARCH FOUNDATION

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From the Chairperson's Desk

This publication, brought out on the occasion of the Silver Jubilee of the M. S. Swaminathan Research Foundation, provides a concise account of some of the major activities undertaken over the last 25 years. We have elaborated key initiatives undertaken to address issues on sustainable natural resource management, and food, nutrition and livelihood security. These initiatives have been undertaken in partnership with other organisations and more importantly in a manner that encourages active participation by local institutions. This compendium gives a glimpse of the outcomes of these initiatives. The lessons from this experience can help us in future planning, in the choice of appropriate and innovative scientific ideas and approaches. The aim of all our interventions has been to foster sustainable socio-economic development in rural areas, and among the most vulnerable social groups.

Research at MSSRF over the last 25 years has led to a large number of scientific publications. The aim of writing these case studies is to give policy makers and the lay public a glimpse of the research and interventions initiated by the Foundation to promote sustainable and equitable rural development. I hope this publication will be of interest to academicians, policy makers, development agencies and concerned individuals.

The Silver Jubilee is a significant milestone in the life of MSSRF. While we can take pride in our achievements, we need to remain conscious of the enormity of the challenges and unfinished tasks that lie ahead. I hope the Foundation will continue to fulfill its basic mandate, to seek and demonstrate innovative scientific methodologies for agricultural and rural development, and for improving the lives of rural men and women.

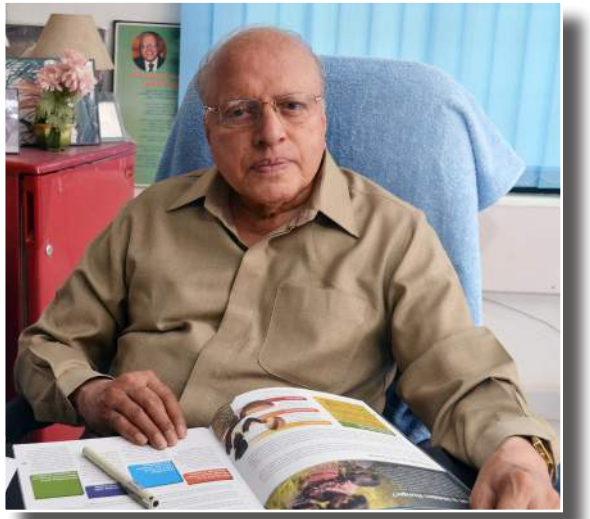
I would like to thank the scientists and staff of MSSRF who have not only contributed to the work reported in this publication, but who have put in tremendous effort in distilling the work of several years for this publication.

Madhura Swaminathan

Chairperson, MSSRF

Foreword

Twenty Five Years of Adventure in Harnessing Scientist-Farmer-Policy Maker Synergy



2013 marks the 70th anniversary of the Bengal Famine which resulted in the death of an estimated 2 to 3 million children, women and men during 1942-43. The Bengal Famine attracted much attention both among the media and the public, since it occurred soon after Mahatma Gandhi's "Quit India" call to the British in 1942. Agricultural stagnation and famines were regarded among the major adverse consequences of colonial rule. I wish to narrate the impact of the twin developments, namely, Bengal Famine on the one hand, and the "Quit India" movement on the other, on the minds of students like me. I was studying at the University College, Thiruvananthapuram, during 1940-44, when gruesome pictures of starving children, women and men in the streets of Calcutta (now Kolkata) and in the other parts of Bengal appeared in *The Hindu, The Statesman* and other newspapers. The goal of my university education was to get into a medical college and equip myself to run a hospital in Kumbakonam left behind by my father, M. K. Sambasivan, who had died in 1936 at a young age.

Unlike today, when students have to search hard for role models, those of my time had many leaders like Mahatma Gandhi, Jawaharlal Nehru and Subhash Chandra Bose whom we worshipped. A few of my college mates and I used to meet to discuss the role we can play when the British quit India. During my B.Sc. Biology course, I fell in love with the science of genetics. Therefore, in a meeting of students where the topic of discussion was our role in independent India, I announced that I have decided to shift my interest from medicine to agriculture, so that I can contribute to Gandhiji's goal of making famine and hunger problems things of the past. Though there was disappointment in my family that I will not be following in my father's footsteps, they fully supported my decision to join the Coimbatore Agricultural College to do a B.Sc. degree in agriculture before proceeding for post-graduate studies in agricultural genetics and crop improvement. I am narrating this event that took place at a crucial stage in my life only to point out the life-changing impact which the Bengal Famine and Gandhiji's vision of a hunger-free India had on young minds. Looking back, I am glad I made this choice and also that I am living today when a historic transition from the Bengal Famine to Right to Food with home-grown food is taking place. On the occasion of the 70th anniversary of the Bengal Famine, Parliament is likely to pass the National Food Security Bill which will be the world's largest social protection measure against hunger.

In my professional career, the period 1947 to '72 was spent mostly on research on the improvement of the productivity of crops like wheat, rice, and potato. I spent the years 1972 to 1980 in Krishi Bhawan, New Delhi leading the programmes of the Indian Council of Agricultural Research (1972-78) and the Department of Agriculture and Co-operation (1979-80). During 1980-82, I served in the Planning Commission first as Acting Deputy Chairman and later as Member, Agriculture, Science and Technology, Health and a variety of other subjects. I introduced two new chapters in the Sixth Five Year Plan – one on "Women and Development" and another on "Environment and Development". I also served during my Planning Commission days as Chairman of the Science Advisory Committee to the Cabinet as well as Founder-Chairman of the National Biotechnology Board and the National Science and Technology Entrepreneurship Development Board. Later, during 1982-88, I went back to a research institution and served as the Director General of the International Rice Research Institute, Los Banos, the Philippines. During this period, I was also President of the World Conservation Union (IUCN) and Independent Chairman of the FAO Council.

When I returned to India from the Philippines in 1988, I felt that I should make a contribution to filling some critical gaps in the ongoing agricultural and environmental research programmes sponsored and supported by different scientific agencies. On the basis of discussions with several colleagues, I concluded that we needed an institution which will promote translational research for converting discovery into application, and participatory research with farm and fisher families, in order to introduce a pro-nature, pro-poor and pro-women orientation to technology development and dissemination. Participatory research helps to combine the ecological prudence of farm and fisher families with frontier science and technology. Another area of research which needed attention twenty five years ago was anticipatory research to enhance the coping capacity of rural and tribal families to the potential impact of adverse changes in temperature, precipitation, and sea level. Such analysis led to the birth of MSSRF in 1988.

The then Chief Minister of Karnataka was kind enough to offer land and other facilities including monetary help to start such an institution in Bangalore. However, I felt that our long coastal area needs urgent scientific attention, since over 25 per cent of our population lives near the coast. At that time, there was very little inter-disciplinary research in progress with concurrent attention to the landward and seaward sides of coastal areas. I therefore welcomed the kind offer of the Tamil Nadu Government to provide space in the Taramani Institutional Area of Chennai for establishing the basic infrastructure needed to begin the coastal system research programme. The establishment of MSSRF at Chennai has been particularly fortunate, since there are several other institutions with which partnership can be developed and also the State has a very rich human resource. The initial work was started in 1988 in facilities kindly provided by the Anna University and later by the Indian Institute of Technology, Chennai. In April 1990, we moved to a rented building in Kotturpuram and later in April 1993, we moved to our own building in Taramani. The funds to start the work came from several prizes received by me including the World Food Prize (1987). Later, several central government departments as well as national and international donors kindly came forward to support our work, both in the form of project funds and corpus grants. Such support and a dedicated team of young scientists helped the Foundation to grow in size, geographic coverage, and impact. Dr. Uma Lele and Dr.Kavita Gandhi, who reviewed in depth the progress made by MSSRF in achieving its mission and mandate during the first twenty years, made the following observation:

> ‘MSSRF has no parallels in its entirety. The Review team searched for but was unable to identify a comparable organisation which combines scientific research with action, uses a combination of modern science and traditional knowledge, and develops innovations to address the triple challenges of poverty, gender inequity and environmental sustainability.’

Inspite of many efforts by State and Central Governments, our country is still in an unenviable position with reference to the persistence of hunger and poverty. A considerable proportion of the world’s poor and hungry live in India. MSSRF came to the conclusion that the poor are poor because they have no assets — no land, no livestock, no fish pond, or the education and skills needed for a job in the organised sector. Therefore, asset building was chosen as the pathway for the poor to come out of the poverty trap. Since a voluntary organisation like MSSRF cannot distribute land or other physical assets, the pathway chosen was knowledge and skill empowerment. Also, efforts were made to bring convergence and synergy among various government and non-governmental programmes. Another significant area of research has been the application of a combination of Mendelian, molecular and participatory breeding methods for developing varieties of rice and other crops resistant to salinity and drought. The genes for such valuable characters have come from the mangrove species *Avicennia marina* and the highly drought tolerant species *Prosopis juliflora.* Such strategic research helps us to enhance our coping capacity to meet the adverse impact of global warming induced sea level rise and more frequent drought. The results are summarised in this document.

I am glad that in a small way the scientists and scholars of MSSRF have helped to carve out a unique niche at the interface of research and development, thereby opening up new pathways for achieving Gandhiji’s vision of a hunger and poverty free India. The skill and technological empowerment programmes involved taking frontier technologies like information communication technology, nuclear and space technology, biotechnology, eco-technology and renewable energy technology to rural and tribal areas. The emphasis was on the conservation and enhancement of the ecological foundations essential for sustainable agriculture, such as land, water and biodiversity. Secondly, emphasis was given to promoting higher on-farm productivity and non-farm employment opportunities through the biovillage model of human-centered development. Community cadres of hunger fighters, climate risk managers and biodiversity conservationists were fostered. Community run Village Knowledge Centres and the internet-mobile phone synergy are helping to convert, in the words of a reviewer, ‘ordinary people into extra-ordinary individuals.’ The knowledge and skill empowerment of rural and tribal women has been effective in enhancing their self-esteem and self-confidence and thereby transforming their lives.

MSSRF has tried to function as a “centre without walls”, interacting with a wide range of institutions and individuals all over India as well as in neighbouring countries like Sri Lanka, Nepal, China, Myanmar, Bangladesh, Pakistan and Afghanistan, in addition to developed countries like USA, UK, Canada, Sweden, Norway, Germany, the Netherlands and Italy.

MSSRF’s current priority is in the field of overcoming the triple burden of calorie-deprivation, protein hunger, and hidden hunger caused by micro-nutrient deficiencies in the diet. The pathway for achieving this goal has been the application of agricultural remedies to nutritional maladies and launching a nutri-farm movement. I am happy that during this year, the legal right to food is becoming operational. **The scientist-farmer-policy**

maker alliance is a formidable one. It is to mobilise the power of such partnership that the scientists and scholars of MSSRF rededicate themselves on the occasion of the Silver Jubilee of the Foundation. Some of the earlier national movements launched by MSSRF are: "Mission 2007: A hunger-free India", Mission 2007: Every Village a Knowledge Centre". Applauding the Mission for a hunger free India initiated by MSSRF, the then Prime Minister Shri Atal Behari Vajpayee said in April 2001:

'The sacred mission of a hunger free India needs the cooperative efforts of the Central and State Governments, local self-government bodies, non-governmental organizations, international agencies and above all, our citizens. We can indeed banish hunger from our country in a short time. Let us resolve today to make the mission substantially successful by 2007, which will mark the 60th anniversary of our independence.'

The last 25 years have seen much progress in the areas chosen by MSSRF for study and advocacy. The Government of India has helped to scale up the successful findings of MSSRF, as for example, Village Knowledge Centres, Pulses Villages, Mahila Kisan Sashaktikaran Pariyojana, Nutri-farms, Every Child a Scientist, etc. At the level of legislation also, MSSRF played an important role in the development of the early drafts of the Plant Variety Protection and Farmers' Rights Act and Biodiversity Act. However, we still face formidable problems of malnutrition, unemployment and poverty. Hence, there is no time to relax. Jawaharlal Nehru used to quote a passage from Lewis Carroll's *Through the Looking Glass*: 'We must run as fast as we can just to stay in place. And if you wish to go anywhere you must run twice as fast.'

In one of his last speeches, Mahatma Gandhi said: 'Forget the past. Remember every day dawns for us from the moment we wake up. Let us all, everyone, wake up now.' This is the lesson we have learnt from the work of the last 25 years.

Let us wake up to the potential of Young India to achieve seemingly impossible tasks.

M. S. Swaminathan
Founder Chairman

Preface

The M.S. Swaminathan Research Foundation was established as a non-profit scientific Trust in 1988 with the funds associated with the first World Food Prize awarded to Professor M. S. Swaminathan in 1987, to employ appropriate and relevant science and technological tools in addressing the challenges being faced by the rural communities. The mandate of the Foundation is to undertake and disseminate strategic, applied, anticipatory and participatory research, based on a pro-nature, pro-poor, pro-women and pro-livelihood orientation to technology development and dissemination. Since its establishment 25 years ago, MSSRF has been supported by the funds associated with several prizes received by Professor Swaminathan, in addition to project support from a wide range of national, bilateral and international agencies.

The main campus of MSSRF is located in the Taramani Institutional Area of Chennai, in 2 hectares of land provided by the Government of Tamil Nadu. In addition to the main campus, MSSRF owns and operates extensive research and training facilities in Puducherry (land provided by the Government of Puducherry), Kalpetta in Wayanad district of Kerala (in 14 acres donated by Professor Swaminathan and his family), Jeypore in Koraput district of Odisha (in a 12-acre plot provided by the Government of Odisha) and Kaveripoompattinam, in Nagapattinam district of Tamil Nadu. An integrated Coastal Resources Management Research and Training Centre is being established in Chidambaram, Tamil Nadu for enhancing the coping capacity of coastal communities against calamities like cyclones, tsunamis and sea level rise. The Foundation has its activities focusing in Tamil Nadu, Kerala, Andhra Pradesh, Odisha, Puducherry and Maharashtra.

From its inception, MSSRF has concentrated on six inter-disciplinary Programme Areas: Coastal Systems Research, Biodiversity, Biotechnology, Ecotechnology, Food Security, and Information and Communication Technology. Programmes focusing on Gender and Grassroots Institutions and Climate Change operate on a cross-cutting mode. Basic, strategic and anticipatory research carried out by MSSRF over the years, aim at employing appropriate and relevant science and technology options for providing new knowledge, information and solutions to current and emerging challenges affecting rural communities. Stakeholder engagement remains central to the field activities. The participatory approach

lends credibility to several initiatives undertaken by MSSRF and the success stories generated out of varied experiences have helped leverage critical policies and played a vital role in scale-ups.

Over the last twenty-five years, MSSRF has made significant contributions in harnessing science for sustainable development. Its work has been recognised nationally and internationally. MSSRF has received the Blue Planet Prize, Motorola Gold Award, Stockholm Challenge Award, National Water Prize, National Water Augmentation Award, and National Award for Women's Development, to name a few. Many of the staff members have also received national and international recognition and awards. They serve as members in technical and policy advisory committees in India and abroad. MSSRF is recognised by the University of Madras, Anna University, Osmania University, and Annamalai University as a Post-graduate Research Centre for research work leading to the Ph D degree and as on date 51 scholars have been awarded doctoral degrees while working with the Foundation.

MSSRF is a scientific institution recognised by the Department of Scientific and Industrial Research, Government of India. MSSRF is eligible for income tax exemption under Section 35(1)(ii) by the Ministry of Finance, Government of India. More recently, the Department of Science and Technology, Government of India has sanctioned grant-in-aid support to MSSRF to further its scientific work for societal development.

This compendium brings out successful studies undertaken by MSSRF since its inception, following an interdisciplinary approach across varied contexts. These studies provide a synopsis of approaches, processes, findings and key lessons in select contexts across Programme Areas. It was indeed a difficult task to compile two decades of work in a concise and cohesive manner. These case studies have primarily focused on interventions related to natural resource management, livelihood enhancement, strengthening of grass-roots institutions, use of appropriate technological interventions and policy impacts of various initiatives. I wish to compliment the staff and scholars of MSSRF for undertaking these challenging and productive studies with commitment and dedication, in partnership with several knowledge institutions and local communities.

We are grateful to Professor Swaminathan for his unstinted guidance and suggestions in developing this publication. Dr. Madhura Swaminathan, Chairperson, MSSRF provided several critical inputs to the shaping of this publication. Dr. N. R. Jagannath has meticulously reviewed the content and has put his best efforts into developing a framework for these case studies. I also wish to sincerely thank my colleagues Dr. S. Rajalakshmi, Dr. V. A. Nambi, Dr. A. A. Nambi, Ms. Reena Eappan, Mr. R. Srinivasan and Mr. K. Prabhakaran for their painstaking efforts in putting together this publication, and Ms. Gita Gopalkrishnan for the thorough editing.

Ajay Parida
Executive Director

Contents

IN SITU BIODIVERSITY CONSERVATION AND SUSTAINABLE USE

The Community Agro-biodiversity Centre (CAbC) — the first regional centre of MSSRF —was established in December 1996 in the Wayanad district of Kerala, a global biodiversity hotspot located in the Western Ghats. CAbC has been responsible for delivering a major portion of MSSRF's community biodiversity programmes. It has built partnerships with state Biodiversity Boards, Panchayat Raj Institutions, local private industries, local communities, media, educational institutions and other stakeholders' organisations for sustainable local development.

Initiatives in Wayanad

During the first phase of the community agro biodiversity programme of MSSRF in 1997-2000, a survey on traditional rice varieties was initiated in the rice-growing locations of Kerala, which resulted in the collection of 98 varieties, including a few with medicinal properties. Traditional cultivars such as *Navara* or *Njavara* and *Chennellu* are believed to possess high medicinal value. In addition, *Chembavu, Kalamappari, Neduvali, Velvali, Narikari, Varakan, Poovali, Tanavala, Karimkuruva, Perunellu, Ulimkathi, Valanellu, Chitteni,* and *Annoori* are also considered medicinally valuable varieties.

Intra-varietal selection, characterisation and popularisation of Navara

A detailed survey of *Navara* undertaken by CAbC reported the occurrence of four distinct sub-types: awned and awnless black- glumed and yellow-glumed grains. A collaborative mode of varietal selection was held with farmer participation to strengthen farmers' informal research and development systems. These attempts also included marker-assisted characterisation of different *Navara* morphotypes and assessment of their nutrient composition and physico-chemical properties. As part of project interventions, speciality rice varieties including *Navara* were purified for quality seed material, with farmers mobilising into clusters for *Navara* cultivation and promotion of value-added products. Thermal retention tests comparing *Navara* and other rice varieties suggested only marginal differences in heat retention between the varieties. The pilot effort in collaboration with the Institute of Applied Dermatology, Kasaragode, to clinically evaluate the efficacy of *Navara* rice (yellow awnless) used as *kizhi* in the treatment of hemiplegic patients was also successful.

Initiatives in Jeypore

The Jeypore tract in southern Odisha is covered with hills and forests and is inhabited by tribal people. In 1995-96, scientists from the Central Rice Research Institute, Cuttack and the National Bureau of Plant Genetic Resources, New Delhi jointly explored the Jeypore tract for rice germplasm and collected 318 accessions of rice. A total of 256 landraces of rice were collected from 67 villages out of which 58 were short duration varieties, 64 were medium duration and 134 were long duration; some of these landraces were aromatic and others exhibited characteristics of being flood resistant, drought resistant and insect/pest resistant

Characterisation and quantification of landraces

Ex situ conservation plots have been maintained in the farmers' fields. In a participatory varietal selection programme, adaptability, preferred traits and sustainable yield were observed to be the key criteria in varietal choice, particularly of resource-poor farmers residing in genetically-rich areas. Currently, 136 landraces of rice (23 upland varieties, 35 medium land varieties and 78 lowland varieties) are conserved; of these 37 varieties are cultivated by farm families in different land categories in 25 villages. The collected materials are conserved in farmers' fields facilitated through field gene-seed banks and also ex situ conservation at the Community Gene Seed Bank, a medium storage facility maintained under controlled temperature and humidity parameters.

Promotion of local landraces of rice: Kalajeera, Machhakanta and Haladichudi

Use of poor quality seed, planting in poorly prepared soils, lack of resources to monitor crop growth and inadequate knowledge of advanced agricultural techniques are reasons for the low productivity of the local landraces. *Kalajeera* is a highly aromatic long duration rice. The potential yield is 20 to 25 ql/ha with high market potential. *Haladichudi* is a medium duration popular variety. Village-wise market promotion has been initiated only for *Kalajeera*. Village grain banks helped in storing market surplus. The Kalinga Kalajeera Dhan Utpadak Samabaya Ltd with its linkage to Orissa Rural Development and Marketing Society has helped in marketing substantial quantities of *Kalajeera* and *Machhakanta* varieties. Value-added products have been prepared using the slender grain variety *Machhakanta* by women self-help groups.

Conservation initiatives at Biju Patnaik Medicinal Plants Garden, Jeypore

The tribal people of Odisha possess rich traditional knowledge on medicinal plants including their use for treating common ailments such as diarrhoea, dysentery, cold and cough, malarial fever, bone fractures, vomiting, headache, anti-sterility, asthma, pyorrhoea and rheumatoid arthritis. A total of 354 ethno-medicinal plant species are conserved in 9 tribal gardens. Commercial cultivation of 21 medicinal plants prioritised by the National Medicinal Plant Board has been taken up, as has the propagation and supply of quality planting materials of 14 commonly-used medicinal plants for primary healthcare. One of the main constraints faced is the declining availability of genuine plants. Since 1996, MSSRF has systematically documented these traditional knowledge related medicinal plants through the help of traditional healthcare practitioners of the region.

Biodiversity mapping

A total of 443 workable grids were identified for biodiversity mapping, covering 7 districts of Odisha, and 651 plants have been mapped from these grids. Out of the total identified plant species, 180 are trees, 155 are shrubs, 186 are herbs, 76 are creepers/ climbers, 43 are grasses and 11 others are orchids, ferns, etc. Three endemic species, namely, Stemona tuberosa, Selaginella nairii and Tragia gagei have been documented. Rare and endangered plants recorded from the grids include Albizia thomsonii, Allophylus seratus, Dolichandrone atrovirens, Gnetum ula, Hemigraphis latebursa, Messua ferrea, Pterocarpus santalinus and Stemona tuberose, found to be both endemic and endangered taxa of the region.

Initiatives in Kolli Hills

Exposure of local communities to global forces is resulting in the rapid erosion and dilution of centuries of traditional knowledge of communities that so far has been effectively utilised for biodiversity conservation, utilisation and enhancement initiatives.

Sacred forests

Tracts of sacred forests (SF) have been until now insulated from human interference on grounds of religious beliefs. Sacred forests (Sami Sholai) are found distributed across Kolli Hills: in the midst of varying agro ecosystems, forest boundaries, on hilltops and slopes, inside reserve forests, their size ranging from one hectare to five hectares. Despite changing social conditions, alteration of size and structure, 240 sacred forests have been recorded in Kolli Hills. Rare species like Myrstica dactyloides Gaertner, Persea macrantha (Nees)

Kostern, Philicium decipens, Canarium strictum Roxb, Alseodaphne semecarpifolia Nees, Ammora rohituka (Roxb.) have been discovered in these forests. SFs are managed by individual families and traditional panchayats in patta land as well as in poromboke land as common property. These relict wild patches are repositories of several medicinal plants and source of non-timber forest produce for the community.

Diversity of millet landraces and agronomic practices

Tribal farmers of Kolli Hills continue to cultivate a diversity of landraces in millets (like little millet, Italian millet, finger millet, Kodo millet, and common millet). Farmers have evolved a variety of locally-suited cropping practices such as intercropping, multiple cropping, mixed cropping and crop rotation based on soil types and rainfall patterns.

Community-based biodiversity management

The objectives of the community-based biodiversity management programme (CBM) being implemented in Kolli Hills and Jeypore are: to increase the resilience of farming communities that depend on plant genetic resources for food and agriculture (PGRFA) to the impacts of climate change; and to develop a strategic action plan to mainstream the methodology and associated practices of community biodiversity management. The approaches to achieve these objectives include:

defining priorities, targets and milestones for strategic action plans to integrate CBM and its practices.

identifying CBM practices that enhance the adaptive capacity of farming communities to implement on-farm management of PGRFA, and increase resilience of communities to the impact of climate change.

incorporating professional and institutional capacity-building at local, national, regional and global levels, in participatory learning and action process facilitation, documentation and strategic planning.

CONSERVATION AND PROMOTION OF RET PLANTS AND WILD FOODS

A floristic study to unravel the angiosperm diversity of Wayanad district highlighted the biological significance of the region that provides habitat for about 25 per cent of rare, endangered, and/ or threatened (RET) flowering plant species of the Western Ghats. A total of 2100 flowering plants were documented, with 52 Red Data species and 650 endemics of the Western Ghats. Since the start of the floristic study in 1999 and the study of RET plant species, scientists of MSSRF have identified 15 new species; 11 of which have been published. The studies led to the establishment of a conservation garden with 125 orchid species, 30 fern species, 156 endemic tree species and 60 accessions of wild tuber crops as well as a CAbC herbarium with more than 8000 specimens of flowering plants of Wayanad. The Ministry of Environment and Forests, Government of India has accredited this garden as Lead Botanical Garden and has given support to augment the components.

Celebrating 80 years and conserving 80 RET species

A project was initiated to mark the 80th birthday of Professor M. S. Swaminathan and to accelerate the conservation efforts of the Community Agrobiodiversity Centre (CAbC) through a targeted number of 80 RET angiosperm plant species of the Western Ghats. The aim was to contribute to national efforts to conserve critically endangered plant species through creation of species recovery and management plans. Recognising the role of traditional beliefs in promoting conservation measures, CAbC has also facilitated the establishment of a zodiac forest (plants representing zodiac signs) and the restoration of sacred groves in its own premises and at Koottakkavu temple, Pozhuthana. The Centre has formed a forum — for RET — in 2007 for ensuring the open-ended participation of organisations and individuals working for the cause of conservation of RET species.

Identifying wild foods for improving nutritional security

CAbC's action research on wild and traditional edible species and associated management practices of Wayanad district stands unique in ensuring nutritional security in the diets of tribal communities. A study of the role of wild foods in the lives of the socio-cultural groups at times of emergencies and food famines revealed that the Paniya and Kattunaikka communities are heavily dependent on the wild environment for their food needs.

Unraveling genetic and food diversity

The study by MSSRF revealed that the tribal groups have extensive knowledge regarding wild food and use a wide array of plants and animals, with some variations amongst different groups. There were 372 wild edibles accessed by tribal communities, which include 102

leafy greens, 19 species of *Dioscorea*, 40 species of wild mushrooms, 5 species of crabs, 39 species of fish and five types of honey. Two genera — Taro and *Dioscorea* — contribute much of the diversity of wild tuber crops and serve as a 'life-saving' plant groups to marginal farming and forest dwelling communities during periods of food scarcity. They consume 9 kinds of Dioscorea tubers, in which the most preferred ones are kavalakizhangu (*D. oppositifolia*) and noorakizhangu (*D. pentaphylla var. pentaphylla*).

Domestication of wild food plants

The Kattunaikkas have attempted to introduce several of the species of *Dioscorea* into their home gardens. Selection of species for introduction chiefly depends on the availability of the variety and its cooking quality. Nannari (*Hemidesmus indicus)*, muthanga (*Cyperus rotundus*), sathavari (*Asperagus racemosus)*, unnithandu (*Costus speciosus*), as well as various species of wild curcuma and wild ginger, are some of the other wild plants used. Roots, rhizomes and tubers are often used as important ingredients in certain traditional medicines. CAbC has established community seed banks integrated with in situ conservation of cultivated yam varieties. Cultivation of all traditional varieties of *Dioscorea* from the Malabar region was envisaged by forming farmers' groups. Through germplasm survey in 8 districts — Kasargod, Kannur, Malappuram, Kozhikode, Wayanad, Ernakulam, Kottayam and Alappuzha — 23 cultivars were collected and community conservation plots were set up. Yam conservation groups were formed after traditional farmers were identified, and decentralised germplasm plots have been established. Taro, *nanakizhangu, inchikachil,* turmeric, ginger, arrowoot, and elephant foot yam were distributed to most deprived communities through SHGs, farmers' groups and NGOs. To create awareness and generate farmers' interest in tuber crops, a central demonstration plot with traditional and improved varieties has been established at CAbC.

Results so far…

The Centre for Medicinal Plants Research of Arya Vaidya Sala, Kottakkal has augmented its already established herbal garden with RET medicinal plants.

Field surveys resulted in the location and collection of 160 species of RET plants, of which 100 are RET trees; permanent monitoring sites have been established for the critically endangered tree species.

A small *Carpellatum* (collection and maintenance of dry seeds, fruits, etc) with a number of species has been established and digital records (hundreds of photographs) of live RET plants and plant parts are being maintained.

An exclusive herbarium has been established at the Western Ghats Endemic Plant Information Centre (WEPIC) for category species conservation, with 1200 voucher specimens and 253 research papers, 15 flyers on endemic plants, collection of literature, a field guide on 100 RET plants of Western Ghats, a RED data book of RET plants Western Ghats, etc.

A conservation garden with many species in specific components like Arboretum with 250 species, RET Conservatory with 130 species, Orchidarium with 75 species, Fernerarium with 120 species, and Vinetum with 75 species has been established in 10 acres of land in the CAbC campus.

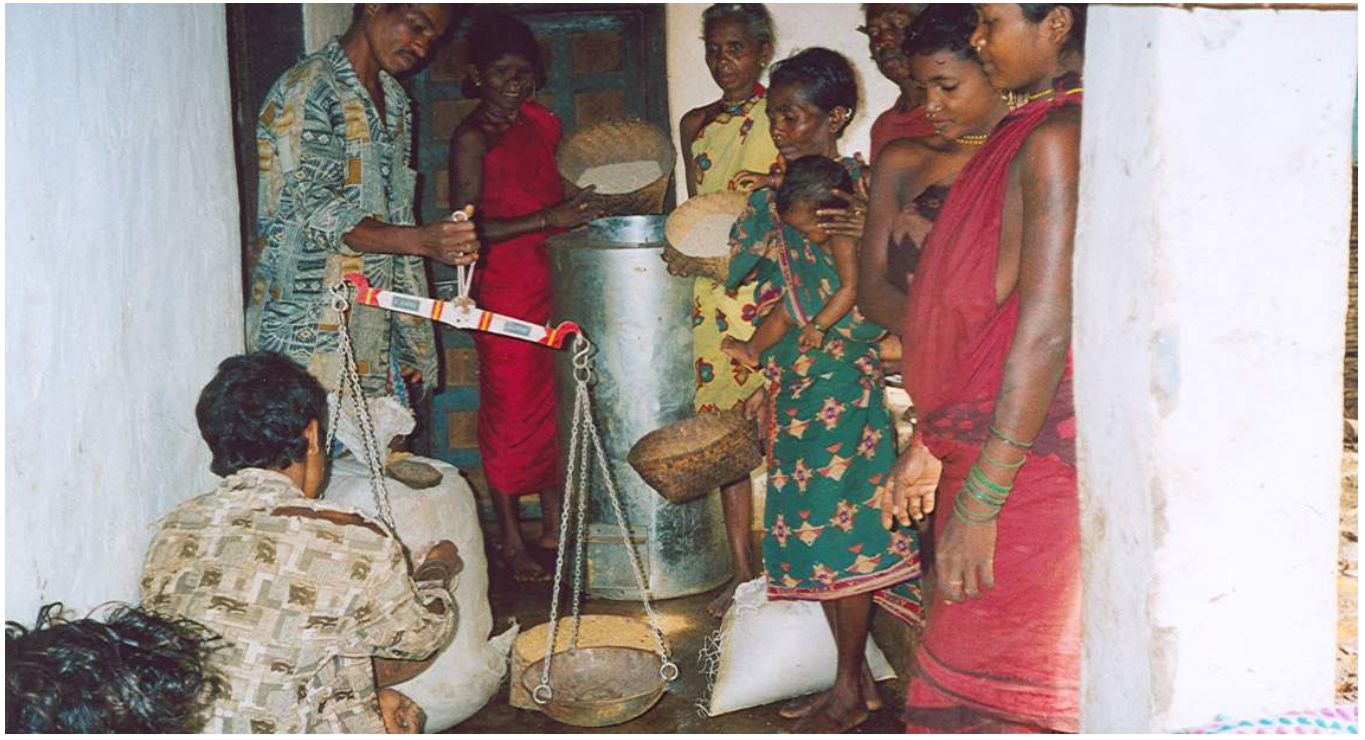
Five new species have been reported including *Impatiens jenkurumbae* (named after the tribal community considering their intimacy with forests), *Impatiens malabarica* (to note the historic significance of this region with reference to plant genetic resources) and *Impatiens meenae* (named after Ms. Mina Swaminathan who made valuable contributions in understanding gender dimensions of wild plant species management).

A feather in the farmer's cap....

The research and extension programmes on farmers' varieties has resulted in the Kurichya and Kuruma tribal communities of Wayanad being accredited with the Second Plant Genome Savior Community Recognition in 2008 by the Protection of Plant Varieties and Farmers' Rights Authority of the Government of India. These communities have been conserving 20-30 traditional rice varieties with unique characteristics like flood/drought resistance, pest/disease resistance, medicinal and aromatic properties. Subsequently in 2010-11, the Wayanad District Tribal Development Action Council, a community-based organisation facilitated by MSSRF of primarily Kurichya and Kuruma tribal communities, received the Plant Genome Savior Award of Rs.10 lakh and a Certificate. The Centre has also played its role in forming SEEDCARE, a grass-roots organisation for the conservation of traditional crop germplasm in the Malabar region. It facilitated the applications for 27 farmers' paddy varieties under the PPV&FRA Act, in which 6 have been accorded with varietal registration in 2012.

In order to address the decline of traditional knowledge, which affects the sustainable use of many wild edibles, CAbC undertakes widespread education and awareness programmes, especially among youth; it also maintains *ex situ* collections of wild roots and tubers, leafy greens, and saplings of diverse wild fruit trees.

COMMUNITY GENE-SEED-GRAIN BANK



Farmers need seed because without viable seed the survival of their households is endangered. In fact, the ways that farmers obtain seed are as old as agriculture, and most small-scale farmers in our country routinely save their seed from one harvest to the next. Nevertheless, these community systems of seed supply are increasingly coming under pressure. Factors such as drought, crop failures, conflicts, difficult storage conditions, and poverty are eroding both the quantity of seed and the number of plant varieties available to farmers. In spite of several World Food Summits during the past decade, the number of people going to bed hungry is increasing and now exceeds one billion. Food security strategies should therefore be revisited. Food security systems should begin with local communities who can develop and manage community gene, seed, and grain and water banks.

Community foodgrain and seed banks

A community foodgrain bank (CFB) is a community-managed, self-reliant food security system and a mechanism for decentralised storage and management of foodgrains at the community level. The community is trained to set up a bank of foodgrains from which they can borrow during times of need, and repay in kind, with interest — also in kind.

Most CFBs have a seed bank alongside the grain bank. Quality seeds of local landraces, purified by the farmers themselves, are deposited in the seed bank. Farmer-to-farmer exchange of seeds is encouraged to build self-reliance and improve resilience. The seed banks provide seeds of short-, medium- and long-duration varieties as well as lowland, medium land and upland varieties of rice, millets and pulses. The seed banks operate at the community level and are linked to participatory conservation systems of farmers. In addition, farmers constantly strive to enhance diversity by cultivating, experimenting and selecting modern and local varieties through participatory varietal selection processes. The seed banks ensure seed security of needy farmers.

The Koraput model

Koraput district of Odisha is considered one of the most food insecure districts, with very high levels

of malnutrition among children and women. Since 2001, MSSRF has facilitated the setting up of 30 community foodgrain banks across 30 villages in the district.

Several steps are involved in getting a CFB started in a village. Detailed need assessments are conducted to determine the requirement of a CFB, followed by building rapport with the community and conducting a preliminary overall survey of the village economy and society. MSSRF staff visit the village regularly to get acquainted with the villagers, and collect basic information on village life through participatory rural appraisals and focus group discussions as well as structured surveys. A detailed analysis of the collected information provides a picture of the food availability situation in the village. A series of meetings and interactions with the community take place to create awareness on the concept of the community foodgrain bank, the process involved in setting it up, the benefits that will accrue to the community, the management procedure, etc. Exposure visits to villages where CFBs are in operation are also arranged for select members of the community. Through a democratic process, the CFB management committee is formed by the Palli Samiti. This management committee is then provided intensive training on operation and management of the CFB, including detailed discussion on aspects relating to identification of land for building a storage place, type of storage structure, contribution of grains from families to build a corpus of grains, interest to be charged for grain loans, accounts on transactions to be maintained, etc.

Paddy, rice, millets and pulses are routinely stored

in the CFBs. About 1260 member households across the 30 villages have directly benefited from the CFBs. Nearly 80 per cent of the households borrow from CFBs in the period from June to September. MSSRF's detailed analysis of CFBs clearly indicates that they support the needy families in lean periods, check exploitation by moneylenders, and help the villagers during family functions and celebration of festivals. Further, sale proceeds of surplus stock from CFBs also go to the Village Development Fund that is used for development activities in the village such as setting up a proper drainage system, concrete roads inside the village, check bunds, purchase of vessels for community use, etc. "We are now self-reliant and do not depend on moneylenders for loans. We can borrow grains from the grain bank in times of need, and when we have guests at home." Such cheerful expressions from women echo from the villages in Koraput.

Setting up of a CFB as an isolated activity, without any efforts at improving the general economic conditions of the village, would affect its sustainability. Unfortunately, caste conflicts and political intervention in grain bank management, lack of interest of the management committee members and non-participation of member households in the management and functioning of the banks have led to closure of some CFBs. Replication of this model piloted by MSSRF is contemplated in partnership with several non-governmental organisations such as LEPRA Society and PRASTUTEE in Odisha.

COMMUNITY GENE BANK

The Community Gene Bank (CGB) was established with a munificent grant from the Government of Italy. CGB is a medium-term storage facility where farmers are encouraged to deposit their traditional landraces of crops such as rice, small millets and grain legumes, with MSSRF serving as the trustee of deposited materials. The accessions, depending on their stored viability, are periodically regenerated. The seed samples may also go back to villages when farmers need them or when the specific seeds are not available in the village grain seed bank. The data set is constituted as the Farmers' Rights Information System (FRIS), with a view to facilitate access and benefit sharing of farmers' varieties in accordance with the two important national laws on agro-biodiversity: the Protection of Plant Varieties and Farmers' Rights Act, 2001 and the Biological Diversity Act, 2002. In addition, the Gene Bank facilitates registration of farmers' varieties under the Protection of Plant Varieties and Farmers' Rights Act and undertakes legal literacy among farmers and grass-roots institutions on the these laws.

Germplasm materials and characterisation

The collections of paddy include their special traits such as tolerance to drought, flood, pests, disease and salinity, aroma of grain and medicinal value of certain accessions. About six rice varieties were identified for their high tolerance to salt during the 2004 tsunami in Tamil Nadu. More than 300 rice varieties were characterised using DUS descriptors prescribed by PPV& FR Authority.

Collections in millets include *Eleusine coracana, Setaria italica, Paspalum scrobiculatum, Panicum sumatrens* and *Pennisetum typhoides*. About 185 finger millet germplasm accessions, 150 drawn from ICRISAT and 35 from MSSRF, were planted, characterised and classified based on inflorescence morphology. These accessions were classified into four races: *Elongata, Plana, Compacta,* and *Vulgaris,* and *ten subraces: Laxa, Reclusa, Sparsa, Seriata, Confundere, Grandigluma, Lialiacea, Stellata, Incurvata,* and *Digitata.*

Collection and validation of indigenous knowledge

CGB has collected 225 systems of indigenous traditional knowledge (ITK) and classified them using a recommended screening procedure into (a) 142 ITK fit only for documentation, (b) 46 ITK fit for incentive and documentation, and (c) 12 ITK fit for incentive, documentation and validation. Validation of the 12 ITKs was done at the Tamil Nadu Agricultural University,

Tamil Nadu Veterinary and Animal Sciences University, Indian Institute of Horticultural Research, and the University of Agricultural Sciences, Bangalore.

Studies on traditional knowledge of tribal communities on plant resources

The study on the traditional knowledge (TK) of tribal communities on plant resources collated valuable knowledge on ethno-medicinal and ethno-veterinary practices, using 119 species belonging to 107 genera of 51 families. *Fabaceae, Poaceae, Solanaceae, Euphorbiaceae, Moraceae, Mimosaceae* and *Rutaceae*, in this order, contributed the largest number of species. Predominant plant parts used in medicinal preparations are leaves (52 per cent), followed by bark (26.9 per cent), seeds (13.5 per cent), roots (10.9 per cent), fruits (12.6 per cent), flowers (6.7 per cent) and whole plants

(5.9 per cent). Altogether, the TKs involved related to management of 84 diseases using 191 formulations for animals, crops and humans among the Malayali tribals at Pachamalai Hills, Tamil Nadu.

Facilitating registration of farmers' varieties

The data built up on the morphological characteristics and DUS were shared with farmers' groups in Jeypore and Wayanad to facilitate the registration of a few selected farmers' varieties under the PPV & FR Act. A total of 27 applications for equal number of paddy varieties from Wayanad, and 38 applications from Jeypore, were submitted to the PPV& FR Authority. This resulted in SEEDCARE, a grass-roots organisation functioning under CAbC in Wayanad, receiving registration certificate for six farmers' varieties — *Chomala. Jeerakasala, Gandhakasala, Chennellu, Veliyan* and *Thondi*.

Creating awareness and capacity building on the legislation of PPVFRA

CGB has coordinated and organised programmes on creating awareness and building capacity of farmers on the legislation of the Protection of Plant Varieties and Farmers' Rights Act. The programmes covered those parts of legislation concerning on-farm conservation, long-term ex situ seed storage, development and maintenance of farmers' varieties, farmers' rights, registration of farmers' varieties, benefit sharing, reward and recognition including the Genome Saviour Award of PPVFR Authority, role of Panchayat Institutions in conservation of local biodiversity, and access to local biodiversity.

Study on screening farmers' varieties of rice for value added products

Sixteen selected farmers' varieties of rice were studied for flake making quality, including organoleptic evaluation, with technical help from the Department of Rural Home Sciences of the University of Agricultural Sciences, Dharward. The varieties included those with varying white and brown pericarp and grain sizes. Varieties with white pericarp were found to be very soft on flaking, with poor shape retention ability.

Regional training programme on plant genetic resources and seeds

Since 2009, CGB has coordinated the regional training on plant genetic resources jointly organised by MSSRF and the Wageningen University and Research Centre, the Netherlands. The topics covered under this field- and lecture-based training are participatory approaches in agrobiodiversity management, participatory learning and action research, managing agrobiodiversity in unpredictable environments, community empowerment, forging conservation with local livelihoods and resilience building, community biodiversity management, resilience and strategic action plans, plant genetic resources policies, and strategic action plans for agrobiodiversity management.

SAVING DYING WISDOM AND VANISHING CROPS

It is estimated that about 87 per cent of all foodgrain production is contributed by three crops: maize, wheat and rice. This has led to the neglect of a large number of diverse crops including small millets, which contribute to local food security and have an important role to play in the livelihood of local communities. Finger millet (*Eleusine coracana* L.), little millet (*Panicum sumatrense Roth ex Roemer & Schultes*), Italian or Foxtail millet (*Setaria italica* L.), Barnyard millet (*Echinochloa colona* L.), Proso millet (*Panicum miliaceum L.*) and Kodo millet (*Paspalum scrobiculatum L.*) are often defined as climate-smart nutritious millets and grown over approximately 2 million ha across India. Millets are hardy and resilient crops cultivated in diverse agro-climatic adverse conditions. The general trend in agriculture, particularly in grain and cash crops, is an increasing shift to mono culture, with focus on a few high yielding varieties and hybrids. One of the chief reasons cited by farmers for lowered preference to the cultivation and consumption of millets is the drudgery associated with its traditional processing.

Status of small millets in Kolli Hills

Kolli Hills is located in the eastern part of Namakkal district in Tamil Nadu. Local communities had developed different cropping systems around millets by choosing inter-crops such as maize, pigeon pea and mustard. These intercropping systems involve smart risk-protection combinations, while addressing diversified food and cash needs. Different micro-regions deploy millet varieties of different maturity periods and abilities, depending on rainfall distribution. However, the introduction of commercial crops like cassava, which feeds the starch-manufacturing industry, and horticultural crops like pineapple, have provided farmers the option to shift from subsistence to commercial farming, with enhanced cash incomes. Further, decline of millets is due to the immediate availability of foodgrains like rice and wheat supplied by the government at highly subsidised rates under its anti-poverty programmes. Less preference is also given to the cultivation and consumption of millets due to the drudgery associated with traditional processing and use.

Strategies for enhancing millets cultivation

MSSRF, in partnership with several agriculture research institutes and universities, NGOs and international agencies, has been conducting extensive participatory research work on millets, aimed at reviving, conserving, creating economic stakes and enhancing the scope for sustainable use. In this context, some of strategies described below have proved successful.

Increasing yield through improving millet cultivation

practices: Together with SHGs, MSSRF has undertaken different agronomic measures such as row planting, reduced seed rates, application of farmyard manure, and also intercropping millets with tapioca to increase yield and net income.

Introducing drudgery-free grain processing technology: All millets except finger millet have very hard seedcoats requiring high abrasive force to remove the grain. No machinery suited to these millets was available to reduce this drudgery. A collaborative project with University of Agricultural Sciences Dharwad and McGill University, Canada, supported by CIFSRF (Canadian International Food Security Research Fund) -IDRC (International Development Research Centre), has led to the development of new prototype machinery for processing millets with processing recovery efficiency of 90-95 per cent.

Development and promotion of new marketable millet products: Value chain building requires specialised training on value-added product development while maintaining consistent product quality, packaging, labeling and marketing. Selected members of SHGs were trained on value addition at the Rural Home Science Colleges under Avinashilingam University, Coimbatore and also at the Agricultural Universities in Bengaluru and Dharwad. This training programme, planned and supported by MSSRF, empowered village women for the first time in production of all value-added items like malt, rava, and ready mixes of millets.

Establishing and promotion of markets for value-added millets products: Though farmers have experience in marketing their primary produce, they lack capacity in marketing value-added products. Through a gradual process, members of SHGs having marketing skills were identified and promoted to undertake product marketing through local retail outlets. The most popular and largely sold millet products were found to

be ready mixes, milled grain of little millet and Italian millet, and finger millet malt. Product differentiation and branding were found to be important tools for obtaining a competitive market position. Products were sold under a specific brand name "Kolli Hills Natural Foods", advertising the products as locally grown and organic. To increase awareness on the nutritional quality of millets and its derived products, MSSRF and SHGs are actively engaged in promoting millet products through exhibitions at local events and annual temple festivals.

Establishing community institutions for promotion of millets: MSSRF organised local farm women and men, enthusiastic in cultivation and consumption of millets, into Self- Help Groups (SHGs) and Farmers' Clubs (FCs). The SHGs were encouraged to build collective savings from their income, carry out financial lending within the group, often linked with local banks, and trained and supported to collectively undertake farming- related activities such as promotion of millet cultivation. Either particular SHGs or members of different SHGs were facilitated and promoted to undertake specific activities of their interest, such as improved production practices, variety selection, quality seed production, management of millet processing units, grain procurement and transportation to processing centres, building value chains, etc. SHGs in 15 villages located in 7 panchayats have their own safe seed storage baskets and institutional systems for regular seed production, distribution and exchange.

STRENGTHENING LIVELIHOODS OF TRIBAL COMMUNITIES

Tribal communities, particularly those living in hilly regions, lack access to information, technology and capital to improve their livelihoods. MSSRF has been implementing the NABARD-funded Tribal Development Programme (TDP) at Thirupuli, Alathur, Gundur and Gundani panchayats in Kolli Hills with the objective of reducing migration of tribal farm families. The intervention includes provision of options for on-farm livelihood diversification through sustainable agriculture, social empowerment, women development and community health. Over a period of 7 years, the programme intends to benefit 1000 families through 1000 acres of orchard plantations called wadi farms. The uniqueness of this approach is the participation and contribution of at least 25 per cent of the programme cost through labour inputs by the tribal farm families.

Programme integration

At present, the farmers in Kolli Hills concentrate chiefly on crop production which is subjected to a high degree of uncertainty in income and employment. In this context, it is imperative to evolve suitable strategies for augmenting the income of a farm. Wadi farms are integrated with silviculture, horticulture and animal husbandry. These enterprises not only supplement the income of farmers but also help in increasing family employment.

Sector-specific programme contours

Horticulture: A mix of plant species meets the families' needs for fuel, fodder and small timber. Model A and Model B1 consist of 188 plants and 170 plants per acre, respectively, of jack, mango and silver oak; Model B2 has 170 plants of jack, cashew and silver oak. All the models include Co4 grass as fodder plants. Wadi farmers are encouraged to undertake inter-cropping in their farms. In the 600 wadi farms, the pattern of inter-cropping has been: millets (12 per cent), banana (25 per cent), pineapple (25 per cent), coffee (50 per cent), tapioca (50 per cent), turmeric (5 per cent), and pulses (2 per cent).

Soil conservation and water resources: In 1000 acres of wadi orchard plantations, existing water resources are not sufficient for irrigatation. To overcome land and water constraints, the run off/seepage water is harvested through mini percolation ponds and water catch pits. Individual percolation ponds, collective percolation ponds, percolation ponds with water storage tanks, and community open wells are being set up with the involvement of 400 farmers who have been identified, based on suitable locations for water availability and conduits. Soil bunding, V bunding, tree platforms and trench-cum-bunds based on field level requirements have been introduced.

Health and nutrition: Some of the basic problems faced by tribal families are related to malnutrition, illness and inaccessibility to health care. To tackle such problems, community health programmes focusing on primary and preventive health care have been implemented. As part of creating nutritional awareness among the participating farm families, several village level awareness camps on water and sanitation have been organised. Towards ensuring nutritional security of the wadi farmers, seeds of a variety of vegetables such as tomato, brinjal, greens, ladies' finger, ribbed gourd, bitter gourd, cucumber, bottle gourd and pumpkin have been procured for distribution among all 600 farmers in Thiruppuli and Gundur Nadu panchayats.

Women development: Some of the major activities pertaining to women's welfare have been the promotion of SHGs for inculcating thrift and credit habits, income generation activities for landless women, drudgery reduction, awareness generation about reproductive health, etc. In order to reduce drudgery of women in fuel wood collection, smokeless stoves have been introduced. The feedback survey on the usage of these stoves reveals that such stoves not only reduce smoke, but also the quantity of wood fuel used and cooking time.

Human resource development: Several promotional efforts including training, capacity building, exposure visits, and sensitisation programmes were organised for the benefit of the wadi communities. Exposure visits and capacity building programmes for farmers

provided inputs on technical aspects and operational issues.

Social capital building: Participation is a basic element for the creation of social capital, and interventions under the present wadi model are designed not only to have an immediate impact on poverty, but also to foster a rich network of cross-cutting ties within society and between society's formal and informal institutions. Formation of groups representing community solidarity is necessary to insulate members from vulnerability. In this context, 53 groups have been formed of which 5 groups were registered with Indian Bank, Semmedu and 16 groups with LAMP (Large Area Multipurpose) Society. Further, Village Panchayat Committees (VPCs) has been formed in the four panchayats comprising the concerned panchayat president, animator and representative of SHGs and Farmers' Club, staff of MSSRF, the local schoolteacher, anganwadi workers, local social workers and panchayat ward members.

Credit programme: To inculcate good credit habits among the participants, a small loan component (around 10 per cent of the project cost) is provided as loan to the project implementing agency (PIA) for the purpose of lending to farmers. PIA has identified suitable off-farms and non-farm enterprises based on field appraisals and farmers' willingness.

Processing and marketing: Interventions are being designed to ensure assured market and remunerative prices for produce. Decentralised processing facilities for major crops like cashew, mango, and jackfruit are being established under the cooperative fold in two levels, namely, village and federation.

COMMUNITY AGRO-BIODIVERSITY CENTRE

MSSRF's Community Agro-biodiversity Centre (CAbC) is located in Wayanad in Kerala, a global biodiversity hotspot. The Centre's main focus is in delivering the concept of community agro-biodiversity management in its four integrated dimensions: conservation, cultivation, consumption and commerce. These four dimensions provide the framework to a practical approach for both strengthening on- farm conservation and sustainable genetic resource management.

On-farm conservation initiatives

The process of on-farm conservation aimed at enlarging the food security basket of local communities by including neglected and underutilised species (NUS) of crops like tubers, grain legumes and leafy vegetables in the diet. A project on roots and tubers helped to identify all domesticated *Dioscorea* varieties of Kerala and enhance their availability through field level multiplication of promising varieties. The seed and food security issues led to development of Field-Gene-Seed-Grain Banks, Water Banks and participatory management of farmers' varieties. Promotion of Seed Villages for rice has been initiated for 6 selected traditional varieties, which are now legally recognised as Farmers' Varieties by the Protection of Plant Varieties & Farmers' Rights Authority (PPV&FRA) of the Government of India. The work in this area also resulted in an MSSRF-facilitated institution — Wayanad Tribal Development Committee — getting the Genome Saviour Award 2010-2011.

Capacity development for sustainable agriculture

Under the Karshakajyothi training programme, men and women farmers have been trained in innovative agricultural techniques. The programme has motivated 68 farmers to initiate different ventures in the area of agriculture and allied sectors, and 7 progressive farmers of the district have been honoured during the annual day celebrations. LEISA (Low External Input Sustainable Agriculture), an approach promoted among marginal farmers, has gained ground in several parts of the district and so have knowledge intensive farming techniques. A Farm School was also initiated to further strengthen this programme. Subjects like soil health regeneration, land management, promotion of recycling, application of botanical pesticides, agro-biodiversity promotion, crop rotation, crop-

specific package of practices, and promotion of different composting methods have attracted wider visibility.

'Green Health' campaign

The 'Green Health' campaign — a programme aimed at revitalising primary health care traditions through trained women self-help groups (WSHGs) — resulted in some key outputs such as community-level awareness and WSHG leaders' training programmes, village-level medicinal plant germplasm management, publication of handbooks on primary health care and medicinal plants, and *ex situ* management of medicinal plants in the form of *ganams*. A database on local medicinal plants covering information on local wisdom is being completed. An important outcome has been the formation of Jeevani, an association for the promotion of medicinal plant cultivation, which is now active in the district.

Rescue of RET plant species

Over the years, MSSRF has successfully imparted education about conservation of threatened flowering plant species. Numerous field trips have been conducted for exploring and collecting over 2000 species of flowering plants, including over 500 RET (rare, endangered and threatened) species of which many are listed in Red Data books. A herbarium was established primarily to house the several endangered flowering plant species relocated from the forests of Wayanad. The Botanic Garden in the Centre with 1800 species has received Lead Garden accreditation by the Ministry of Environment and Forests. The RET conservation programme has raised 51,750 seedlings of 68 species for *ex situ* conservation and re-introduction. The Western Ghats Endemic Plants Information Centre, with a database of 1465 endemic plants, is functioning as a repository of knowledge of plant systematics and conservation.

Livelihood enhancement

The initiation of the Department of Science and Technology supported LEAFS (livelihood enhancement, agriculture and food security) programme is an important milestone in the history of CAbC. Activities under this initiative have started yielding visible results, particularly in crop-based interventions, soil and water conservation and bio-inputs production.

Recognising wild/marginal foods and food crops

Restricted access to forests and change in lifestyles has resulted in the alienation of tribes from utilising and popularising "uncultivated foods". Intensive education and awareness programmes for students, farmers and women groups were conducted on the importance of wild food diversity. A major output has been a publication on wild edible foods, which comprises information of over 300 different wild foods and their management aspects, with a gender focus.

Multi-pronged activities are planned for the advancement of tribes like Paniya, Adiya and Kattunaikka, focusing on sustainable market development of rice, yams, fruits and vegetables, wild food plants, and spices like pepper and ginger.

GLOBALLY IMPORTANT AGRICULTURAL HERITAGE SYSTEMS - JEYPORE AND KUTTANAD

In order to safeguard and support the world's agricultural heritage systems, FAO started an initiative in 2002 for the conservation and adaptive management of Globally Important Agricultural Heritage Systems (GIAHS). The initiative aims to establish a basis for international recognition of the dynamic conservation systems of agricultural biodiversity, knowledge systems, food and livelihood security as well as cultures found throughout the world. GIAHS are defined as 'remarkable land use systems and landscapes which are rich in globally significant biological diversity evolving from the co-adaptation of a community with its environment and its needs and aspirations for sustainable development'.

The Jeypore model: Domestication and conservation of rice genetic resources

The Jeypore tract of Odisha (located in Koraput district) is well known for the genetic diversity of Asian cultivated rice and has been considered as the centre of origin of an ecotype of rice (*Oryza sativa*). The landraces or traditional varieties growing here are thought to harbour dominant genes for biotic and abiotic stresses, aroma and palatability; they also hold promise for their utilisation in future plant breeding and biotechnology initiatives. The tribal farm families inhabiting this area have been responsible for the domestication and conservation of rice genetic resources for several generations. Traditional cultivation practices suitable for diverse agro-ecological zones are still carried out by the tribal communities, using their indigenous technical knowledge in rice farming and antiquity of rice in the region. The vast rice genetic resources would help to meet the future necessities of farmers. So also, local genotypes will adapt to the ever-changing environment.

Recognising the traditional farming system and rich biodiversity of Koraput, it was declared as the 18th site of Globally Important Agricultural Heritage Systems by FAO in January 2012, being the first site in India to be so recognised. The GIAHS sites recognised so far serve as inspiring examples of human innovation and creativity in the field of agriculture and food security. The tribal women and men of the Koraput GIAHS in India have shown pathways to develop a climate-smart food security

system based on mixed cropping and local-level gene, seed, grain and water banks. They have also identified naturally biofortified crops like *moringa* (drumstick), iron-rich pearl millet, vitamin A-rich sweet potato, etc. The Koraput GIAHS shows how to apply agricultural remedies to nutritional maladies and thereby achieve the goals of both food and nutrition security.

The Kuttanad model: Below Sea -Level Farming

Kuttanad is a delta region of about 900 sq. km situated in the west coast of Kerala. The area is a large mosaic of fragmented landscape patches

Dr. Manmohan Singh, Prime Minister of India felicitating two tribal achievers from Odisha

and varied ecosystems such as coastal backwaters, rivers, vast stretches of paddy fields, marshes, ponds, garden lands, edges, corridors and remarkably networked waterways. The Kuttanad Below Sea Level Farming System (KBSFS) is unique as it is the only system in India that practices rice cultvation below sea level. FAO declared this as the 19th site for Globally Important Agricultural Heritage Systems in May 2013.

The major land use structure of KBSFS is flat stretches of rice fields in about 50,000 ha of mostly reclaimed delta swamps. The rice fields, which are popularly known as *puncha vayals*, exist in three landscape elements: *Karapadam* (upland rice fields), *kayal* (wetland rice fields) and *kari* (land with black coal-like material). Farmers of Kuttanad have developed and mastered the spectacular technique of below sea level cultivation for over 150 years now. This unique system contributes remarkably well to the conservation of biodiversity and ecosystem services, including several livelihood services for local communities. The Kuttanad GIAHS serves as a model for developing farming techniques to checkmate the adverse impact of sea level rise. It also helps to prevent the proliferation of climate refugees.

MANGROVE GENETIC RESOURCES CONSERVATION CENTRES

Mangroves can be invaluable donors of crop genotypes adapted to coastal salinity through recombinant DNA technology, with their salt-tolerant characteristics transferred to other species. With this in mind, the formation of a global grid of genetic resource centres for mangroves, sea grasses and other coastal flora which would protect the ecological security of coastal regions and the livelihood security of coastal communities was proposed. An integrated effort towards the conservation, evaluation, classification and sustainable utilisation of mangroves was felt to be the need of the hour.

Key initiatives

Proposals on the setting up of potential Mangrove Genetic Resources Conservation Centres (MGRCC) were invited from 9 countries — Papua New Guinea (Oceania), the Philippines, Indonesia, Malaysia and Thailand (Southeast Asia), India and Pakistan (South Asia), and Cameroon and Senegal (West Africa). A team of scientists and mangrove managers conducted travelling workshops in these countries and recommended sites using 10 criteria: genetic aspects, ecological aspects, utilisation levels, neighboring flora/fauna, state of mangroves, accessibility, management of personnel, anthropogenic factors, socio-political factors and land size. Out of 23, four sites, namely, Bhitarkanika (India), Sandakan (Malaysia), Baimuru (PNG), and Mouanko Estuary (Cameroon) were selected as MGRCC.

In 1992, an international training programme on "Conservation of Mangrove Forest Genetic Resources" was organised in Chennai with the aim of i) training a cadre of specialists in mangrove forest genetic resources conservation and sustainable management and ii) assisting in the development of a national biodiversity conservation strategy with emphasis on mangrove and coastal ecosystems. Twenty participants nominated by governments and selected from 12 countries, such as Brazil, Colombia, Guyana, India, Indonesia, Malaysia, Papua New Guinea, the Philippines, Panama, Senegal, Thailand and Vietnam, were trained. A publication titled *Conservation of Mangrove Forest Genetic Resources: A Training Manual* was brought out. Candidates prepared a charter for mangroves for their respective countries. The charter prepared by the candidate from Vietnam won the Vavilov Medal.

A mangrove ecosystem information service (MEIS) came into being at MSSRF in Chennai as a part of the MGRCC project. It is a collection of four databases:

Experts database (MANEXP): A directory with information on mangrove experts, with names, country, locations, affiliated institutions, subject matters and field of specialisation, with 560 entries from 61countries.

Bibliographic database (MANBIB): A collection of abstracts and references of mangrove literature from 1975 onwards, based on mangrove literature contents published in peer review journals, proceedings, monographs, books and related bibliographic references, with more than 5000 entries.

Resources database (MANRESA): A register of 22 core sites of mangrove-rich countries with data on mangrove species, geographical and biological aspects, color images and site maps.

Genetic variability database (MANVAR): An inventory of species, sub-species and intra-species variation, including brief taxonomic data, floral diagrams and morphological details.

MEIS has evolved into the development and establishment of the Global Mangrove Database and Information System (GLOMIS) as a project of the International Society for Mangrove Ecosystems (ISME) based at Okinawa, Japan. GLOMIS is accessible online (www.glomis.com) and coordinates four regional centres located in Brazil, Fiji, Ghana and India. MSSRF functions as the regional centre in India.

Two out of the four selected MGRCCs are fully functional, those in India and Malaysia. At the global level, the project's training programme has been effective, with participants applying the skills they learnt in their respective countries, thus promoting conservation, sustainable management or rehabilitation of mangroves. The genetic resources of mangrove plant communities are now being utilised through biotechnological interventions, which include analysis of genetic diversity and species relationship using molecular marker technology, isolation and characterisation of salt-tolerant genes of mangrove plants to develop salt-tolerant crop varieties.

JOINT MANGROVE MANAGEMENT

"If there are no mangrove forests, the sea will have no meaning.It's like a tree without roots; for mangroves are the roots of the sea."

– Fisherman in the Andaman Sea

Attempts to restore degraded mangroves in the past have yielded limited results. Marginalisation of local communities in mangrove management is the major reason. In order to fill this gap between science, the local community and management agencies, MSSRF implemented its Joint Mangrove Management (JMM) project on a pilot scale during1993-2003, in partnership with the Tamil Nadu Forest Department, Government of India's Ministry of Environment and Forests, and local communities. The objective of the JMM programme was to enhance capacities of local communities, NGOs, community-based organisations, government agencies and research institutions to restore and sustain mangrove wetlands through participatory analysis of issues and action, and thereby improve natural capital for livelihood security.

Participatory research findings

Working plans of the Forest Department repeatedly mention that attempts to restore degraded areas have yielded only limited results. Participatory research involving the Forest Department and local communities showed that the clear-felling system of management practised by the government from 1930 to the late 1960s has been primarily responsible for degradation of mangroves. Studies by MSSRF indicated that large-scale clear-felling exposed mangrove wetlands to sunlight, which caused evaporation of soil water, leading to development of trough-shaped topography. Tidal water entered the trough-shaped portions and became stagnant. Evaporation of stagnant water increased soil salinity to a level that was lethal to mangroves. As a result, no regeneration of mangrove plants has been seen in the clear-felled areas.

Restoration technique

The restoration technique was simple. A canal system, consisting of main and feeder canals, was designed and dug in the demonstration area. Through this canal system, tidal water could flow freely in and out of the degraded area (instead of stagnating), thus decreasing soil salinity and increasing soil moisture, which in turn support mangrove growth. This improvement in the biophysical condition helped in the natural regeneration of mangroves.

The success of this effort led to the implementation of the Joint Mangrove Management Programme in Pichavaram and Muthupet mangroves in Tamil Nadu, Krishna and Godavari mangroves in Andhra Pradesh, Bhitarkanika and Devi mangroves in Odisha and the

Sunderbans in West Bengal. User communities were identified, mobilised and organised into the village-level institution, Village Development and Mangrove Council (VDMC). The general body of VDMC facilitated the JMM process in partnership with stakeholders. Participatory rural appraisal and socio-economic surveys were used to identify concerns of the community and the Forest

Department, relating to mangrove conservation, management and socio-economic and infrastructural development. Funds for the project were mobilised from the Forest Department, financial institutions and other government institutions.

Key results

The innovative, simple and cost-effective method that was developed and demonstrated to restore degraded mangroves has led to the establishment of 33 village level institutions for joint mangrove management, with about 5240 mangrove user families as members, in Tamil Nadu, Andhra Pradesh, Odisha and West Bengal. About 12000 ha of flourishing mangrove forests have been brought under JMM. Mangrove restoration activities continue to create employment for rural communities. Fishery resources, particularly crab resources, have increased substantially after mangrove restoration. State Forest Departments and NGOs have used the model to mobilise resources and are replicating it.

Impact

The community-based Joint Mangrove Management programme has played a catalytic role both in terms of developing and demonstrating suitable models as well as in bringing changes in programmes and policies. The increased allocation of resources from the Central Government to State Governments for mangrove restoration and management programmes makes it clear that action to restore and conserve mangrove wetlands at the national and state levels has strengthened greatly. The Ministry of Environment and Forests has prepared and implemented a National Mangrove Action Plan, which included JMM as the best available model for mangrove management.

ON-FARM STRATEGIES FOR SUSTAINABLE DEVELOPMENT

As part of its pro-nature approach, MSSRF has been promoting sustainable development models which depend on a high degree of management of biological resources, depending upon the local context. It includes sustainable agriculture, organic farming and integrated farming systems. The common indicators of the technologies and approaches are environmentally sound, economically viable and socially acceptable.

The framework

The framework / approach adopted while taking up the interventions among farmers is of a socio-economic and technical nature. It comprises training and capacity building, participatory research and technology development, strengthening community-based institutions, nurturing local-level innovations and leadership, and facilitating partnership and linkages to ensure sustainable livelihood systems through optimum utilisation of existing bio-resources. People-centered multi-stakeholder participatory methods have been adopted in situational analysis, planning, implementation, monitoring and evaluation of the project. Concerned government line departments at the block level, especially agriculture extension departments, have been involved in the activities.

Salient features of the interventions

Sustainable agriculture

Need-based training and capacity building programmes, demonstrations, technology refinement/ customisation on various methodologies, etc., were organised in a participatory way through farmers' associations, with local farmers as resource persons. The technologies introduced include sustainable soil and land management, integrated crop management practices, and integrated weed, nutrient, water, pest and disease management. Around 4500 (42 per cent are women) small and marginal farmers have been trained on context-based sustainable agricultural practices. A total of 1250 men and 1025 women farmers were trained in seed production technologies and seed standards, and linked with both government and private seed-producing firms. The training and capacity-building programmes among women and men farmers helped to create a horizontal network among them, which paved the way for horizontal knowledge transfer among members. Farmer-friendly, need-based learning materials have been developed in both print and digital forms on identified themes such as soil and water management, soil sampling, Codex Alimentarius and food safety, ICT-based knowledge, medium-range weather advisories, local crop management practices, etc.

Organic farming

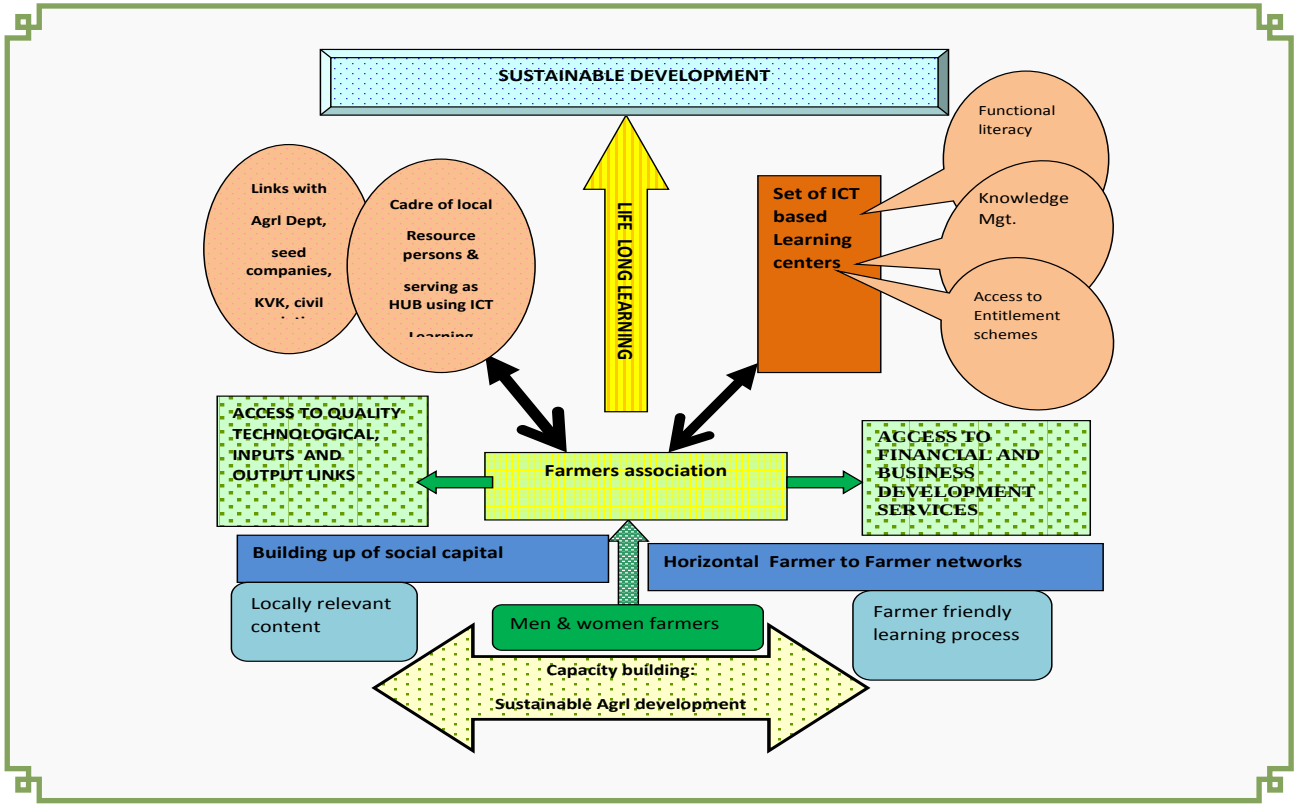
While the primary focus has been on food safety and environmental protection in the larger context, the major factors for adoption in the case of small and marginal farmers have been market opportunities, environmental safety and cost of production. Based on this, two kinds of organic farming have been promoted in the field — consumer/market-driven organic farming and farmer-driven organic farming. Certified organic farming has been facilitated in Thonimalai and Kolli Hills in Tamil Nadu by comparing the market advantage as well as default traditional management systems as a value-addition strategy. It is primarily to enhance the farm income of small and marginal holders in the geographically-isolated marginal ecosystems. The certification helped to establish internal social control systems and traceability systems to improve market potential. Following this, farmers have been mobilised into groups to avail market support services as well as financial and insurance services with appropriate linkages through farmers' producer companies. Farmer-driven organic farming has been facilitated in the plains with the objective to reduce the cost of cultivation and to demonstrate the fact that agriculture based on chemical inputs is unsustainable and that organic farming is viable in terms of ecology and economics. Produces are sold locally in the conventional regular markets without premium pricing.

Integrated farming systems

For the better, crop-centered agricultural management has shifted towards integrated crop, livestock, fishery and agro-forestry based livelihood opportunities along with the promotion of off-farm income generation skills. Farmers have been encouraged to follow a low external input agriculture approach in which integrated nutrient and integrated pest management play a very vital role. Adoption of the traditional practices, especially eco-agriculture practices, has also been supported. In all, 406 farmers have been practising integrated farming systems (IFS) with different combinations of enterprises in the Chidambaram region of Tamil Nadu and 380 farmers on aquaculture-based IFS in the Kendrapara region of Orissa. Nearly 180 farmers are replicating the models in different combinations.

Results / outcomes

The adoption rate of sustainable production technologies has been more than 75 per cent. Farmers have developed interest and capacity to customise the technical processes to suit their context. Facilitation of farmer-to-farmer learning has provided a friendly environment to exchange/share experiences, information and knowledge. The major outcome of the interventions has been the development of grass-roots institutions, such as the Manikollai Lift Irrigation Farmers' Association (460 members, 23 per cent women) and the Reddiyarchatram Sustainable Agricultural Producer Company Limited (900 shareholders, 32 per cent women) to access services related to technology, inputs and finance, including credit and markets.



BIOVILLAGES: TRANSFORMING LIVES AND LIVELIHOODS

Resource-rich farmers were able to benefit from the Green Revolution and become richer, while small and marginal farmers and landless labourers increasingly found themselves pushed to the deep end. Small and marginal farmers were unable to access and afford the technological advancements that were changing the face of farming. MSSRF's biovillage approach offers strategies to facilitate the development of human resources into income and employment opportunities, through skills development, value addition and on-farm, off-farm and non-farm production activities, with appropriate forward and backward linkages.

The beginning of the biovillage programme

The biovillage programme, originating from the recommendations of an interdisciplinary dialogue organised at MSSRF in 1991, was designed to facilitate the transfer of knowledge to the poor, especially women, in the rural areas by identifying, internalising, innovating and implementing relevant technologies that would enhance their socio- economic status. The biovillage project was initiated in March 1991 in Puducherry (Pondicherry) with initial support from the International Fund for Agricultural Development (IFAD), and later in the expansion phase by UNDP and JRD Tata Trust. The Government of Puducherry supports by providing various schemes.

The biovillage is a pro-nature, pro-poor, pro-women and pro-jobs development paradigm that seeks to promote sustainable agricultural and rural development by concurrently attempting to mitigate the twin concerns of the present times, viz., the degradation of the resource base and persistence of rural poverty, through technologies which are ecologically compatible, economically viable, energy efficient and socially equitable.

Pro-nature orientationis reflected through ensuring the sustainability of productivity of the bio-physical resource base and employing environmentally compatible interventions.

Pro-poor orientation is achieved by employing interventions that improve the livelihood security of the resource-poor through empowering them with technology and skills to enhance access to income and employment. This is achieved through value addition to time and labour, through knowledge, skill, information and organisational empowerment of rural families.

Pro-women orientation is ensured through empowering women with skills and access to income and reducing the drudgery of work at home and outside.

The various on-farm interventions include testing

and demonstration of new technologies (through integrated crop management practices) on horticulture, floriculture and crop varieties. Knowledge management is through organising Farmers Field Schools (FFS), Training of Trainers (ToTs) and using various ICT tools. System of Rice Intensification is replicated in about 250 acres involving 300 farmers. Nutrition gardens have been established in 500 households in 25 villages.

The several market-driven off-farm activities include mushroom production, coir rope making, dairying and poultry rearing. The mushroom production process to suit micro-level conditions benefiting landless labour women was a challenge. Coir rope making from locally available raw materials is a group activity in which 3 Women Self-Help Groups (WSHGs) have been involved and more than 75 women have been trained in marketing support. MSSRF introduced the concept of fodder banks and more than 1000 such banks have been established benefiting 1500 milch animals. Similarly, MSSRF has been responsible for introducing Tellicherry-bred goats in the biovillages.

Non-farm businesses like sanitary napkin production, terracotta items, petty shops, tailoring, etc., have also been introduced in the villages to give the landless women new skills and knowledge that would enhance their income- and employment-generating capabilities.

Pro-women dimension

Ms. Tamizhmani from Pillaiyarkuppam village, Puducherry is overjoyed today as she is one of the early participants when the biovillage movement began in 1991. Being associated with the biovillage has given her the courage to question wrongs and be a leader. Like Tamizhmani there are more than 120 women and 15 men role models or change agents who are committed to bring about transformational change as part of the biovillage movement now being replicated in more than 52 villages in Puducherry. Women's self-help groups have been strengthened over the years, characterising the growth phase of the biovillage project in the first decade of the 21st century. During this time, the number of women members increased to 4500 under 350 self-help groups, which have been facilitated to form the Innuyir Grama Sangam Women's Federation in 2005. In all, 120 role models have been identified for horizontal transfer of knowledge during training programmes, and many of them have been elected as panchayat representatives. The support from the Asia Initiatives and Friends of MSSRF, Australia in establishing over 310 micro credit banks has significantly contributed to building the financial capital of the rural communities. Through conducting more than 6000 training days, the belief that skill training should have market potential for it to be meaningful has been validated. In 2012, the farming community has been supported to form the Pasumai Farmers' Producer Organisation with 385 members.

Programme outreach

In 1999, a Biovillage Resource Centre (BVRC) was established in Pillaiyarkuppam village, to provide service facilities such as timely availability of quality seeds, custom hire of farm implements, input supply management, 24/7 animal healthcare services, etc. Production of bio-control agents, and poultry feed, as also spawn and mushroom production and processing have been set up. Knowledge management through the Village Resource Centre and satellite Village Knowledge Centre on sustainable food security, on-farm and off-farm technologies, market price intelligence, meteorological information, government entitlements, etc., are disseminated to the resource-poor through the use of ICT tools and technologies. The biovillage programme is currently spreading to other ecological regions of the Indian states where MSSRF works, benefiting around 20,000 households, targeting 25,000 ha of agricultural land spread over 250 villages. New challenges like urbanisation, industrialisation and new government schemes have motivated the communities to revitalise their priorities in seeking new opportunities and making strategic changes in the on- and non-farm sectors.

The biovillage project has demonstrated that knowledge, skill, technological and managerial empowerment holds the key to poverty eradication on a self-replicating and self-sustaining basis. It is hoped that the biovillage model of sustainable human development will become the pathway to happy and sustainable societies in the coming decades, making "Every Village a Biovillage".

COMMUNITY BASED BIO-INDUSTRIAL WATERSHED

The biovillage model of sustainable development as conceived by MSSRF gave concurrent emphasis to farm productivity and profitability as well as non-farm employment, including small-scale industries and eco-enterprises. The successful outcome of the biovillage model prompted MSSRF scaling up this approach at the micro watershed level through the concept of bio-industrial watersheds proposed by Dr. J. S. Bali. The broad objective is to extend the techniques of sustainable management of natural resources on a watershed scale, managed by the local community of farm women and men and landless labourers.

Bio-industrial watersheds

MSSRF initiated the bio-industrial watersheds (BIWS) project in five varied geographical and ecological areas in 2007, supported by the Sir Dorabji Tata Trust, Mumbai. Three of them were managed by MSSRF in the Pudukottai and Villupuram districts of Tamil Nadu and Koraput district in Odisha, and two by the State Agriculture Universities.

The concept of bio-industrial watershed management incorporates sustainable water and livelihood security, in order to promote market-driven enterprises based on the value chain analysis and agricultural raw products. The approach builds on the conventional system of watersheds through scaling up with value addition and new markets, with appropriate socio-economic institutional systems, co-owned and managed by watershed communities in diversified agro-ecological regions wherein livelihood security is deemed as important as physical structures and natural resource management. Gender equity where participation of women goes beyond livelihoods is emphasised, and women are provided space to actively participate in the watershed committees.

Key outputs

Physical assets

The construction of 108 water-harvesting and conservation structures covering 1684.5 acres of land enhanced recharge of groundwater and water security for the first crop and helped 1500 small and marginal farm families improve their income by 10-30 per cent. The integrated farming system model was designed for 23 farm ponds, with diversified livestock, poultry, fisheries, floriculture and horticulture cultivation. At Tolla village, Koraput district, Odisha, 3 dug wells were initially constructed for poor tribal families with 15 per cent community contribution and now there are

58 wells benefiting 185 households, with some wells connected to pedal pumps.

Natural assets

Integrated crop management practices, such as value chain analysis and participatory technology development processes, increased on-farm productivity on 2684 acres. Farmers' Field Schools and Village Knowledge Centres have provided needed information, capacity building and other support

services. Integrated dry-land horticulture models with agro-forestry plantations have been established on 481.8 acres. Indian Council of Agriculture Research support has enabled the identification of the climate vulnerability status of the communities and the development of climate-smart agricultural practices.

Financial assets

A total of 2580 households have enhanced their income by 17 to 23 per cent (Rs.16, 000-Rs.24, 000) annually from various diversified off-farm and non-farm livelihoods. Custom hire of farm equipment helped in the recovery of capital costs, as well as enabling cost efficiency and timely operations. Funds of about Rs. 3 crore have been leveraged through various sources like government schemes, financial institutions, etc. New partnerships have been developed with industrial establishments as part of their corporate social responsibility programmes: Hindustan Petroleum Corporation Limited has contributed to the construction of water harvesting structures.

Human and social assets

Three Rural Women Federations have been facilitated to ensure long-term sustainability of the various activities implemented. Three Farmers' Agri. Producer Organisations effectively work on improving on-farm productivity and profitability through participatory technology development (PTD) processes, value addition and marketing.

Local level transformation

Dalit families of Thattankudi hamlet in Pudukottai district owned 20 acres of land which remained fallow, due to lack of irrigation facility. The BIWS project established a dry-land integrated farm in this land with diversified cropping systems like intercrops, horticulture and floriculture plants, tree species with both short- and long-term yields, as well as livestock rearing, with a demonstration model for varied irrigation devices and mulching. The State Agriculture Department contributed mango saplings worth about Rs.1,12,000, the Horticulture Mission supplied vermicompost worth Rs. 30,000, and the panchayat contributed Rs. 15,000. The success of this effort is now being replicated in more than 143 acres of rainfed / fallow lands covering 20 villages in the BIWS area.

Conclusion

In April 2012 BIWS, Odisha received the Rashtriya Jal Puruskar (National Water Award) for 2010 (cash prize of Rs. 10 lakh) and BIWS, Pudukottai received the Bhoomijal Samvardhan Puraskar (Ground Water Augmentation Award) for 2010 (cash prize of Rs. 1 lakh).

The watershed communities have demonstrated the value of scientific methods in promoting climate-smart agricultural processes, which in turn has ensured employment and income security at the local level.

"Bio-industrial watershed movement involves mobilizing the power of partnership among local communities, government departments, financial institutes, industrial houses and technological experts and hoped that every watershed becomes a bio-industrial watershed to ensure work and income security to rural and tribal families" ***- Prof MS Swaminathan*** .

HOMESTEAD GARDENS FOR NUTRITION

A home garden is a farming system that combines physical, social and economic functions on the area of land around the family home. The most important characteristics of home gardens are their location adjacent to homes, close association with family activities and a wide diversity of crop and livestock species to meet family needs. Small-scale farming worldwide typically combines production of different crops, vegetables and livestock. Diversity in size, form and function makes it difficult to define home gardens, but their place in the farming systems of the rural landscape is readily recognised.

Initiatives in Odisha

The limited availability of vegetables, especially during the off-season, high market prices and lack of awareness regarding the importance of nutritious consumption are key factors that limit vegetable consumption in Koraput district. Also, only a small number of traditional vegetables like broad beans, cowpea, pumpkin, bottle gourd and ash gourd are generally seen in the kitchen gardens of the tribal families. Poor availability, accessibility and absorption contribute to severe malnutrition in Koraput district. Vitamin A deficiency affecting the vision of young children is prominent in this area. Integration of food rich in micronutrients into the diet is the most sustainable way to improve micronutrient status in the human body. Vegetables are the most affordable and sustainable dietary sources of vitamins, trace elements and other bioactive compounds.

Most of the households have in their food basket at least two types of vegetables such as green leafy vegetables and tubers. Some of the fruit-bearing trees like lemon, guava, custard apple, jackfruit and mango have been planted along the borders in their home gardens. In addition, the food basket in some households consists of vegetables such as drumstick, chilly, tomato, yams, cauliflower, carrot, papaya, green banana, spinach and various *amaranthus* species which are rich in iron and vitamins.

The recommended dietary allowance for vegetables, as per ICMR norms, is 125 gm per person per day. The minimum size of plot required to grow green leafy vegetables, root vegetables and other vegetables for a five-member family is 250 sq. m. In summer, the cultivation is restricted to a few vegetables in gardens with water availability from wells. In the rainy season, a

large number of vegetables like colocasia, yams, sweet potato, radish, different green leafy vegetables, beans, brinjal, chilli, tomato, lady's finger, ridged gourd, spine gourd, cowpea, country beans, cluster beans, bitter gourd, cucumber and pumpkin are grown in the home gardens. In winter, the more common vegetables are: cauliflower, cabbage, carrot, knol-khol, bush beans, chilli, brinjal, onion, tomato, radish, coriander, and green leafy vegetables.

To further enhance the size of the food basket, 437 kitchen gardens have been established in 11 villages in Kundura and Boipariguda blocks of Koraput district. In addition, a "seven plants campaign" was taken up to promote planting of papaya, drumstick, chilly, lemon, guava, banana and yam wherever space was perceived

to be a limiting factor.

Aroids in home gardens

Aroids have great potential as food crops and can thus play an important role in the food security of the poor people in the Jeypore area. Besides being a supplementary food, they can perform as buffer foods in crisis times, especially during shortage of cereals. With their high beta-carotene as well as micronutrient content, aroids are affordable and sustainable components in food-based nutrition interventions.

> *"Most direct, low cost method for rural poor to increase micronutrients in their diet. Homestead gardens is one of the possible interventions for enhancing food security for the poor."*

The edible aroids which are cultivated and used as food are *Colocasia, Alocasia, Xanthosoma* and elephant foot yam. In addition to the tubers, leaves and leaf stalks are also used as vegetables. *Colocasia* and elephant foot yam are the important aroids grown in Odisha. Preliminary evaluation of a few varieties showed that *Gajendra* (elephant foot yam) and *Muktakeshi* (taro) are the best in terms of productivity, cooking quality and taste.

More detailed analysis of plant associations in the home garden could provide a better knowledge of the ecological and economic compatibility of different plants species. Perennials require less labour for their care and hence are more affordable to poorer people, while 'annuals' play the role of the early succession plants, providing high net primary productivity. Furthermore, improved vegetable production and consumption through home gardening is thus the most direct, low cost method for the rural poor to increase micronutrients in their diet. It is only one of the possible interventions for enhancing food

and nutrition security for the poor and it should be considered in the context of a broader national food security strategy.

ADDRESSING PROTEIN HUNGER THROUGH PULSE PRODUCTION

Pulses are an essential source of protein in the diet of the predominantly vegetarian Indian population and the cultivation of these legumes has been a long-standing tradition. Chickpeas (*Cicer arietinum*), pigeon peas (*Cajanus cajan*), black gram (*Vigna mungo)*, green gram (*Vigna radiata*) and red lentils (*Lens culinaies*) are the top five pulses grown in India and account for over 80 per cent of the total pulses production in the country. In Tamil Nadu, the total area under pulses is around 9.5 lakh ha with a production of 4.08 lakh tonnes. The average state productivity of pulses is around 430 kg/ha which is far below the average productivity of the country. The shortage of pulses has resulted in nutrient/protein hunger. Towards ending protein hunger, the Participatory Pulse Programme, a small but significant initiative by MSSRF is timely.

Programme activities

The MSSRF intervention started in June 1996 with the pulse village programme in 60 acres in Ramanathapuram and 29 acres in Pudukkottai (total 28 farmers) in order to develop models for improved productivity of pulses. The approach focused on life-saving watering practices with the help of water harvested in the farm ponds and in improving the productivity not only in physical and economic terms but also in terms of productivity per unit of water. At Sivagamipuram in Pudukkottai district, 15 farmers with 25 acres of permanent fallow lands came together for collective farming. During the December 1997-April 1998 cropping season, the farmers used only life-saving irrigation from wells under a collective system and improved their productivity with yields ranging from 300 to 500 kg per ha.

In 1999-2000 the pulse village model was initiated in the Kannivadi region of Dindigul district, focusing on precision farming activities for production of pulse crops. During this period, two crops (black gram and green gram) were harvested in the demonstration plots. Two farmers have adopted the techniques of precision farming (variable-rate application) in their fields. On-farm trials were conducted for black gram and green gram to evaluate phosphorus (P) use efficiency, using different sources of phosphorus. The results indicated higher yields and the phosphorous use efficiency rates were recorded.

Demonstration of variable-rate application technique

In 2000-2001 the cultivation of red gram under variable-rate application (VRA) technique was demonstrated. The results concluded that VRA method ensures substantial productivity, while reducing the input cost to a considerable extent. The average yield of red gram was 1,275 kg/ha. This is 48 per cent more yield compared to the Tamil Nadu average and SA1 variety of red gram released by TNAU. In 2001-2002, to replicate VRA along with integrated pest management (IPM) in the fields, Bengal gram (55 acres at Sriramapuram village), black gram (5 acres at Ellpatty village) and red gram (10 acres at Samyarpatty) were cultivated. As part of the replication process, during July 2001, a large-scale on-farm demonstration was undertaken involving 48 farmers, covering an area of 75 acres (65 acres for cowpea and 10 acres for black gram), in the Samyarpatty region.

Programme expansion

In 2007-09 under the bio-industrial watershed (BIWS) initiative, a red gram (ICPH 2671 variety) seed village programme was initiated in 3.3 acres with technical input from ICRISAT in Meyagoundanpatti cluster, Pudukkottai district. In 2009-11, black gram (VBN1) was introduced in 3 acres, resulting in two tonnes yield. In the three BIWS sites, more than 300 acres of pulses are being cultivated based on value chain analysis and climate variability analysis. The result of the participatory varietal selection trials for selecting suitable climate-resilient varieties in Villupuram district under the BIWS programme indicates that black gram VBN-4, VBN-6 and NUL-7 performed better, while green gram VBN-2, CO-7 and VBN-3 showed good results and red gram UPAS 120, CO-7 and CO-6 were more promising. In Pudukkottai, green gram VAM-2, VRM-1, CO-6, black gram VAM-4, VAM-6, CO-6 and red gram VAM-2, CO-6, CO-7 performed better. In Koraput district, green gram CO-6, CO-7, Tarm-1, black gram VAM-5, OBG-33, PU-30 and red gram Lakshmi, Co-6, Co-7 did well.

Pulse Panchayat: A new initiative in pulse production

The logical impact of the Particpatory Pulse Programme initiative has been the emergence of a

holistic concept of "pulse panchayat" which brings with it a package of knowledge, innovations, demonstrations, seed production and mass production, as also forward and backward linkages of pulses in a panchayat. In Pudukottai district, which is one of the driest regions in Tamil Nadu receiving an average rainfall of 922.8 mm, climatic variation resulting in erratic monsoon behavior has affected agriculture, especially dry land agriculture. The Edaiyapatti panchayat community has passed a resolution and pledged to put maximum available land (about 200 ha) into pulse production. The South Vellar Agri. Producer Organisation (SVAPO) facilitated by MSSRF is coordinating the project supported by OCP Foundation, Morocco. Professor M. S. Swaminathan declared the panchayat as pulse panchayat in the presence of about 300 men and women farmers in April 2013. It is envisaged that this model will be extended to convert every panchayat into a "pulse panchayat" to reduce protein malnutrition and protein hunger in our country.

CONSERVATION OF COASTAL RESOURCES AND LIVELIHOODS

Landholding farmers, fishing families with crafts and gear, and other landless and assetless farming and fishing families constitute the bulk of the coastal community. They use two types of resources for their livelihood: market oriented and capital driven, of which the latter is more subsistence oriented. The limiting concept of "livelihood", meaning only income-generating activity, deprives the poor from using biodiversity-rich ecosystems for conservation, enhancement and utilisation for improving their livelihoods. Further, the current approach to conservation is driven by erroneous assumptions: a) biodiversity conservation and poverty reduction are separate issues; b) biodiversity conservation is more of environment-related issues whereas poverty reduction is akin to more of socio-economic development; c) livelihood security of communities and ecological security provided by ecosystems and biodiversity cannot be integrated; and d) biodiversity conservation can be achieved by laws and acts. Some of these assumptions negate the very core of livelihood systems linked to local action on biodiversity conservation strategies. The core is defined by assets available in a livelihood system and the space for decision-making, which governs the use of bio resources and other assets at the disposal of tribal, fisher and agrarian communities.

Sustainable livelihoods approach

Considering the fact that currently followed livelihood approaches have not achieved desired results, a new sustainable livelihood (SL) approach as conceived by the Department for International Development (DFID) has been adopted by MSSRF to link livelihood and biodiversity conservation. The guiding assumption of the SL approach is that people pursue a range of livelihood outcomes consequent to biodiversity conservation initiatives by which they hope to improve or increase their livelihood assets to reduce their vulnerability. The five types of assets that form the core of livelihood resources range from financial, human, natural, and physical to social. They constitute the actual building blocks for livelihoods. Further, the SL approach attaches importance to the underpinning principles of poverty-focused and livelihood-oriented eco development.

MSSRF, over a period of time, has demonstrated through its field programmes how the sustainable livelihood approach can facilitate integration of biodiversity conservation and livelihood security of coastal communities. Some examples:

Traditional canal fishing replicated in mangroves

The Muthupet mangroves are located in the south-eastern part of the Tamil Nadu coast. Out of 12000 ha, healthy mangroves are present only in 1885 ha whereas degraded mangroves occupy 7178 ha (60 per cent). People belonging to 26 hamlets, including 22 fishing hamlets, use the resources of these mangroves. Although degraded mangroves are distributed all over Muthupet, a careful look into RS (remote sensing) imageries shows that much of the dense and healthy mangroves are concentrated in one area. In this area, a 300-year old traditional method of fishing practised by a particular fishing community helps mangroves remain healthy. The traditional method of fishing is locally called vaikkal meen piddipu which means "canal fishing". In this method, canals about 1.5 to 2 km in length and about 1.2 m deep are dug across the mangroves from the sea to the landward side. The pen, which is placed in the mouth of the canals, allows tidal water to go in and out of the canals during high tide and low tide but does not allow juvenile fish and prawns to migrate out of mangrove areas. The trapped juveniles are left to grow in the mangrove area for about 3 to 4 months, after which well-grown fish and prawn are periodically harvested using a unique trap. As a result, soil salinity is low in these areas but soil moisture is high, which helps the mangrove plants to establish and grow healthily.

MSSRF, along with the Tamil Nadu Forest Department and fishing families of a village called Veerankoil, replicated the canal fishing method in degraded mangroves. The Tamil Nadu Forest Department provided natural capital by allotting 100 ha of degraded mangroves to the community for the project; MSSRF and the fishing community joined together to constitute human capital to design and dig

20 canals in the degraded areas. MSSRF provided much of the expenditure (financial capital) and community members also contributed by providing free labour. The community had boats and canal digging implements (physical capital). Above all, the community itself selected 20 poor families, allotted each family a canal, and developed and implemented norms on how to utilise and maintain these canals (social capital). This replication was started in the year 1999 and now in the entire degraded mangrove in the areas where these canals are dug, each family is getting about Rs. 20,000 to 30,000 as income from canal fishing in a period of 4 to 5 months.

Multi-clustered artificial reef

Artificial reefs are man-made structures deployed in the sea, targeted to increase coastal productivity and enhance biodiversity conservation in the long run by providing hard-bottom habitats. Artificial reefs are entirely different from fish aggregating devices (FDA). Fish aggregating devices are either natural or man-made temporary structures that are used to congregate fish for harvest, whereas artificial reefs are permanent structures, which establish a new habitat for fish and other marine organisms to breed and feed. MSSRF in partnership with the Central Marine Fisheries Research Institute (CMFRI), Thuthukudy, Tamil Nadu Fisheries Department, and the local fishing community of Therespuram near Thuthukudy established an artificial reef in the Gulf of Mannar. Four modules, one for grouper fish, one module for lobster, and two for all other reef fishes have been developed and established in response to environmentalist demand that the artificial reef should enhance population of other non-target reef fishes and also provide substratum for coral growth. Discussions with the fishing community of Therespuram have indicated that fishing families are harvesting about 3 to 5 tonnes of grouper fish from the site, along with 300 to 500 kg of lobsters.

MANGROVE-FISHERY FARMING SYSTEM

In India, coastal aqua farming — constituted mainly by prawn (shrimp) farming —emerged as an important sector in fisheries in the late 1980s. During the early phase of prawn farming, a semi-intensive culture system was followed, which increased prawn production at the rate of 8.4 per cent per year till the mid 1990s. Disease, excessive use of artificial feed, increased input costs and poor environmental management, as well as the lack of different activities to diversify livelihoods within the aqua farming area are considered responsible for the current poor status of coastal aquaculture both in India and in many parts of the world. The social impact of decline in aqua farming is enormous. Many of the farmers, who converted their agriculture land into aquaculture farms, are currently getting no income either from agriculture or from aquaculture; they migrate either temporarily or permanently in search of employment and livelihood to nearby urban areas. In this situation, MSSRF's Integrated Mangrove Fishery Farming System (IMFFS) provides some tangible solutions for sustainability of coastal aquaculture and also provides opportunities to enhance the adaptive capacity of local communities to sea level rise.

IMFFS model in practice

The traditional leaders, youth and women groups, and members of other village-level institutions were introduced to the concept of IMFFS and a village-level committee consisting of an equal number of women and men was set for IMFFS planning, implementation and monitoring. In consultation with local communities, private aqua farmers, representatives of the state Fisheries Department and Revenue Department, and local engineers, protocols of two IMFFS models were designed and developed.

Design of the IMFFS farm

The IMFFS farm has been designed in such a way to create more space for raising mangrove trees and enough space for the culture of fish and crab. In the model farm that was demonstrated, space for mangrove plantation was created by constructing inner bunds or mounds inside the aquaculture pond. as shown in Fig 1a and 1b. These inner bunds occupied 30 to 35 per cent of space for mangrove plantation and 70 to 65 per cent for fish culture. The model farms were designed in such a way to have 3 to 4 feet of water in the pond all the time to support fish culture. This was achieved by keeping tidal outlet 3 to 4 feet above tidal inlet.

Mangrove plantation

In pilot testing, *Rhizophora* species were selected for planting at the lower edges of bunds and *Avicennia* species for upper rows, because *Rhizophora* requires

regular wetting by tidal water. In the prototype IMFFS farm, a total number of 1723 *Rhizophora* saplings and 327 *Avicennia* marina saplings were planted in a pond one ha in size.. *Rhizophora* saplings were planted in two rows along the lower edges of the bund whereas *Avicennia* saplings were planted about 2 m above the *Rhizophora* plantation. At the end of two and a half years, *Rhizophora* trees reached an average height of 2.26 m with large numbers of silt roots and *Avicennia* trees reached 1.69 m. Growth rate of mangrove trees is almost similar to natural conditions.

Fish culture

Culturing of sea bass — a commercially important fish — was attempted in the prototype pond. About 500 fingerlings of 8 cm length, acclimatised in the IMFFS pond itself in nylon enclosures, were released into the prototype farm. After a period of 10 months, about 125 kg of sea bass was harvested along with about 161 kg of other fishes such as milk fish, mullets, tilapia, etc.. In the pilot testing ponds, experiments on different types

of culture such as growing tiger prawn and mullet together and culturing of sea bass with biofeed such as tilapia are being undertaken to increase the margin of profit from fish culture.

Output

The important output is that a coastal aquaculture farming system wherein raising of mangrove trees and culturing of fish can be done in an integrated manner has been successfully developed and demonstrated with the participation of stakeholders.

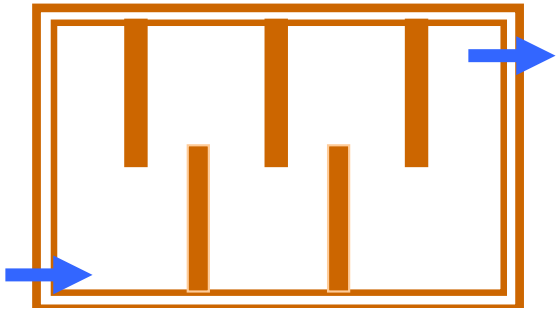
Aquaculture experts belonging to both state and central government institutions were brought on an exposure visit to the IMFFS farm; The Aquaculture Authority of India has authorised that the IMFFS model can be used to reduce the carbon footprint in prawn farming;, with this, prawns can be sold at a premium price. The State Forest Departments of Odisha and Gujarat are interested in replicating this model through their Integrated Coastal Zone Management programmes.

Advantages

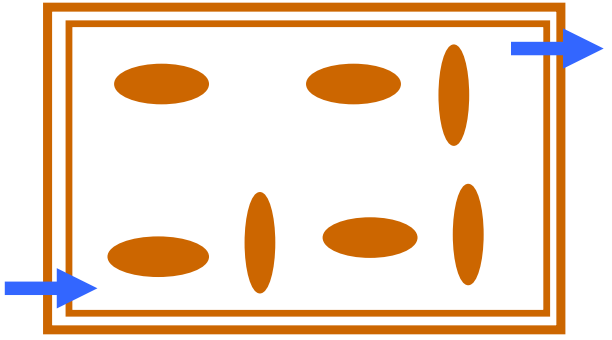
Integrated mangrove fishery farming is an environmentally friendly and energy efficient system of farming, where no artificial chemicals are used, and since the water refreshes through tidal currents the energy requirement to maintain fish culture is minimal. This results in a sustainable farm, rather than semi-intensive and/or intensive coastal aquaculture farms, which rely on external energy and inputs in the form of artificial feeds, chemicals, water changes, etc. Semi and intensive shrimp pond farming have limited life due to their environmental impacts. The productivity and the profitability of the integrated farm can be further enhanced through introducing hatchery- produced shrimp larvae, mangrove crabs and high-value fish species in the ponds. IMFFS provides huge potential for rehabilitating abandoned shrimp farms in the coastal belt, both at the national level and in the global arena. The mangrove root system will provide a natural environment for crabs to hide, feed and grow.

Challenge

Replication of IMFFS by poor and marginal fishing families is severely affected by lack of ownership of saline land; though saline-affected common lands are available on a large scale, they are all mostly owned by the government and no suitable policy exists to allot these lands to fishing families to take up IMFFS.



1a Farm with inner bunds



1b Farm with inner mounds: along the edges of the inner bunds and mounds mangroves are grown

FISH FOR ALL CENTRE

As part of the post-tsunami rehabilitation programmes of MSSRF, a Fish for All Research and Training Centre was set up at Kaveripoompattinam in Nagapattinam district, Tamil Nadu. It was directed to function as a research/ training-cum-demonstration centre for strengthening and diversifying the existing livelihoods and identifying alternative livelihoods for the fisher families and the coastal communities, by adding value to the chain from "capture/culture-consumption", through a process of learning-by-doing involving multi-institutional teams and participatory approach of stakeholders. The major mandates of the centre are natural resource management, capacity and institution building, and policy advocacy. The Centre demonstrates low external input sustainable aquaculture (LEISA) through components like crab farming, inland fish culture and shrimp farming using good aquaculture practices (GAP).

Key initiatives

Fish Processing Unit

The Fish Processing Unit educates, trains and develop skills among the fishers in the standard practices of hygienic pre-processing of local fish and preparation of value added items, and helps market them. Regular baseline data are collected from randomly selected sample villages on details of fish landing to understand the landing trends in the area and to plan the annual operations of the Fish Processing Unit. A breakthrough on the successful link up of fish vendors to entrepreneurs as well as retail marketing of fish products through FPU has been accomplished.

Scientific packages/practices of inland fish culture

As part of the post-tsunami rehabilitation work, nearly 124 freshwater fish culture farmers were also included for technological support. Earlier, the inland fish farmers were practising traditional methods of fish culture having many drawbacks. The Fish for All Centre organised focused group discussions to identify the problems of the inland fish farmers and to enable them to undertake

good aquaculture practices. The freshwater fish culture practitioners had to be taught scientific know-how with a view to enhancement of fish productivity and also to link them with various line departments to facilitate financial support

and avail subsidies.

Concrete pedal pumps

One of the best post-tsunami interventions has been in the area of reviving and promoting sustainable water management of the salt-affected agricultural fields and water bodies in Nagapattinam district of Tamil Nadu. Many of the problems faced by farmers could be traced to issues of water storage. In order to provide an alternative to water lifting, concrete pedal pump technology, with capacity to deliver 60-80 litres of water per minute, was tried first in Vellapallam and Vettaikaraniruppu near Nagapattinam. It has proved to be successful, and initially, nearly 75 pumps were fabricated and distributed in two villages in Sirkazhi block. Realising that concrete pedal pumps have good potential, a third phase of the project has been sanctioned to the Fish for All Centre in 2012. The special features of concrete pumps include water delivery up to 80 litres per minute, at least twice as much as the output of other manual pumps; water lifting up to 8 m vertically and more than 400 m horizontally; local manufacturing, service and maintenance; no fossil fuel or electricity required; very easy foot-driven

operation; very durable body made of heavy duty concrete, hence no rust or expensive repair.

Integrated farming system

An important activity of the Fish for All Centre has been the implementation of the integrated farming system (IFS) to enhance agricultural production through optimal utilisation of resources for improving the incomes of small and marginal farmers. The project looked at strengthening and diversifying on-farm livelihoods through integrating crops and allied activities, utilising water for off-season crops and establishing grass-roots institutions for self-reliance. Components like aquaculture, dairy, poultry, goat rearing, cropping (paddy followed by pulse), horticulture crops, banana, forage crops, vermicomposting, *Azolla* pit and agro forestry are involved in IFS.

To augment training and capacity building, a total number of 100 farmers practising IFS were federated as M.S. Swaminathan Farmers' Welfare Association with NABARD support. It is planned to channel all help in terms of technical inputs / loans to the farmers of this federation, whose members are from 5 Farmers' Clubs. In 2012, Vivekanandar Farmers' Club from Valuuvakudi was selected as the best in Nagapattinam district by the lead bank, Indian Overseas Bank.

VALUE CHAINS FOR SMALL HOLDERS

Value chain management assumes great importance in rapidly growing globalised and liberalised market situations, with post-harvest value addition to primary produce becoming more significant, mainly in terms of quality and safety. Here the key issue is limited access to technology and participation of small and marginal farmers, especially women farmers, in the different activities of the value chain.

Value chain initiative

The value chain initiative of MSSRF identifies and promotes need-based support structures and facilitates new gains, especially inputs and outputs, through adopting the approach of vertical and horizontal integration. Linking farmers with the market is a crucial aspect in agricultural development. Here, vertical integration implies taking additional activities into the value chain after harvesting, i.e., processing or grading the produce; and horizontal integration refers to the involvement of the farming community in managing the value chain.

Primary processing is level one of the value addition process in the vertical value chain. The goal of the initiative was to increase participation of small producers in the value chain management of maize, pepper and cotton for sustainable livelihoods. The main objective was to establish effective and efficient market linkages and channels by reducing intermediaries and thus gaining collective bargaining power. The second level of value addition is secondary processing in which basic processing, packing and branding was done in small millets and traditional paddy landraces. This process included community mobilisation, group formation, technology incubation, system management and so on. The initiative adopted an innovative 4C approach, inter-linking conservation, cultivation, consumption and commerce.

Strategies

The specific strategies of the intervention included organising the primary producers into three entities: the Reddiyarchatram Sustainable Agricultural Producers Company Limited, a farmers' producer company with 900 small holders as shareholders; Kolli Hills Agro-biodiversity Conservers' Federation (KHABCoFED) that consists of 943 members (of which 420 are women) involved in different operations in the millet conservation,

cultivation and marketing efforts; and Kalinga Kalajeera Dhan Utpadak Samabaya Ltd (KKDUS) with 440 members, focusing on conservation and promotion of traditional paddy cultivars.

The companies were linked with formal financial agencies like the National Bank for Agriculture and Rural Development (NABARD) and local service banks as well as with wholesale marketing agencies; and appropriate training was organised to improve the farmers' knowledge and skill in pre, current and post production phases. Members of community institutions were trained in operating mills, processing culinary preparations of value-added products, packing and labelling. Multiple marketing strategies were adopted to sell millets as whole grain, processed rice flour and value-added products.

At the farmer level, efforts were made to increase end-to-end integration of farmer's participation from production to processing. The generic strategies adopted to promote the value chain on the identified crops comprised a) chain mapping and assessment, including the skill and assets of the stakeholders; b) building engagement to have mutual trust among actors in the chain; and c) chain development through innovation (process upgrading through identifying appropriate technologies, product upgrading based on the market demand, intra-chain upgrading and inter-chain upgrading) and monitoring.

Key activities

Preparation of primary producers database at the village level through organising village level meetings and collection of information on area under cultivation and production estimates

Capacity building training to producers on sustainable production methods, in the case of maize

Facilitation of linkages and agreements for procurement, and fixing prices, quality parameters and freight details

Establishment of village-level collection centres

Initiation of purchase through service providers and payment to the primary producers

Key outputs

The concerned company directly received the financial support as a loan from NABARD.

Farmers were sensitised to sell quality products to meet market demands and develop a reliable supply base in an organised manner, which is to be group-wise consolidated and compiled at the village level.

Direct and better market linkages for pepper and maize reduced the actors in the supply chain (mostly commission agents or middlemen).

Correct weighment and on-the-spot payment to the farmers ensured increase in profits.

The outcomes have included the demonstration of a model for aggregating maize, cotton, traditional paddy cultivars and pepper at the village level using direct market links, as well as value addition in small millets and traditional paddy cultivars. The ultimate outcome of the intervention is that the 4C paradigm-based value chain efforts have ensured conservation of diverse landraces of millets and paddy and enabled the farming families to manage their resources sustainably.

Key challenges have been competition from existing traders, ensuring the optimum moisture content while purchasing the product, timely availability of godowns to stock the purchased products, and delay in logistical arrangements.

Participation is the key to bringing voice and providing space for small and marginal farmers to access benefits in value chain operations. Harnessing advancements in science and technology for decentralised agro-processing units is important for small and marginal farmers to access and participate in the value chains.

EMPOWERMENT OF WOMEN FARMERS

Improving the ability of women to access the constituents of development — in particular health, education, earning opportunities, rights, and political participation — forms the crux of women empowerment, which holds the key to long-lasting social change in communities. Empowering women must be a united approach, a cause that requires continued attention and stewardship by all. Towards this endeavour, MSSRF has been augmenting its sustained efforts for empowering women, creating an environment of hope, alleviating their distress and enhancing their progress.

Mahila Kisan Sashaktikaran Pariyojana

Mahila Kisan Sashaktikaran Pariyojana (MKSP) was started by MSSRF as a response to the agrarian crisis and the large number of suicides by farmers in the Vidarbha region of Maharashtra. The programme aims at creating an environment of hope, to alleviate the distress faced by women farmers and ensure their gradual empowerment by mobilising and organising them into groups, building their capacities to practise sustainable agriculture and promoting their activities towards household food security.

The programme started modestly with educational scholarships to children of farmers who had committed suicides in Wardha and Yavatmal districts. In 2007, it was decided to intervene with women farmers, especially to empower them to enhance productivity, profitability and sustainability of their small rain-fed farms and promote household food security and to enable women to function effectively, both to develop themselves as farmers as well as to develop agriculture in the region.

Priority for membership in the programme is for women farmers who are widowed or single, who have small and marginal landholdings or are landless, and who are from the disadvantaged castes. Women farmers are formed into groups (*samitis*) at the village level and the women farmers' groups — called *Jagrit Mahilâ Shetkari Samitis* — act as the fulcrum. The programme began in 2008 with 12 women farmers' groups with 156 members across 12 villages. By March 2013, the programme has spread to 60 villages with 170 groups, covering more than 2500 women farmers. Total land cultivated by the women farmers is close to 10800 acres. The programme has three focal themes: institution building, sustainable agriculture, and household food security. Different

methods of capacity building such as trainings, demonstrations, exposure visits are employed to teach various techniques to women farmers. For every 3 or 4 contiguous villages, one community resource person has been identified while every village has one village resource person. The experience they gain over the years in grooming the women farmers' groups gives them immense scope to emerge as leaders and to take over as office bearers of the proposed federation of women farmers.

Challenges

A big challenge relates to difficulties encountered by women farmers in adopting sustainable agricultural practices. Some complain that having no cows or bullocks at home makes it difficult for them to acquire organic material such as cow dung and cow urine. The proposed plan to produce bio inputs collectively would address the issue to a large extent. The programme is designed and being implemented in a manner that it becomes self-replicating and self-sustaining. Until 2011 it was supported by funding from Friends of Swaminathan, Australia and subsequently by the Ministry of Rural Development, Government of India.

Educational support

Education is a fundamental right of every child, but how does a child access this right if the father commits suicide leaving the family on the verge of financial breakdown? MSSRF strongly believes that all children should have the opportunity to receive an education, regardless of their financial situation. This belief has led it to work in the Vidarbha region since 2006. Its first programme was extending financial support to the school-going children of farmers who had committed suicide. This programme was initiated in Wardha district and 78 children from 37 families across the district were covered to begin with.

Education in government schools in Maharashtra being free, the financial support was primarily intended to provide for clothing, footwear and purchase of nutritious food for the children and meet examination and extra coaching fees in higher classes. Accordingly the amounts were arrived at for different categories: up to Class 5, Rs.1500/annum; Class 6 to 8, Rs.2000/annum; Class 9 and 10, Rs. 2500/annum and Class 11 and 12, Rs.3000/annum.

In collaboration with the Wardha District Teachers' Association, special coaching classes in English, Science, and Mathematics have been arranged for the children during vacation camps. Career counselling sessions have also been arranged to provide guidance on various opportunities available for higher education. Children are taken on exposure visits to places of interest in and around Wardha. From 2006 till 2013, 36 girls and 25 boys who were covered by this programme have passed Class 10, and 21 girls and 16 boys have passed Class 12. Suitable vocational training options are arranged for children after completion of Class 10 or 12. It is heartening to find that many students who were covered under this programme have completed vocational training and have secured employment: six students have completed the nursing course, one student has obtained a diploma in agriculture and five students have completed diploma courses in engineering.

Words from the heart: Broken young minds motivated

"I was in Class 4 when my father committed suicide. After I passed 10th examination; I was very worried about my higher studies since I did not have proper guidance or financial help. At this time, I received a message from M.S.Swaminathan Research Foundation to attend a meeting on career guidance. I joined the Auxiliary Nurse and Midwife (ANM) course in Swami Vivekananda Medical Mission (SVMM), Nagpur. The Foundation granted me a stipend ranging from Rs, 2,500/- to Rs. 3,000/ per annum from 2006, which helped me buy books, sandals, notebooks, uniform, etc. This is really a great help to me and my family. Presently I am working as ANM in SVMM which is an institute of very high repute in Nagpur,"— Rushali Petkar from Kurzadi Fort.

Expression of friendship with Jagrit Shetakari Mahila Samiti.

"I have never been active in farming either in my parental home or at my in-laws place. I started cultivating my late husband's land. I felt very helpless and used to desperately consult other villagers for help with inputs, practices etc. But soon *Jagrit Shetkari Mahila Samiti* changed all that. As a member of the group I learnt a lot of things regarding cultivation and now I am in a position to teach good cultivation practices to others" — Ujwala Petkar of village Kurzadi Fort.

GRASS-ROOTS INSTITUTIONS

Fostering science and technology for sustainable and equitable development continues to remain the core mandate of MSSRF. Though developments in science and technology help to address environment and economic dimensions, the major challenge in achieving sustainable and equitable development is nurturing community-based self-sustaining institutions capable of translating the concept into practice at the local level. Sustainable local development is achieved when socially inclusive approaches are adopted and supported by sustainable grass-roots institutions; it also depends on how the processes and structures of local-level institutions are positioned and shaped to function effectively and efficiently for a longer period of time. Principles essential to the local self-governing grass-roots institutions are social inclusion (including gender), effectiveness, participation, ownership and accountability. Provision of platforms for poorer sections of the community to articulate their entitlements and issues affecting their livelihoods are critical in development.

For sustaining local development, forming and nurturing people-centric, people- controlled and people-managed grass-roots institutions are essential. These institutions are capacitated to manage common property resources, private property resources, and also individual properties. MSSRF has been successful in facilitating the emergence of many such institutions in all the areas the Foundation works in.

Institutions managing common property resources

The objective of institutions managing common property resources is to ensure sustainable governance of natural resources such as soil, water, land and biodiversity, including fish species. They are facilitated to evolve institutional arrangements and management regimes for the efficient use, equitable allocation and sustainable conservation of the resources. More than 10 Joint Mangrove Management Councils in Pitchavaram are effectively governing mangrove resources and their ecosystems; 16 Village Development councils in Koraput district (Panchabati Grama Unnayan Samiti) and nearly 500 tribal members from different subcategories in Wayanad district (Wayanad Tribal Development Action Council) are managing the conservation, enhancement and

utilisation aspects of biological resources.

Producer organisations

There are eight producer organisations formed across MSSRF field locations; the current focus of these is on creating access to technology and input services at the group level with special emphasis on ensuring household food security.

South Vellar Agri. Producer Organisation (SVAPO). Illupur, Pudukottai district, Tamil Nadu, with a membership of around 350 families, works on issues of soil and water conservation and on-farm livelihoods, with special focus on pulses cultivation.

Women farmers in the Vidarbha region were mobilised and organised into samitis at the village level; so far around 170 samitis have been federated into an apex level body called Women Farmers' Federation, Wardha.

SEEDCARE in Wayanad, Kerala, has been working with paddy-growing farmers to promote the conservation of traditional cultivars.

Reddiyarchatram Sustainable Agricultural Producers Company Limited (RSAPCOL), working in the Kannvadi region of Dindigul district, is a Farmers' Producer Company (FPC) with 920 shareholders (68 per cent men and 32 per cent women) organised into 64 groups. The company facilitates input, output, technical, financial and insurance services.

The Kalinga Kalajeera Dhan Utpadak Samabaya Ltd. (KKDUS) in Odisha has created good rapport in the 44 operational villages of 3 blocks. Large-scale cultivation of rice varieties *Kalajeera, Machhakanta* and *Haladichudi* has been taken up in these villages.

Farmer Producer Organisation, Karasanur, Villupuram district, Tamil Nadu, is working with 300 members, focusing on small onion and paddy cultivation.

The Wayanad Agricultural & Rural Development Association (WARDA) takes up broader issues in agriculture at the district level to influence policy making.

Jeevani Oushad Sasya Karshaka Sangam, Wayanad, with 35 members, is involved in medicinal plants cultivation, utilisation and marketing.

Federations of self-help groups

To enable rural poor to have access to credit and generate self-employment opportunities, rural women and men belonging to resource-poor households have been targeted, mobilised and formed as self-help groups (SHGs), and then federated. Four federations have been functioning across different field sites of MSSRF.

Innuyir Grama Sangam with 3200 women members in Puducherry

Kulumai SHG Federation with 2400 women members in Kannivadi, Dindigul district of Tamil Nadu

KHABCOFED with 460 women and men members in Kolli Hills, Tamil Nadu

Rural Women Entrepreneurs Federation with 420 women members in Illupur, Pudukottai district, Tamil Nadu

The annual turnover of these federations is in the order of Rs. 120 million. Credit, saving and insurance services as well as access to technologies, new knowledge and skills for women to take up entrepreneurial activity in off-farm and non-farm sectors are facilitated through the federations. The major off-farm and non-farm livelihoods are small-scale dairying in a collective mode, stall-fed goat rearing, backyard poultry raising, mass multiplication of biological inputs, mushroom cultivation, value addition to agricultural residues and wastes, handmade paper production, compost preparation, coir rope making, artificial gem cutting, etc.

For effective and sustainable functioning of grass-roots institutions, a deeper understanding of community context, community planning, community action and mobilisation processes, opposition and resistance to discriminatory local actions, intervention and maintenance of efforts and strategies for community-level improvement are important.

VILLAGE LEVEL INSTITUTIONS FOR COASTAL RESOURCE MANAGEMENT

Right from its inception MSSRF has been firmly committed to mainstreaming participatory development processes into its operations. In the effort of promoting sustainable rural development, village-level institutions (VLIs) were set up for greater community participation, particularly of the poorest of the poor and women. These VLIs are variously called as Village Mangrove Council, Village Development Council and Village Development and Management Council, depending on the goal and objectives of interventions. The first VLI in MSSRF was started in 1996 in MGR Nagar in Pichavaram and since then more than 40 VLIs have been formed in the coastal areas of Tamil Nadu, Andhra Pradesh and Odisha.

Process of VLI formation

The objectives of VLIs are a) to provide platforms for people to plan, implement and monitor project interventions, b) to provide opportunities for women and marginalised communities in decision making and c) to create ownership of all project activities implemented in the village. Organising the villagers into new VLIs is process intensive. Different methods and tools such as one-to-one interactions, group discussions, village meetings, cultural events and exposure visits are used as tools to motivate people towards getting organised.

Structure and functions

A three-tier structure is being adopted in all the project villages. The General Body (GB) is constituted with adult male and female representatives of each household. This is the bottom of the tier and acts as the decision-making body in approving micro plans, budgets and expenditure. The next tier is the Executive Committee (EC) that consists of selected representatives from the GB who are well informed about the village and are committed to village development. From among the EC members, the Office Bearers (OB), i.e., President, Secretary and Treasurer, are selected with the consensus of the general body and they are the leaders of the VLIs. MSSRF has been successful in persuading the village communities to give 50 per cent representation to women in the EC. At least one of the office bearers is a woman, who is a signatory of the bank account opened in the

name of the VLI for transacting project funds. The GB meets at certain intervals whereas EC meets regularly every month on fixed dates and reviews the progress of activities and prepares future plans. Decisions taken and resolutions passed in GB and EC are recorded.

Roles and responsibilities of VLIs

Right from the beginning, VLIs have played a vital role in planning and implementing project components, especially in mobilising the community for active participation in the process of need assessment and livelihood analysis in coastal resource management. The VLIs ensure the identification of the poorest of the poor and women-headed households and prioritise appropriate target groups to receive services to strengthen their livelihoods. The financial assets provided by the project for executing activities as well as the revolving funds are meticulously managed. The EC along with MSSRF mobilises support from government agencies for decentralised management of coastal resources, which has ensured the long-term sustainability of these resources.

The outstanding achievement of such village-level institutions has been in bringing about gender equality. The entry of women into public space, especially in traditional institutions, has customarily been restricted. The situation has changed with the formation and socially inclusive structure of VLIs which enable women to participate in the monthly meetings of traditional panchayats. Their ideas are not only given priority but women members often outnumber men in the decision-making processes.

BRIDGING THE DIGITAL DIVIDE

"Information Communication Technology (ICT) turns out to be a solution for development issues…", "Connectivity… no longer an issue in rural areas", "ICT… a gateway for knowledge empowerment and livelihood enhancement" — these are statements echoed by multiple stakeholders in several forums across the globe. The situation was not like this way back in the 1990s, when the concept of the Information Village was conceived by Professor M. S. Swaminathan with the forethought that technology when applied appropriately can play a powerful role in creating remarkable change among the resource poor. The majority of people in India live in the rural areas, with huge information and knowledge gaps in aspects related to their lives and livelihoods. Despite systems and procedures, most information about government entitlements as well as technical know-how and field-level do-how rarely reach the last mile, leaving a wide gap between rural and urban India.

Genesis of the programme

The seed was sown for the knowledge revolution using technology during an interdisciplinary dialogue on Information Technology held at MSSRF in January 1992. The expert dialogue concluded that the future of food security in the developing world, especially South Asia, would depend largely on scientific, indigenous and shared knowledge as a catalyst for growth and development.

Hub and spokes model

The Information Village Research Project was conceived as a hub and spokes model. This was pilot tested in Villiyanur (hub) and spokes in Kizhur, Mangalam and Embalam villages in Puducherry in 1998, adopting a participatory approach. The hub, the Village Resource Centre (VRC), focuses on 5 Cs — content, capacity building, connectivity, convergence, and care and management. Communication strategies facilitate knowledge transfer between and among rural communities, scientists, academicians and experts on various subjects, using multiple modern technologies, through Village Knowledge Centres (VKCs). Systematic approaches and methods are employed to provide information and knowledge to the rural populace and the resource poor, in aspects related to farming, fishing, health and education.

Technology innovation and appropriation

MSSRF identified appropriate low cost technologies and innovated new technologies by taking components from existing tools such as v link systems, Motorola smart trunk systems, VHF radio technology, wired public address systems and spread spectrum techniques. These were used to connect clusters of villages in a radius of 30 to 60 km, to disseminate locale-specific, demand-driven information to the inhabitants. Moving beyond those adopted in the initial stages, a wide range of newer technologies such as Worldspace radio, satellite and internet-based video conferencing, fisher friendly mobile applications, mobile vans, wireless / GSM based public address systems, mobile-based audio conferences, voice and text SMS, etc. are operational today.

Key outcome

Over a period of time, the Information Village piloted in Puducherry became a community-owned and community-managed Village

Knowledge Centre, bridging the rural-urban digital divide. It has witnessed a multiplier effect as a community-centered model across Tamil Nadu, Maharashtra, Odisha, Kerala and Andhra Pradesh. It evolved into Mission 2007: Every Village a Knowledge Centre and made policy impact at the national level to spearhead ICT-enabled knowledge empowerment. The project has received international recognition and several significant awards, including the prestigious Motorola Dispatch Solution Gold Award in 1999 and Stockholm Challenge Award in 2001.

Impact of Village Resource and Knowledge Centres

Need- and season-based services of agriculture and allied services focusing on weather forecasts, market trends, farming practices, integrated pest management, integrated crop management and integrated nutrient management practices relevant to main crops like paddy, sugarcane, cotton, pulses and horticulture crops as well as care and management of livestock, including quality milk production and fodder, are the main areas of content in the VRC/VKCs. The mobile soil- and water-testing laboratories operating in Tamil Nadu and Maharashtra test micro and macro-nutrients in the soil as also hardness of water, and provide advisories to improve soil fertility. Youth, children and other community members are benefitting from computer literacy programmes such as Microsoft Unlimited Potential Programme, Intel Learn Programme (ILP) and Computer-Aided Learning Programme. Rural communities are provided with health services such as tele-health education, health camps on ophthalmology, women's reproductive health, etc., and awareness camps and advisories on epidemic outbreaks such as malaria, dengue fever, chicken pox, etc.

ALLIANCE FOR RURAL KNOWLEDGE TRANSFORMATION

Rural women and men are rich in traditional knowledge and wisdom derived from their experience of working with nature and natural resources. To tap this expertise, MSSRF's Village Knowledge Centre (VKC) programme was started in 1998 in Pondicherry (now Puducherry). In 2004, MSSRF initiated steps to extend Village Knowledge Centres (VKCs) to different parts of the country in the form of multi-stake holder partnerships called Mission 2007: Every Village a Knowledge Centre.

Mission 2007 is a coalition of public and private partners from academia, civil society and financial institutions, international support groups of the United Nations, bilateral agencies, and various corporate houses in the private sector. The network mobilises the power of partnership to harness ICT to empower rural households with knowledge and livelihood opportunities. Five taskforces with members drawn from the alliance partners and other organisations have been constituted to manage connectivity (rural), content (contextualised, demand-driven), capacity building (appropriate learning systems and curricula), co-ordination (linkages between knowledge providers and seekers), and care and management (community ownership). Since August 2007 this network/ movement has been re-named Grameen Gyan Abhiyan (Rural Knowledge Movement).

Grameen Gyan Abhiyan (GGA), a national movement for knowledge empowerment of rural families, is a multi-stakeholder partnership, facilitating national and regional events related to ICT-enabled rural development activities for addressing the burgeoning problems of rural India like poverty, illiteracy, ill-health, and low farm productivity with the mission to establish VKCs in over 600,000 villages in the country. The GGA Secretariat, hosted by MSSRF, provides a platform

for the partners to a share their expertise in the national conventions organised every year.

Key outputs at the national level

Announcement of 'Saksham' portal for training in ICT by Microsoft

Provision of $250 PCs for rural areas by HCL

Support for the establishment of 750 VRCs at the block level with satellite connectivity and teleconferencing facilities by Microsoft

Coverage of more than 450 blocks by ISRO

Allocation of Rs. 100 crore to NABARD's Rural Infrastructure Development Fund (RIDF) for establishing tele-centres

Inclusion of knowledge connectivity programme Bharat Nirman

Announcement of the Rural Innovation Fund by Microsoft-telecentre.org

Addition of the word Gyan Chaupal (Village Knowledge Centre) as a generic term to specify any type of Rural Knowledge Centre

Launch of INdG, a knowledge portal in regional vernaculars by CDAC

Inclusion of the VRC/VKC concept in IGNOU's Virtual Counselling Programme

At the international level, global leaders discussed Mission 2007 at the World Congress on ICT4D in Italy; GGA initiatives have been promoted in Chile, Malaysia, Sri Lanka and Morocco both through training and technical support; and similar networks have been triggered such as the PAN Africa Network, ICTA in Sri Lanka, Telecentre Network in Bangladesh, PhilCeCNet in Philippines and Mission Swaabhimaan in Nepal.

FISHER FRIENDLY APPLICATIONS

The coastal small craft fishing community is one of the most vulnerable groups in India, facing a number of challenges threatening its lives and livelihoods, such as unpredictable weather and ocean states, danger zones in the sea, lack of GPS information on fish shoals, etc. Also unavailable are inputs on quality fish processing, value addition and storage, market trends and government benefit schemes. "Every day is like a struggle against strong winds, huge waves, and it is an unpredictable industry, we are living with perpetual uncertainty with challenges in our life" are typical words frequently voiced by fishermen. Wind speeds and direction, wave heights and direction, sea currents and direction, and sea temperatures are the major factors that decide the daily sea conditions and they depend solely on their traditional knowledge to determine these before proceeding out for fishing.

Interventions

In this context, MSSRF in partnership with the Indian National Centre for Ocean Information Services (INCOIS) has leveraged scientific information services such as ocean state forecast (OSF), potential fishing zones (PFZ) to the fishing community from 2003. Over a period of time a range of information and communication technologies has disseminated such crucial information to fishermen enabling them to make rational decisions, starting with display of PFZ and OSF information on notice boards in the VKCs and through public announcements in the villages using loudspeakers.

Fisher Friendly Mobile Application

Since 2005, penetration of mobile phones has reached high levels in rural areas, which has enabled MSSRF to provide information as text messages. The Fisher Friendly Mobile Application (FFMA) has been designed to act as a decision-making support system catering to the demands of fisherfolk towards information needs as "a one-stop shop". Upon sending a single-button-click request from an icon-based software application on their mobile phones, fishermen can access vital updates on wave height, wind speed and direction, potential fishing zones, news alerts, government schemes and latest market prices in their local language (Tamil). Participatory methods and techniques have been adopted to understand and incorporate the views and suggestions of fisherfolk and key stakeholders including service providers into FFMA design.

FFMA was developed jointly by MSSRF, Qualcomm, Tata Teleservices and Astute Technology System under Qualcomm's Wireless Reach programme and launched in December 2007. CDMA (code division multiple access) mobile phones were distributed to fishermen in Puducherry and Tamil Nadu and fishermen could access information both on land and on the sea. MSSRF VRCs simplify the scientific data and upload the same along with government schemes related to fisheries, market rates and emergency contacts, in the website, linking it to the database in the server. Nearly 20,000 fishermen have downloaded this application for accessing information on a daily basis.

As development is a process, MSSRF has realised the need for upgrading the existing FFMA to suit emerging technology development as well as the needs of the fisherfolk. The need for strengthening this application with new features was identified during participatory meetings with fisherfolk and it has been upgraded for Android platform in Tamil and Telugu vernaculars interfacing GPS facilities, with the support of Qualcomm's Wireless Reach programme and technical support of Tata Consultancy Services. This would enable fisherfolk to access low-cost GPS facilities to navigate without trouble to fishing grounds and also to mark essential points such as rocks and corals.

WEATHER INFORMATION BASED FARMING

Under the Swiss Agency for Development and Cooperation's programme 'Vulnerability Assessment and Enhancing Adaptive Capacity to Climate Change in Semi-arid Regions of India', MSSRF along with local partners experimented with the establishment of village-level mini agro-met observatories. The objective was to train local communities in gathering, interpreting and disseminating weather-related information at the local level, in order to build the capacities of the farming communities to cope with weather-based crop production risks. The underlying hypothesis of this initiative was that the data collected from the meteorological instruments by the community would help over a period of time to develop weather-based thumb rules for taking appropriate farm decisions based on simple weather parameters like rainfall, wind speed, temperature and relative humidity.

Mini agricultural meteorology observatories were set up in 2 villages each in Andhra Pradesh and Rajasthan. The objectives for the establishment of the mini agro-met observatories were to

provide the community a hands-on experience in weather data recording.

understand the local climate through collection and interpretation of data.

train and equip a few members of the community to become 'Climate Risk Managers' in the long run.

plan weather-based agricultural activities using thumb rules developed, thereby enhancing adaptive capacities to climate variability.

create a visible impact among the farm communities and encourage them to participate in the process.

Agro-met features

Weather observatories: The manual mini agro-met facility is simple and is relatively inexpensive.

The facility has minimum equipment like the rain gauge, Stevenson Thermometer and anemometer. The observatory provides daily weather data, both morning and evening, on the basis of rainfall, wind speed, maximum temperature, minimum temperature and relative humidity.

Local-level capacity building: Two women and men each from the 4 project villages were selected and trained along with the technical staff from local NGOs. The training focused on recording of weather data from the observatory in a register; interpretation of weather data; development of thumb rules based on weather data collected and field crop observations made; preparation of agro-advisories; and dissemination within the community. Besides this, the Climate Risk Managers (CRMs) were trained to maintain the instruments on a day-to-day basis and also to computerise the weather data collected.

Weather information: The weather information comprised rainfall data for sowing and irrigation scheduling decisions; wind speed for pesticide spraying and propping decisions; maximum, minimum temperatures and relative humidity (both maximum and minimum) for pest and disease outbreak and irrigation scheduling decisions.

Case study to evaluate the efficacy of agro-met information for farm decision making

To validate the strength of agro-met information for farm decision making, an in-depth case study was undertaken at Kundai village of Udaipur district of Rajasthan. Ten farmers (the 'agro-met' group) were selected at random from the category of farmers who took up maize sowing during July 2008 (*kharif*) based on the agro-advisory provided by the CRM for sowing. Similarly, another set of 10 farmers from the same village were selected as 'control' farmers. A pre-tested and refined questionnaire was developed to collect information individually from the 20 farmers. Relevant information was gathered by local NGOs Sahyog Sansthan and Action for Food Production (AFPRO) and analysed by MSSRF. The quality of the data was checked and processed for interpretation.

In the cropping pattern under study, maize-wheat is adopted by 90 per cent of the households in the village. The first crop was maize (kharif) followed by wheat (rabi). During the dry spells within the cropping season, based on the weather information generated locally, one or two life-saving irrigations were administered at appropriate times to stabilise the productivity.

Analysis of data revealed that by adhering to farm decisions based on data generated from the mini observatory, the 'agro-met' farmer group recorded a benefit cost ratio of 1.2, from the cropping system of maize-wheat, while it was 0.96 for the 'control' farmers. The partial budgeting analysis also indicated that there is an estimated positive change for the 'agro-met' farmer group.

Key lessons and implications from the case study:

Farmers need to unite as a group and take farm decisions based on weather data from the local observatory, after thorough discussions among themselves.

Inculcating climate / weather consciousness among the community will enable achieving maximum benefit from weather-based farm decisions.

Climate Risk Managers need periodical training (both pre and post season).

Motivation of the local communities is vital. Strengthening local institutions like the Smart Farmers' Club (SFC) is fundamental in supporting weather-based farming at the community level.

Though formal dissemination mechanisms like the Village Knowledge Centres are generally agreed to be necessary to help leapfrog the communication process, this may not be applicable in all circumstances.

VOICING SILENCE

Women constitute around 48 per cent of the 710 million Indian voters, a largely silent category whose core concerns have generally been interpersonally, institutionally, and politically oppressed, ignored, underplayed or denied by policy makers despite the agenda of women empowerment being talked about frequently. In particular, women farmers — the voiceless pillars of Indian agriculture — are subjected to great inequity in access to resources and benefits and in addition they are deprived of relevant information to make well-informed decisions towards their empowerment. Building up of a society, where women can breathe without the fear of oppression, exploitation, apprehension, discrimination, and the general feeling of persecution which goes with being a woman in a traditionally male-dominated structure, and finally being able to voice their concerns, becomes imperative.

Voicing Silence, a project of MSSRF from 1992 to 2008, is a unique effort at gendered theatre which has acted as a catalyst in the process of women's awareness and empowerment. Gender, culture and social activism have been the three major concerns of *Voicing Silence*, illustrated through developing plays on women's issues or from a feminist perspective; organising collective sharing of experiences through women's theatre festivals, bringing together cultural workers, theatre persons, social activists and NGOs; and working with different communities of women, supporting them to use theatre as a tool for self-expression and empowerment.

In the span of one decade of its functioning, *Voicing Silence* worked on evolving a distinctively female theatre idiom, with a feminist slant; it worked with traditional women theatre artists, explored the limits and uses of existing folk forms, conducted workshops, and most importantly produced several plays, both for the street, for flexible stages and the proscenium stage. The content has ranged from reworking of traditional myths to current social issues: the *genres* from folk and traditional to avant-garde; the *format* and *location* from street and open spaces to auditoria; the *audiences* from rural to metropolitan; the occasions from women's conferences to cultural

jathas, college shows and local festivals. Moving away from re-visioning Hindu myths, *Voicing Silence* attempted to unearth the rich resource of the Sangam corpus in Tamil literature. The

sponsors too have varied: educational institutions, small town festival committees, women's groups, Dalit groups, NGOs, literary societies, and Tamil diaspora, as well as mainstream theatre festivals.

Theatre initiatives

The workshop mode was adopted while developing the plays, with emphasis on collective functioning, mutual support and group criticism. Twelve plays were developed from 1992-2008. The first play was *Subbutai*, on women's dilemmas in decision making on intimate personal issues in the context of middle class families and how women are compelled to be the carriers of 'traditional' values. *Pacha Mannu* raised the issue of female infanticide/foeticide, an extreme form of gender discrimination that shadows every woman's life. *Vellavi* ("White steam"), on gender involving caste, class, age, education and technical know-how, is a real life story of a dhobi woman who has seen the ups and downs of life. *Panit-t-Thee* ("Frozen fire"), a solo performance, explored gender identity through the tale of Amba-Shikandi in the Mahabharata, the woman who struggled to become a man in order to seek justice in a man's world. The play *Avvai* showed how the patriarchal world view suppressed the image of a youthful, sensuous woman, fearless in expression, and turned it into a less threatening one. *Pavazhakkodi* brought out the issues on male and female relationships and subsequently, *Medai Pesudu* was focused on the feminist perspective. The play *Manimekalai*, based on the Tamil epic in the era of Buddhism-Brahminism conflict, explored the struggles against caste and gender oppression. For four continuous years, work with a group of professional women actors from traditional Tamil theatre genres led to several finished performances; and work for two consecutive years with transgendered persons (*aravanis*) led to a theatre campaign for their rights.

Apart from plays, *Voicing Silence* organised specific workshops for communities like the quarry women of Pudukkottai, Dalit women of Tirunelveli district, professional female stage artists and transgendered people. Moving away from the pattern of established street theatre models of providing answers, *Voicing Silence* attempted to initiate discussions based on theatre games, performances and role plays.

KULAVAI, the name of the interactive women's theatre festival-cum-seminar conducted from time to time by *Voicing Silence,* is a Tamil word connoting the ululations of women on ritual occasions and ceremonies, and refers to celebrations. KULAVAI 96, at the national level, was the first attempt to link theatre persons interested in gender issues with cultural activists and NGOs addressing women's issues through theatre. KULAVAI 97 was a confluence of professional women stage artists of Tamil Nadu from a range of forms — traditional genres to the contemporary street theatre of protest. KULAVAI 99 was a celebration of women's voices from the four southern states on the same themes. KULAVAI 2002, dedicated to women directors, featured a seminar to critique and understand the work of women directors, and showcased their work KULAVAI 2003, in a one-day festival, presented nine women solo performers from around the country, in a day-long series of performances, speaking in different voices, styles, forms and languages.

TORCH BEARERS OF RURAL KNOWLEDGE REVOLUTION

India is on the threshold of a truly revolutionary era of discovery and information explosion. In rural India, human resources are grounded with enormous potential and experiences, particularly rich in traditional knowledge and wisdom, but are unrecognised in the vanguard of development. These are hidden and unspoken potential, which have made outstanding contribution to public good in areas relevant to rural life in villages.

In MSSRF, the National Virtual Academy (NVA) has been mandated to recognise and felicitate such grass-roots "academicians" who have consistently impacted the development of their communities. NVA identifies socially-committed grass-roots experts in different thematic areas such as agriculture, animal husbandry, fisheries, health, education, social welfare, conservation and natural resource management, disaster management, etc., with the help of various institutions and experts, and awards them the NVA Fellowship. A special effort is made to establish contact with people living and working in farmers' distress hotspots, drought or flood-prone areas and geographically remote regions. Since its inception in 2005, NVA has identified rural men and women every year for the award of NVA Fellowships. The Fellowship does not have any monetary benefits. It is only a social recognition.

NVA has so far inducted 1568 Fellows, 968 men and 600 women across 24 states in India, and 31 overseas fellows covering 26 men and 5 women from 11 countries. Every year there is a Convocation in which the chosen Fellows are acknowledged. In recognition of the value of the transformation in rural India that these change agents have accomplished, eminent persons like Mr. Ranil Wickramasinghe, then Prime Minister of Sri Lanka, Dr. A.P.J. Abdul Kalam, Former President of India, Dr. Bruce Alberts, Former President, National Academy of Science among others have been invited to preside over the annual Convocations. The profile of Fellows shows that they transform knowledge in their possession by a) linking their fellow members in the village with government schemes, including subsidies for procuring implements; b) training/exchanging knowledge among fellow members on agricultural practices, water and fertiliser management, pest and disease management, organic farming, crop cultivation and latest technologies like System of Rice Intensification, drip irrigation, precision

farming, etc.; c) capacity building on both off-farm and non-farm aspects in micro enterprises; and d) adult literacy programmes and innovative practices in children's education.

NVA offers a lifelong learning opportunity to pioneering leaders through constant update of information and knowledge for strengthening developmental processes in villages across India through its Training School.

Some enterprising NVA Fellows

Janaki from Thirukanchipet, Pudhucherry has brought to the forefront several development issues faced by the Dalit community and is striving to address some of them by engaging with government officials. One of the issues brought to the government arena is the challenge faced by her community to transport the deceased to the graveyard crossing the Sankarabarani river. Janaki played a pivotal role in raising this concern with the government and pushing for the construction of a bridge across the river. The issue drew the attention of local and central governments, as also media. Government has agreed to take corrective measures.

K. *Kandasamy* hailing from Goundampalayam, Tamil Nadu, is an expert on agricultural practices and precision fishing techniques. He has enabled the poor and downtrodden to benefit from government schemes and entitlements.

Ashaq Ahmad Lone from Jammu and Kashmir works tirelessly among the community to create awareness about various entitlements, including getting proper shelter for the homeless. He is very enthusiastic about his Fellowship Award that has enabled him to link with the Social Welfare Department and Nehru Yuva Kendra in providing vocational training to 140 girls.

Ms. Pournima Vijayrao, a leader from Maharashtra, has supported women through the formation of 10 Self-Help groups, trained them in sericulture and added meaning to their lives. She is popularly known for her krishi kirtans and frequently shares knowledge on various topics on Akashwani.

Pratap Kumar Patnaik from Odisha strives to educate girl children in his community and has organised several awareness programmes on the importance of education, sanitation and healthcare for mother and child. He is working with various villages to encourage and promote blood donation among the tribal population and wants to set up a blood bank.

The Jamsetji Tata National Virtual Academy Fellows aims to fulfill Gandhiji's vision of Purna Swaraj through Gram Swaraj. When fully developed the NVA will be the largest professional academy in the world with nearly one million fellows drawn from 500,000 villages. The NVA represents the most serious attempt so far undertaken to bridge the urban-rural digital divide as well as gender divide. It also represents the power of partnership in the technological and skill empowerment of the rural poor. It provides a powerful tool for achieving the UN Millennium Development goals the areas of hunger and poverty elimination and gender justice and equity"

- MS Swaminathan

AGROBIODIVERSITY CONSERVATION CORPS

India is one of twelve mega biodiverse countries of the world, contributing to 8 per cent of known global biodiversity. Biological diversity exists in the wild; domesticated agricultural biodiversity, including crops, varieties and breeds, is a cultural and human construct involving application of knowledge. Wild biodiversity is conserved through a network of Protected Areas covering 4.7 per cent of the total geographical area while domesticated biodiversity has been receiving increasing attention only in recent decades. Economic compulsion coupled with lack of awareness on domesticated biodiversity among the local population has led to gradual but steady erosion. In order to fill the gap in the area of domesticated agrobiodiversity, the Community Biodiversity Programme of MSSRF has been making consistent and systematic efforts for evolving models for conservation and sustainable use, with specific focus on Tamil Nadu, Kerala and Odisha. Effective biodiversity preservation requires that those that are entrusted to its conservation and utilisation are equipped with the necessary capacities through training and education.

Programme outline

Until and unless the local population develops a strong economic stake in conservation- related activities, the maintenance of biodiversity may become a lost cause. Thus conservation, together with enhancement and utilisation of agrobiodiversity, not only serves as a feedstock for biotechnology but emerges as an important global public good in the context of overall development. In the process of transition of the country from the Green Revolution to an 'evergreen revolution', agrobiodiversity will have to play a major role.

In 1996, MSSRF launched a 5-year programme covering Tamil Nadu, Kerala, Odisha and the Union Territory of Lakshadweep, with the support of the Netherlands Ministry of Foreign Affairs, in order to create awareness amongst local communities about agrobiodiversity. The goal being *in situ* conservation of agrobiodiversity, the emphasis of the programme was on the active participation of communities and capacity building of volunteers identified/selected. The Agrobiodiversity Conservation Corps (ACC) came into being.

The programme concentrated on building capacities of individuals and groups in the area of

identification, characterisation and conservation of agrobiodiversity, with special focus on local youth. Several institutions and scientists gave their time and knowledge in training volunteers. Training materials on the concept of agrobiodiversity were prepared in the local languages — Tamil, Malayalam and Odiya — and used in various levels of training including lectures, participatory resource mapping, group discussions and field exercises of inventorying biodiversity. A total of 212 volunteers were trained at various field sites in four batches during the project period, male volunteers: 127 and female volunteers: 85. The topics covered includeda) Research b) Training and Capacity Buildingc) Institution Building and d) Conservation Information and Empowerment.

Volunteers expanded their knowledge base about participatory rural appraisal, resource mapping, preparation of charts and posters, herbarium, collection of seeds, inventorying and monitoring, and also undertook exposure visits and participated in workshops for enhancement of skills and knowledge, through structured programmes. In Dharmapuri a formal society, the Vellanmai Uirunda Padukapu Sangam (Agrobiodiversity Conservation Society) was registered. An Awareness Centre was constructed by the volunteers donating their stipendiaries earned over a period of two years. In Wayanad, ACC were trained in the preparation of the People's Biodiversity Register (PBR) and helped to document and record the dying knowledge and wisdom of local people about their natural resources, including various flora and fauna, with prior informed consent. ACC identified a local heritage site in Meppadi panchayat in Wayanad District as part of PBR efforts.

Activities of the project supported the then Biodiversity Bill (now Biodiversity Act 2002) and PPVFRA Bill (now Protection of Plant Varieties and Farmers Rights Act 2001) that were tabled in the Parliament of India.

Communication and outreach

As MSSRF's efforts to provide expert domain knowledge and insights into agro-biodiversity conservation challenges are continually increasing. MSSRF is also alongside enhancing its intellectual leadership, articulating abilities and communication methodologies effectively to its stakeholder's constituency. Towards this endeavour, the monograph *Agrobiodiversity Conservation Corps: Catalysts of a Community Agrobiodiversity Conservation Movement* serves as an important communication material to share scientific research outputs and outcomes. During the final convocation function in 2001, the significant contribution of the Corps to the revitilisation of the conservation tradition of rural and tribal families was acknowledged. Conservation of biodiversity would be meaningless without strengthening the livelihoods of rural and tribal families.

PANCHABATI GRAMA UNNAYAN SAMITI

Scientists at MSSRF realised the need to develop procedures for recognising and rewarding the contributions of tribal and rural families, particularly those of women, in accordance with the provisions of the Convention on Biological Diversity (CBD), to conserve, cultivate, consume and commercialise biodiversity with special focus on landraces of rice. In this context, initiatives were undertaken to motivate the tribal communities of Koraput district to conserve landraces of rice, millets and medicinal plants through both *in situ* and *ex situ* conservation. This met with success which was visible in the selfless efforts of tribal communities of the Jeypore tract that earned them the Equator Initiative Award 2002, presented to them at the World Summit on Sustainable Development in Johannesburg, South Africa. The citation reads: 'In recognition of the outstanding achievements of tribal communities of the Jeypore Tract of Orissa towards the conservation of biodiversity and reduction of poverty in the Equatorial Belt'.

The Equator Initiative Award (Rs. 14 lakh) has been a significant motivational factor for the tribal community of Jeypore to initiate an endogenous and sustainable mechanism of people's self-organising actions into a local social system. The action resulted in the formation and registration of a farmer's association, the Panchabati Grama Unnayan Samiti (PGUS) in 2003, with MSSRF as facilitator.

Objective of PGUS

The motivation of this initiative has been to popularise the success achieved in harnessing science and technology to make the villages self-reliant in agriculture and food security. It was believed that concerted efforts towards massive orientation and capacity building to improve the level of competency of human resources would go a long way in achieving the goal of PGUS.

Structure and resources of PGUS

Six nominees from the Central Village Committees (CVC) of each village represent the general body,

which also takes care of gender equity. Each village contributes Rs. 25/month as member fee. The interest from the Equator Initiative Award amount is used for village biodiversity and bioresource conservation efforts. These take the form of training and capacity building programmes on natural resource management as well as income generation schemes through various on-farm and non-farm livelihood enterprises.

Activities

Cultivation of local crops such as rice, *ragi* and pulses, fish farming, mushroom production, etc., has been enhanced through the dissemination of appropriate technologies, to enable food security. Benefits from entitlement schemes have been facilitated through effective linkages. Winnowing fans and seed materials were availed from the Agriculture Department at subsidised rates. Tree plantation was promoted both as avenue and in barren forest land through supply of saplings at the household level. There has been an increase in maize cultivation (51 acres), *arhar* planting (95 HHs) and raising of backyard poultry (203 HHs). *In situ* conservation of 40 traditional rice landraces was demonstrated in two villages, specially identified by PGUS. Twenty-three farmers raised 17 landraces in 13 acres (primarily for their own consumption). *Machhakanta, Kalajeera* and *Haladichudi* landraces were popularised in an area of 52 acres. The village grain seed bank was established to provide farmers access to quality seeds in time.

Outcome

For PGUS, training of human resources rather than hardware construction is important.

PGUS development interventions address humane and environmental concerns (aligned with pro-poor, pro-nature and pro-gender principles).

Diversified, sustainable, and equitable economic, ecological and human development is through building organisational and individual competence and confidence.

CLIMATE RISK MANAGERS

A significant body of evidence points to the threats that the Indian sub-continent faces due to climate change. Several efforts are underway already to support adaptation research and action, but capacity remains limited as the challenges mount. According to the Indian Council of Agricultural Research, India has about 127 agro-climatic regions and there is need to understand climate-associated problems in each of these regions through focused research, to formulate codes of action for dealing with drought, floods and sea level rise. Climate change adaptation actions require a good understanding of risks in a given context to be able to respond strategically, using available resources and knowledge. Managing the risks associated with climate variability is integral to a comprehensive strategy for adapting agriculture and food systems to a changing climate. So it is imperative to build on the existing capacities and provide additional capacities to various stakeholders at the local level for understanding and managing climate risks.

The rationale

At the community level, what is needed is the right information at the right time to effectively manage climate risks. Though the traditional risk management and coping strategies are valid, it is important to bring a scientific perspective to the approach. There is requirement for adequately trained people to provide timely forecasts, help in identifying suitable climate risk management measures and enhancing the adaptive capacities of the farming community. This calls for training of selected individuals in various facets of climate risk management, especially in terms of assessing climate-related risks, identifying the most suitable adaptation measures, promoting weather-based farming, forecasting extreme events, propagating best practices in managing water, agro-biodiversity and other resources, with an emphasis to prepare the local communities to handle climate-related risks and enhance their livelihood options.

Objectives

To assess / understand climate risks in selected sites and make an inventory of best practices /adaptation measures suitable to the area

To establish a dedicated training centre to

train a cadre of 'Master Trainers' in local level climate risk management

To prepare a training manual / toolkit

To establish a model mini agro meteorological observatory

To impart training for about sixty 'Climate Risk Managers' from each of the selected six agro-climatic zones on a pilot basis, through the network of 'Master Trainers'

To create a ready reckoner for specific agro-ecological zones looking at the array of time-tested best agricultural practices/ cropping mix suitable for varying conditions, especially under the three weather codes — normal, deficient and excessive rainfall conditions.

The module

A training module has been developed covering all the relevant aspects including the basic science of climate change, its impacts on various sectors (agriculture, water, health and energy), and various locally-relevant response options. The idea is to provide a broad overview on climate change issues and provide the trainees (Climate Risk Managers) the capacity to interpret, identify and suggest possible actions. The module has been translated into Tamil and will be published in Malayalam and Hindi too.

Four training programmes have been conducted involving 140 participants selected from various districts of Tamil Nadu covering 4 agro-ecological zones. The composition is about 56 per cent of men and 44 per cent of women. Three agro-met stations were established in the field sites and hands-on-training were provided to the selected CRMs from the respective areas to record and interpret weather information on a daily basis. Pest management, soil assessments, nutrient requirements, crop performance, manure and fertiliser management, irrigation requirements and schedules, and water conservation measures are some of the popular topics that gained attention during the training interactions. Two field visits were organised for the participants at the Rice Research Centre in Tirur, where they had the opportunity to interact with scientists. The CRMs also work closely with the local panchayats and the extension officers of the respective regions. The interface between extension services and the CRMs will be strengthened to effectively carry out risk management strategies and to leverage existing government-sponsored schemes.

The programme staff interact closely with the local panchayats in designing innovative capacity-development manuals and frameworks for managing climate-related agricultural risks, and address gaps and support/improve climate-related information products and services that enable a range of agricultural risk management interventions. It is envisaged that the programme will be extended to the project sites of MSSRF in other States in the next few years.

COMMUNITY HUNGER FIGHTERS

The physical, mental and spiritual development of human beings are negatively impacted by food shortages and chronic undernourishment, thus preventing them from pursuing an active social life. In the long term, this means that a given society loses its human resources and scope for social capital building initiatives. Food, agriculture and nutrition experts recognise the value of tapping into resources, insights and experiences that have traditionally been overlooked in response to hunger and malnutrition. India's relatively open political and social system, its constitutional guarantees for the protection of minority and disadvantaged groups, and active civil society organisations provide a sufficiently broad framework and enabling environment for fostering genuine people-centric capacity enhancement programmes. One such is MSSRF's cadre of Community Hunger Fighters (CHFs), volunteers chosen from within the village trained to confront the social realities of high levels of undernutrition in the community. The CHF programme has been launched in selected villages in Koraput district of Odisha: Bolliguda, Gunthaguda, Nuaguda, Banuaguda, Lachnaguda, Disariguda, Majhiguda and Bhatiguda,

The rationale

A plethora of programmes are being implemented by the Central and State Governments to improve the health, income and nutritional status of the population but without much of a success. The majority of female-headed households, for example, are not reached by institutional delivery structures of credit, social, and technical support, since these organisations are yet to understand, appreciate and finally recognise the importance of the equity and empowerment component of the development process. All of these realisations led MSSRF to believe that, for fighting against hunger and malnutrition, people themselves need to be proactive change agents and actively demand, seek and utilise entitlements and urge for good governance for effective social capital building processes.

Methodology

Community Hunger Fighters is an action-cum-education project wherein critical awareness and desire for action among village communities are created through training five representatives from

a village, consisting of men and women leaders belonging to different social groups and selected by the village community. Using secondary data, villages/ hamlets primarily consisting of households with marginalised communities such as Scheduled Caste and Scheduled Tribes were selected and the project discussed. Capacity building of the 5 representatives was done through a residential training programme spread over 3 modules, addressing issues of food availability which included the concept of a balanced diet, safe drinking water and integrating nutrition concerns in agriculture. Participatory training methodologies such as role plays, group discussions, simulation activities and games were adopted to trigger thinking processes and help participants to critically reflect on and analyse their problems. Exposure visits to developmental efforts by other organisations were also organised. Periodic follow up and interaction was maintained. Participant observation, formal surveys, scrutiny of government records and views and opinions of the CHFs were used in assessing outcomes.

Key interventions

Generating awareness: The CHFs identified and spread key messages on food and nutrition security through songs and in informal and formal meetings. In Lachnaguda village, the CHFS had organised a rally with 150 school children on health and hygiene issues.

Addressing undernutrition: In Bolliguda, Gunthaguda and Nuaguda, the CHFS had referred 3 anaemic women to the primary health centre, facilitated deworming of 85 children below six years of age and counseled 22 households on appropriate feeding practices. In the villages of Banuaguda, Bhatiguda, Disariguda, Lachnaguda and Majhiguda, 66 households were motivated to take up vegetable cultivation in home gardens.

Seeking entitlements: Two of the women CHFs were elected unopposed as ward members. These women members took an active role in participating in village meetings and in supervising the implementation of schemes. Village health and sanitation committees were formed in five villages and several households have applied for sanitation facilities. The CHFs belonging to marginalised sections actively mobilised their community members to participate in village meetings. In eight villages, the ultra poor households were identified by the villagers using appropriate criteria. In five villages, a village action plan has been prepared. This consists of latrine facility for every household, drinking water facility, pucca houses under Indira Awas Yojana's Mo Kudia programme for some BPL and poorest families, old age pensions, widow pensions, work under MGNREGA, digging of ponds under the Mo Pokhari scheme, construction of anganwadi building, school building, concrete cement road, community building, check dams at the community level and issue of public distribution system cards.

Outcome

The trained CHFs have gained a wider perspective of food and nutrition security issues and are able to appreciate the connections and convergence between the various schemes and programmes being implemented to improve food and nutrition security, as judged by the wide range of interventions undertaken by them.

The project launched formally in October 2011 has so far trained about 90 CHFs from 18 villages in Kundra and Boipariguda blocks of Koraput districts in Odisha. About 1748 households, covering a population of 845 Scheduled Tribes, 317 Scheduled Castes and 633 Other Backward Communities have been reached. Further, a 23-minute film has been produced in both English and Odiya documenting salient features of the project.

PLANT DOCTORS

There are several overarching socio-cultural factors that influence decision-making for farm management, in general, and pest and disease management, in particular. Resource-poor marginal farmers seldom take right decisions on their own and depend on the local pesticide dealers for solving their field problems. Often they fail to identify and explain the exact problem to the pesticide dealer, and so rarely succeed in managing the issue. To put an end to such situations, MSSRF and CABI have jointly initiated the Plantwise programme on a pilot mode in Tamil Nadu, Puducherry and Maharashtra.

Plant Clinics and Plant Doctors — A conceptual innovation

Plantwise is a unique programme aimed at building local capacity and infrastructure to address farm issues in aspects related to pest and disease. Selected progressive farmers and extension workers are identified and trained on a set of modules developed by CABI, and called 'plant doctors'. The plant doctors establish plant clinics in their respective villages; clinic sessions are conducted in a common area in a village regularly on the scheduled date and time. Farmers are encouraged to bring samples of the affected crop to the clinic. The plant doctor examines the sample, diagnoses the problem and offers advice on treatment.

Process

Discussions with the village panchayat president, ward members, progressive farmers and other key stakeholders in the village were held to enable them understand the concept and identify a common location to establish the plant clinic and fix convenient times to operate the clinic. Awareness of the concept was created among the community using different communication strategies including awareness meetings, propagation through newspapers, handbills and mobile-based voice messages.

Potential smallholder farmers were identified and trained as plant doctors through a five-day course, ensuring that each clinic has two plant doctors. The plant doctors educate the farmers on bringing appropriate crop samples. Doctors are provided with a tool kit which consists of a hand lens, knife, gloves, tissue papers, sanitisers and formats to collect case histories and issue prescriptions. The plant doctors examine the samples and record the case history with preset questions to diagnose the problem in a scientific manner, to confirm whether it is a pest disease or nutrient deficiency. If the farmers are unable to bring

a sample because of its robust size and if the field is nearby, the plant doctors also visit the field. After diagnosing the problem, farmers are educated in detail about its characteristic symptoms, threshold level and its impact on crop loss and are given advice on preventive and curative measures. The disadvantages / harmful effects of red-labeled as well as banned pesticides, pest resurgence and pest resistance to

pesticides are all explained and, based on the severity of the problem, locally available cultural, biological and chemical methods of treatment are recommended. Detailed prescription sheets and fact sheets are prepared to give the correct recommendation to the farmers. After the sessions, participants are monitored and feedback collected for the improvement of the programme. Pre- and post-assessments on plant clinic sessions are being done to strengthen the activity.

Systematic procedures are followed to collate data from each clinic and the same is shared with CABI. Fact sheets are prepared both in English and the regional vernacular by trained persons detailing symptoms, crop loss and control measures, and validated with farmers. The finalised factsheets are shared through the global knowledge bank. This ensures promotion of good agricultural practices to secure a green environment and reduce crop loss.

Outcomes

The major result of this programme is that farmers are able to get effective recommendations for their crop issues on the spot, saving time, energy and cost, and are able to take informed decisions. The farmers become aware of the problems and tackle them with local resources and cost-effective, eco-friendly measures. Due to the plant clinic sessions, farmers have now realised the ill-effects of chemical pesticides and are willing to adapt integrated pest management (IPM) measures.

The positive feedback shared by the farmers was that crop loss was prevented and a gradual increase in income was possible due to adoption of recommendations prescribed by plant doctors. The increase in the number of participants in the clinic sessions serves as a qualitative indicator. The uniqueness of this initiative is that the farmers are equipped with new skills essential for their livelihood and available within the village, enabling them to meet today's challenges in agriculture.

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GENETIC AND LEGAL LITERACY

Health and nutrition, conservation of biodiversity, empowering people through IT and sustainable agricultural practices have been identified as broad issues and areas for genetic awareness by the Government of India, with the objective of making people scientifically literate, and to inculcate in them the habit of putting scientific awareness to practical use in day-to-day life. The challenges posed by the subject of genetics and biotechnology cannot be met without a greater investment in, and emphasis on, that aspect of broad health literacy called genetic literacy. Progress in the field of biotechnology has immense implications for the conservation and enhancement of vast bioresources. Biotechnology and genomics programmes can provide new ways to use plants and microbes, resulting in improved environmental quality and economic sustainability of communities. MSSRF has played a lead role in starting Genome Clubs as an outreach programme in schools and has conducted genetic literacy programmes in rural areas to create a cadre of youth, young men and women with a functional knowledge of genetics and legislation pertaining to biodiversity and rights of farmers on seeds.

Objective

The objectives of Genome Clubs are to

- disseminate proper information to the stake-holders through workshops and camps
- promote interest and knowledge about natural resources and the environment among the emerging generation
- foster concern to protect bioresources and natural heritage
- increase awareness of the economic, cultural, scientific and aesthetic values of fauna and flora
- provide opportunities to acquire attitudes, values and skills needed to protect and improve the natural environment
- make aware the impact that emerging technologies (including biotechnology) have on maintenance and enhancement of bioresources

Genetic literacy initiatives

The Every Child a Scientist programme in Chennai has completed ten years and targets economically and socially underprivileged students, mainly from the neighbouring schools run by the Chennai Municipal Corporation. The objective is to kindle awareness on biodiversity conservation,

sustainable and equitable use of bioresources, basic health and hygiene, and environmental issues. Animated experiments, computerised quiz programmes, games, interaction with experts, and field visits are some of the methods adopted to facilitate learning. The interactive lectures for the students are mostly on subjects such as biotechnology, biodiversity, information technology, health and diseases, global warming and greenhouse effect, types of pollution and rainwater harvesting.

A unique "Touch and Smell" garden has been developed in the Chennai campus for visually impaired people to experience the joy of nature and learn by exploration through the senses of touch and smell. Apart from children from the blind schools, visually impaired adults from various NGOs also visit the garden and MSSRF has been imparting training for establishment of similar gardens in different blind schools

Workshops conducted by MSSRF have focused on issues and legislations in relation to bioresources conservation and enhancement, namely, the Biological Diversity Act 2002 and the Protection of Plant Varieties and Farmers Rights Act, 2001. Participants of the workshops have been exposed to various concerns such as the cultivation of *Kalajeera* rice, *Navara* rice, millets and pulses; the concept behind setting up of community gene/ seed/ grain banks; the importance of community rainwater harvesting systems; and the value of vermicomposting. In addition, MSSRF has conducted four-week, residential vacation training programmes for school students. Field trips to biodiversity-rich areas have been organised and students sensitised on the need and implications of biodiversity conservation. These programmes have been mainly designed to increase awareness on environmental challenges and inculcate a scientific temper among students; and such programmes have been conducted in Chennai, Odisha and Kerala.

Genome Shikhha (Genomic Flame) a bimonthly magazine in Odiya is printed and distributed (2000 copies) regularly in the town of Jeypore. The Genome Club members run this magazine by themselves, and contribute articles and poems. Some of the students have started genetic awareness campaigns on their own in their villages and schools. The participants have been able to develop and maintain village-level bioresource registers. Genome Club members have also organised various competitions in their schools to spread awareness on biodiversity and bioresource conservation.

Impact

Impressed by the popularity of the Genome Clubs, the Department of Biotechnology announced a National Programme and launched DNA Clubs in schools across India. MSSRF played a crucial role in developing the modalities for establishment of the DNA Club programme and also coordinates it in Andhra Pradesh, Tamil Nadu, Kerala, Karnataka, Puducherry, Andaman and Nicobar Islands and Odisha, in partnership with leading organisations.

FARM SCHOOL: FARMER TO FARMER LEARNING

One of the key recommendations of the National Commission on Farmers is the establishment of Farm Schools in outstanding farmers' fields for effective technology dissemination and revitalisation of the agricultural extension system, which would help in enhancing incomes. Such schools foster self-directed farmer-to-farmer learning based on the principles of learning by doing as well as seeing and believing. Exchange of 'knowledge' among the farming communities leads to finding locally-relevant solutions to needs and problems faced.

MSSRF has established 5 Farm Schools: two in Tamil Nadu and one each in Odisha, Kerala and Maharashtra. These schools have been set up in land donated by progressive farmers who host the training programmes. In Tamil Nadu, the farm school in Thanjavur district has been constructed on land provided free of cost by Mrs. Kalaivani Rajendran in Pasupathikovil village. In Dindigul district, the farm school is hosted by Mr. and Mrs. Kalaiselvan of Meignanapuram village, an innovative and recognised small farmer couple and shareholders of the Reddiyarchatram Sustainable Agricultural Producers Company limited (RSAPCOL). In Odisha, the farm school has been established on the farm of Mr. Gobinda Ghiuria, a progressive farmer of Nuaguda village in Lima panchayat of Kundura block. In Wayanad, Kerala, construction of the farm school has been on Mr. Eldho Baby's farm at Idiyamvayal, Pozuthana gram panchayat. In Maharashtra, a farmers' training school has been set up on the premises of Sri Sant Lahanuji Maharaj Sansthan in Takarkhed village, Wardha district.

The objective in these schools is to impart a sense of grass-roots realism to the capacity building programmes by facilitating horizontal networks among men and women farmers in enhancing

skills on improved agronomic practices. The host farmers are small and marginal landholders predominantly adopting the integrated farming system approach. The learners at the farm schools are small and marginal farmers too. The process supports interactive learning in which the 'trainer' and 'trainee' learn from each other. The role of the 'trainer' and 'trainee' becomes fluid in such a process where a 'trainee' at one point of time becomes the 'trainer' and 'trainer' at another point of time becomes the 'trainee'. Each school has the capacity to train 30 to 50 farmers at a time, with facilities for separate accommodation for men and women farmers.

The learning methods are (i) learning based on hands-on experience, (ii) observations in the field, (iii) group interaction, and (iv) sharing experiences with peer groups. The network continues and farmers mutually share their experiences to fine-tune the technologies according to their context. Each farm school adopts different methods to institutionalise the interventions. The knowledge workers from the regional Village Knowledge Centres facilitate the sessions in partnership with the farm school on a regular basis according to the crop and seasonal conditions.

In the process of customisation of agricultural technologies, farmers integrate the formal knowledge and the tacit oral knowledge into a combined package. It enables the ability of the farming community to manage the agricultural knowledge and information system. Learning objectives of farm activities are not limited to those of the work field alone, but also include interactive and empowerment domains. The farm schools play a vital role in bringing the different partners together: the agricultural department, universities, service providers and researchers become partners in the interactive learning process rather than being mere providers of new knowledge. Such continuous support builds stronger horizontal networks as well as trust among farmers, both of which are critical factors in technology transfer and dissemination.

TRAINING SCHOOL FOR GRASSROOTS ACADEMICIANS

"A candle which is not lit cannot light others; A teacher who is also not learning cannot teach others"
- **Rabindranath Tagore, *Gitanjali***

The National Virtual Academy (NVA) Training School was launched in February 2007 to meet the emerging needs of NVA Fellows, telecentre managers/ operators and stakeholders across rural India by undertaking appropriate and systematic capacity development programmes, including on-site and off-site training programmes.

The NVA training school has been actively engaged in telecentre.org initiatives, by designing and extending appropriate capacity building measures to strengthen knowledge and skills of telecentre managers and operators, leading to sustainable rural development. National and regional level consultations have been organised involving key players to map the needs of telecentre managers and operators in order to design appropriate courses. The outcome of these exercises facilitated the development of appropriate curriculum and need-based training programmes, including community needs assessments, alternate energy sources, e-forums, Training of Trainers, etc. Counseling sessions have also been conducted for telecentre operators. Learning materials for the course on telecentre management have been developed in Tamil and Malayalam in collaboration with Indira Gandhi Open University (IGNOU). In partnership with Welthungerhilfe, one of Germany's biggest private organisations for development aid, potential NGOs in Tamil Nadu, Andhra Pradesh, West Bengal and Odisha have been trained in establishing Village Knowledge Centres in their respective project coverage areas.

NVA has been mandated to recognise rural men and women who are actively engaged in their communities as "grass-roots academicians" and award them the NVA Fellowship. NVA Fellows are involved in a kaleidoscope of development activities and stay abreast of the latest developments in various sectors, and possess necessary skills to negotiate for change. The training school undertakes activities such as a} regular participatory knowledge management workshops to map expertise and needs of NVA

Fellows at the national level; b) creation of a helpdesk at MSSRF at Chennai; c) need-based phone-in programmes on major livelihoods and government entitlements; d) skill-building training programmes on topics related to agriculture, media, soft skills, etc. It also puts some of the State-level resource-based organisations, Village Resource Centres and other institutions in touch with NVA Fellows.

MSSRF- IGNOU Community College

Mainstream education often fails in the case of tribal and poor rural populations, especially because of poor accessibility, high costs and rigidity in the teaching-learning process. In this context, the community college model introduced under the Indira Gandhi National Open University (IGNOU) is an alternative system of education, intended to provide seamless education at different levels such as certificate, diploma and degree, with provision of multiple entries and exits. The Foundation has partnered with IGNOU in 2010 to establish the MSSRF-IGNOU Community College at Jeypore, to make education feasible and affordable to the tribal and other deprived classes of people living in the remote areas of Koraput district.

The college has identified and initiated programmes and courses based on need analysis and social survey of local requirements. Short-duration vocational/skill enhancement courses and training programmes have been undertaken in horticulture, watershed management, computers, etc., to make the large number of unskilled workforce as well as college/school dropouts in the locality educated and suitable for employment. Special efforts are made to bring them to the graduate level after undergoing a special preparatory course. The overall intellectual development of the students is ensured through hands-on experience, exposure visits, workshops, special lectures, etc. Besides academic development, initiatives are taken to encourage extracurricular activities such as sports and games, essays, debates and quiz competitions.

For the convenience of the students of remote villages who are unable to travel to the college at Jeypore, a satellite learning centre has been set up at Kaudiaguda, Kundra where classes are held regularly.Some of the educational programmes of the MSSRF-IGNOU Community College have become so popular that government agencies like the Integral Tribal Development Agency have been sponsoring students belonging to the ST community to these courses for the last two years. The College took part at the National Convention of Community Colleges at New Delhi which led to the Principal being invited as the only delegate from Odisha to the World Education Summit held at New Delhi in 2011.

RESOURCE CENTRE FOR GENDER AND DEVELOPMENT

"We talk about poverty across societies, and no-one raises any problems. We talk about gender subordination across societies, and people cry cultural imperialism!"- White

The Uttara Devi Resource Centre for Gender and Development was set up in 1997 in order to mainstream gender concerns within MSSRF. The core objective was to promote the incorporation of gender issues and the idea of gender equity in research and action related to development, with special emphasis on rural and agricultural development. The sub-objective was to encourage, maintain and develop gender perspectives in all the activities and programmes undertaken by the Foundation.

Core activities

Research studies, interventions in curriculum design and opening up platforms for discussing current and burning issues related to gender have been some of the main pursuits of the Resource Centre. One of the outstanding outcomes is the work on gender issues related to biodiversity. Starting with the book *Gender Issues in Biodiversity Management* in 1997, the first of its kind worldwide which has stimulated more such studies globally, there have been a series of studies and publications focusing on women's contributions to biodiversity conservation and management. These have covered a wide range of topics:

Women's Participation in Panchayati Raj: A case study from Tamil Nadu

Paddy in the Rocks: Gender roles and local institutions in Kolli Hills

Studies on wild food management and the effect of changing cropping patterns on the use of wild edibles and on gender roles and responsibilities

Studies on gender and food security dimensions of rice-farming livelihood systems in the seven North-Eastern states; "Gendered Price of Rice" was published in the *Economic and Political Weekly* June 2005.

Climbing a Long Road: Women in Agriculture in India: Ten years after Beijing — Review paper to assess the progress of women in India with special reference to agriculture and natural resource based livelihoods

Contributions to a collection of invited papers *Gender, Food Security and Rural Livelihoods*

Gender and Social Inclusion for Sustainable Livelihoods, the outcome of a consultation on technology development and delivery models for sustainable livelihoods

In addition, to commemorate the International Rice Year 2004, workshops were organised on the broad theme of Gender, Rice and Food Security. Also, a research methodology course in women's studies was arranged in 2006 for post-graduate women scholars in Tamil Nadu and Puducherry.

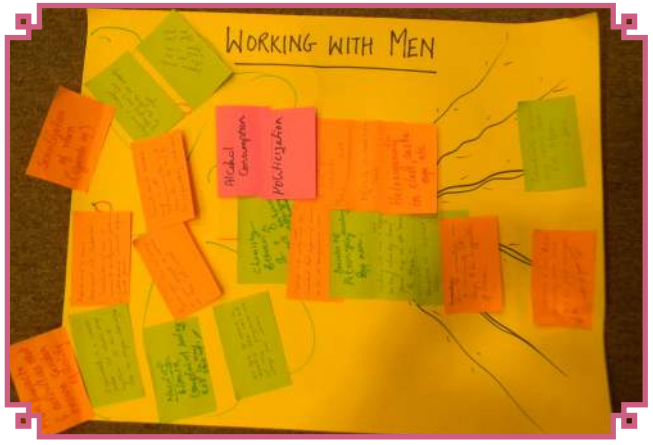
To bring greater sensitivity to gender issues in agricultural research, teaching and extension systems, the Centre, in partnership with the Centre for Studies on Gender Concerns in Agriculture (CSGCA), Kerala Agriculture University, initiated the work to develop a curriculum for integrating gender in agriculture studies at the undergraduate level. This initiative was done through a series of discussions and workshops. New linkages were established with Gandhigram Rural University and Krishi Vigyan Kendras for engendering the agricultural studies curriculum.

Internalisation of gender across MSSRF programmes

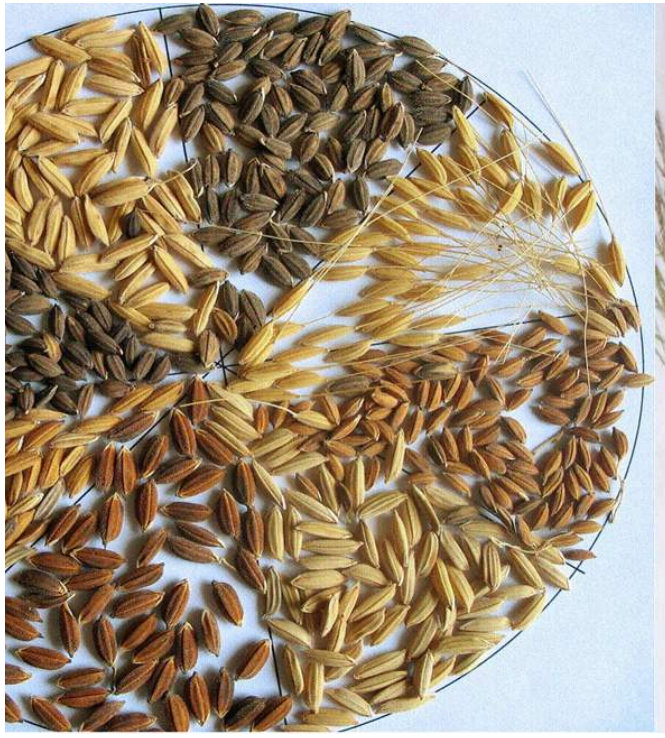
The process of integrating the gender dimension in all projects and activities of the Foundation was started with the setting up of forums, organising training and capacity building programmes, and facilitating evaluation and gender audits. A Gender Task Force was set up in 1997 as an inter-project group for sharing information and exchanging ideas, documenting progress, developing research tools and indicators, planning training programmes and mobilising external resource expertise. In 1999, the Gender Advisory Committee was set up to advice the Executive Director and management on gender issues. The committee provided inputs for two specific aspects of policy: internalisation of the gender dimension in all projects and gender-sensitive personnel policies. Under the latter, institutional focus was provided to employment policy, support services, gendered work culture and behavioral norms; a gender cell was set up to deal with harassment and victimisation. The Gender Concerns Forum was initiated to share concerns, queries, information and experiences relating to gender in all programmes. Most importantly, from 1997 to 2007, the Centre has organised several need-based orientation and sensitisation workshops, training and capacity building programmes for better integration of gender in the project cycles across MSSRF Programme Areas.

An informal review was carried out during 2009-2010 on the strategies adopted by the Centre over the decade since its inception. The review was followed by a workshop on 'Gender Integration and Mainstreaming Strategies at MSSRF: Moving Forward' in March 2010. As an outcome of the workshop, strategy was revisited and a GIM (Gender Integration and Mainstreaming) group was formed in April 2010 consisting of around 18 members across Programme Areas.

The Resource Centre for Gender and Development works in partnership with other initiatives in MSSRF in mainstreaming gender at the institutional and programme area level in a comprehensive manner.



ASSESSING SPECIES DIVERSITY USING MOLECULAR MARKERS



The development of molecular techniques for genetic analysis has led to much augmentation in the knowledge of crop genetics and the understanding of the structure and behaviour of the genomes of many species. DNA molecular markers are therefore versatile tools to assess and analyse the genetic architecture of species, understand the nature and extent of genetic diversity within and between the populations of plant species, as well as at the intra and inter-specific level.

Diversity and phylogeny

At MSSRF, molecular marker-based studies were undertaken to study the diversity and phylogeny among the mangroves and other crop species in order to identify key species/ genotypes for conservation and maintenance of diversity at field and habitat levels. RAPD (Random Amplification of Polymorphic DNA), RFLP (Restricted Fragment Length Polymorphism), AFLP (Amplified Fragment Length Polymorphism), SSR (Simple Sequence Repeats) and ISSR (Inter Simple Sequence Repeats) molecular marker techniques were used to determine the phylogeny, diversity both at intra- and inter-population and species levels. Nine peer-reviewed publications — the first published reports on molecular phylogeny of mangroves — have contributed to the literature in understanding the detailed genetic architecture of the mangrove species.

Diversity assessment studies

Inter-specific and intra-specific variations were analysed, using RAPD, RFLP, PCR-RFLP of chloroplast and mitochondrial regions and AFLP markers, in most of the abundant species of mangroves found along the Indian coast, namely, *Avicennia species, Rhizophora species, Acanthus ilicifolius* and *Excoecaria agallocha*. An interesting study was done to identify the parentage of a *Rhizophora* hybrid using a mitochondrial genome specific probe, through RAPD & RFLP markers. *Rhizophora apiculata* and *R. mucronata* had 96.5 per cent similarity with that of the hybrid and the RFLP profile of *R. apiculata* was exactly the same as that of the hybrid, establishing its maternal status for the hybrid. Ten species belonging to 4 genera of the mangrove tribe *Rhizophoreae* were analysed for species identification and genetic relationship using 9 mitochondrial gene probes.

Though the component species of each genus were clustered together, a high degree of heterogeneity was observed among 4 species of genus *Rhizophora* and 3 species of genus *Bruguiera*. Species-specific profiles were obtained for all the species in various probe-

enzyme combinations. Extensive collection helped document the genetic fingerprint in *Pennicetum typhoides* and related species using 13 accessions collected from different states of India; and 8 wild species of the genus *Pennicetum* revealed that the samples from western Indian collections contributed significantly to the overall diversity among the accessions.

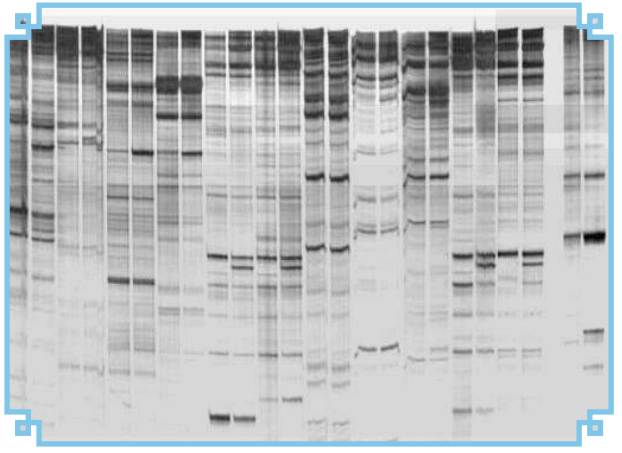
A detailed analysis of 49 Indian rice accessions — including 29 landraces from the Jeypore tract, 12 modern cultivars, and 8 traditional cultivars from Tamil Nadu — revealed that genetic diversity was higher in the modern cultivars than in the traditional ones and that the process of breeding modern cultivars did not appear to cause significant genetic erosion to the extent of diversity.

A similar study was done in *Cajanus* landraces using RFLP and PCR-RFLP markers among 30 accessions and 10 wild species. AFLP markers were used to study genetic diversity in 26 landraces of black gram, *Vigna mungo* and the analysis revealed that 3 samples contributed significantly to the overall diversity of the landraces studied.

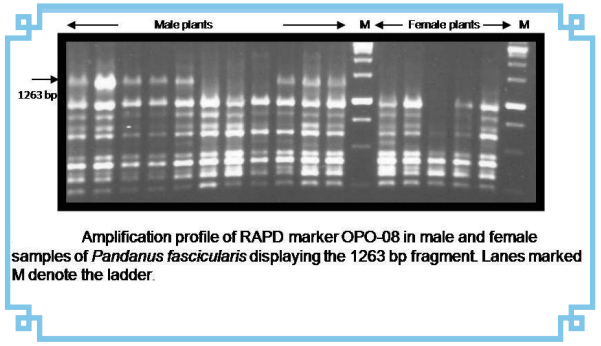
Among all the 7 minor millet species, 119 accessions were analysed through PCR-RFLP and species-specific banding profiles were obtained. MSSRF's work showed that digestion of the chloroplast gene regions trnS-psbC with 2 four-base-recognising enzymes may be a method of choice for species-specific identification in many species. Similarly, species-specific AFLP profiles were obtained in 10 primer combinations as well.

A male specific marker has been identified in *Pandanus fascicularis* using RAPD and ISSR markers, which was later converted into a SCAR (sequence characterised amplified region) marker. Of the 89 RAPD and ISSRs used, one decamer consistently amplified a 1263 bp band in the males which was absent in the females. As there is no information on the presence of sex chromosomes in *Pandanus*, this marker can be used to differentiate the sexes at an early stage. This work is extremely useful in identifying the male plants which are preferred due to their economic value.

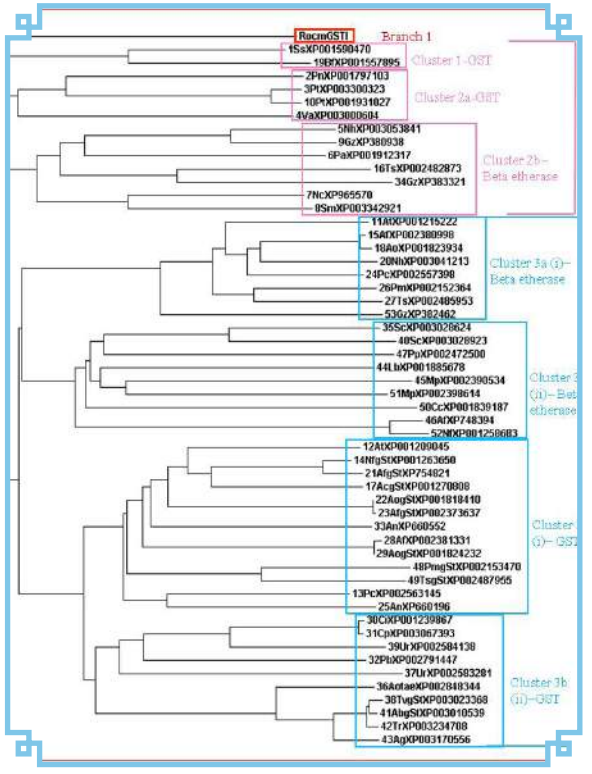
MSSRF is focusing on studying the diversity among the nutritionally important *Moringa oleifera* populations in India. This study is important to identify genetic diversity



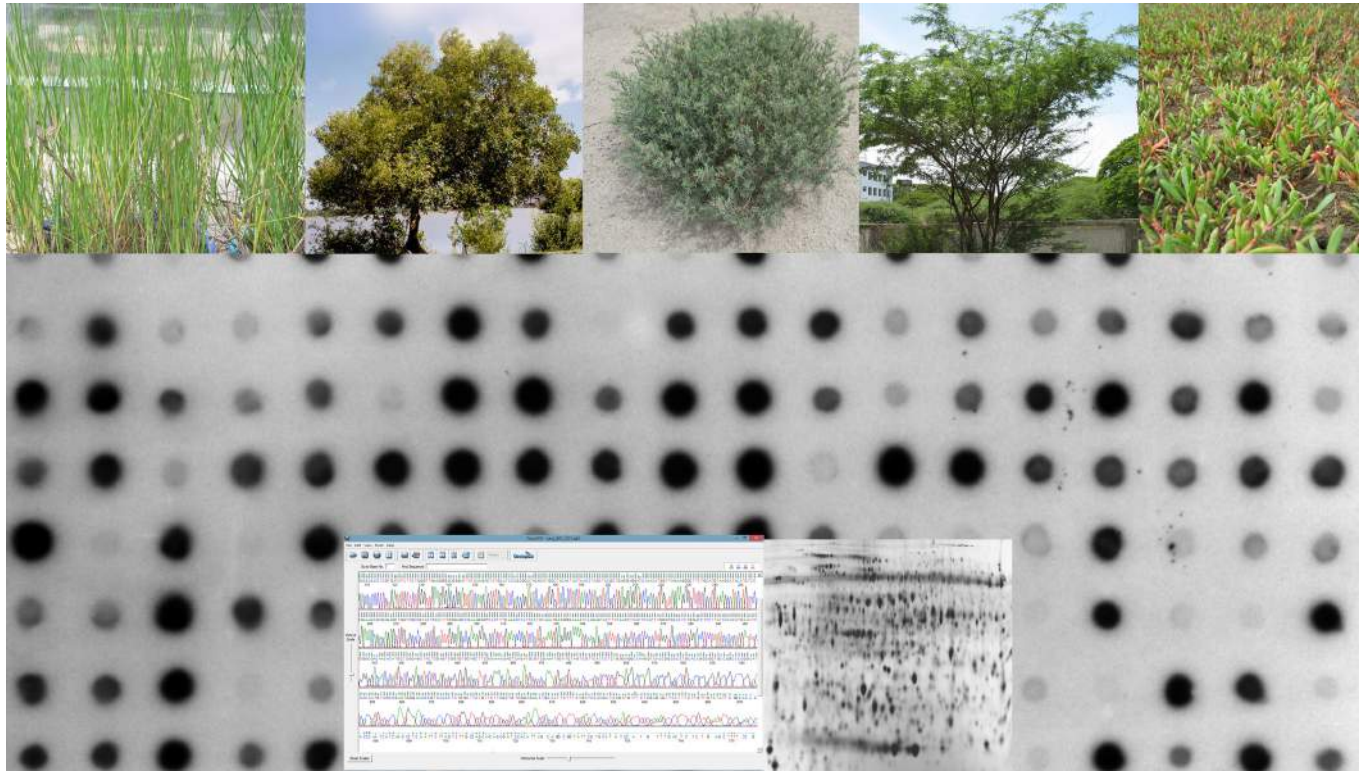
in *M. oleifera* for the development of genetically distinct germplasm and for conservation purposes. MSSRF has analysed a large number of accessions from different districts in Odisha, Andhra Pradesh and Tamil Nadu for iron content, phenotypic differentiation based on seed character, and diversity analysis using SSR markers.



Amplification profile of RAPD marker OPO-08 in male and female samples of *Pandanus fascicularis* displaying the 1263 bp fragment. Lanes marked M denote the ladder.



UNRAVELING PLANT DEFENCE MECHANISMS TO ABIOTIC STRESS



Agricultural productivity is majorly impacted by various abiotic stresses, particularly from salinity and drought. MSSRF chose to work on halophytes as these grow very luxuriantly even in extreme saline soils and are an excellent source for genetic combinations that can be incorporated into developing improved crop varieties,. Abiotic stresses cause accumulation of key enzymes of the degradation pathway, polyamines, and synthesis of osmoprotectants and antiporters. Most of the abiotic stresses trigger a similar cascade of genes, and therefore any one or more stress-tolerance mechanisms is likely to render the plant tolerant to many other abiotic stresses.

Isolation and characterisation of genes

In order to isolate and characterise the genes responsible for abiotic stress tolerance, MSSRF selected species with natural tolerance to salinity and drought stress conditions. Studies were undertaken with the mangrove species *(Avicennia marina, Porteresia coarctata, Sesuvium portulacastrum, Suaeda maritima*), other economically important species (*Prosopis juliflora, Pandanus fascicularis, Jatropha curcas*) and the lichen species (*Roccella montagnei*).

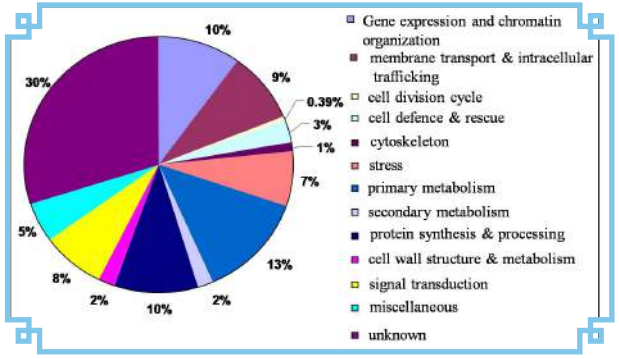
Random expressed sequence tag (EST) sequencing of 1841 clones from the salt-stressed Avicennia marina leaf library revealed that ~30 per cent were novel cDNAs with no homology to any previously characterised genes in the public databases. In other words, it means that 30 per cent of genes expressed in stressed A. marina plants are unique genes that have not been reported or found in any other species. Reverse northern analysis of 52 genes revealed that 26 genes were up-regulated and five genes were down regulated under salt stress, indicating clear roles in conferring saline tolerance to the plant.

EST sequencing of 1750 clones produced 1467 high-quality reads from the stressed *P. juliflora* leaf library which is highly adapted to dry, saline coastal areas and has overtaken large parts of the estuarine ecosystem in many parts of India. These genes were classified into functional categories, and comparison with the public databases revealed that 114 genes were homologous to genes already reported in stress response(s) and included heat shock proteins, metallothioneins, lipid transfer proteins, and late embryogenesis abundant proteins. Of the ESTs analysed, 26 per cent showed no homology to previously uncharacterised genes in the

public databases. Fifty-two clones from this category were selected for reverse Northern analysis — 21 were shown to be up-regulated and 16 down regulated under stress.

In an effort to identify flowering as well as putative sex-specific genes, a cDNA library was constructed by isolating good quality, high concentration total RNA from a fresh flower of Pandanus. A total of 979 flower-specific ESTs were thus obtained. Several putative sex-specific genes like pollen specific protein, Arabinogalactan, MADS-box transcription factor, LIM transcription factor, profilin, etc., were isolated.

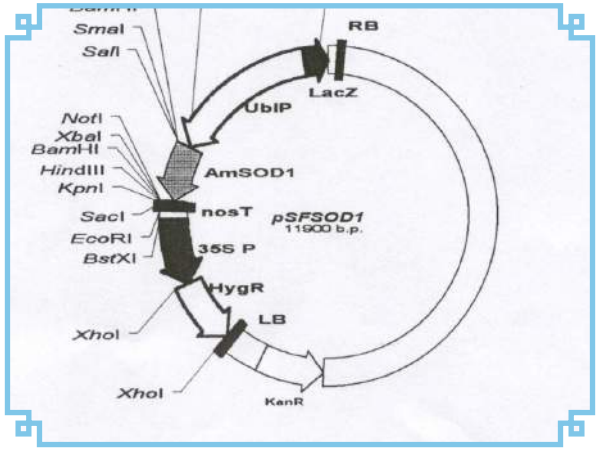
Roccella montagnei was the first genome sequencing of



lichen, for potential gene mining for biotic and abiotic stress tolerance, secondary compound synthesis and the molecular basis of symbiosis. In all, 1097 ESTs were characterised from cDNA library of R. *montagnei* out of which 812 ESTs are found to be unknown, i.e., do not show any homology to any reported genes. Full length gene of size 8,162bp with all active domains encoding the polyketide synthase gene (DnPKS) from lichen *Dirinaria applanata* has been characterised. DnPKS mRNA showed an induced expression in D. *applanata* cultures exposed to UV radiation, neutral pH and 4 per cent mannitol.

Characterisation of promoters

Promoters are regions of DNA that facilitate the transcription of a particular gene, and are typically located upstream of the genes they regulate. They represent critical elements that work in coordination with other regulatory regions (enhancers, silencers, boundary elements /insulators) to regulate the level of transcription of a given gene. One of the extensively studied promoters in MSSRF's laboratory is

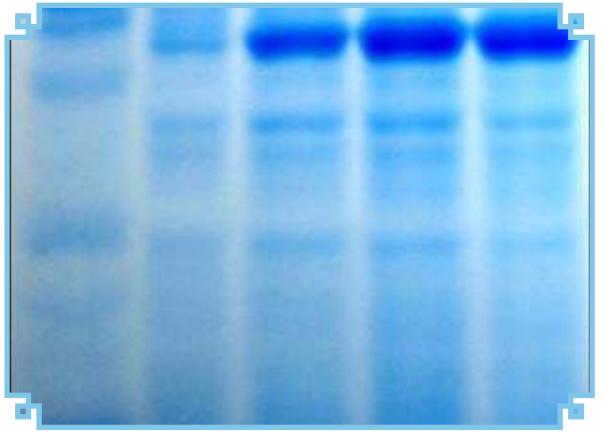


Am244 from *A. marina*. Deletion studies of the native promoter has been done, which will be compared with the commercially available universal promoters, for efficacy of expression under stress. Many native promoters have been isolated and are under various stages of screening.

Small non-coding RNAs appear to be crucial regulators of both transcriptional and post-transcriptional gene silencing under stress. A comprehensive list of micro (m) RNAs from an organism will accelerate the progress to the understanding of the stress response pathways. Understanding protein-protein interactions is important as also the proteomics approach for structural and functional predictions in stress-tolerant phenotypes. MSSRF has therefore initiated preliminary work on study of these RNAs in mangroves and in pearl millet.

Understanding of protein-protein interactions

A study using 3 halophytes, namely, *Sesuvium portulacastrum, Salicornia brachiata* and *Suaeda maritima* that can tolerate high concentrations of soil salinity is being carried out to understand molecular mechanisms of salt tolerance. Difference in gene expression is monitored using subtractive hybridisation at the mRNA level while two-dimensional gel electrophoresis is used to monitor protein level changes. Such an effort is expected to result in the identification of potential genes that can be used in future to transform salt- sensitive crop plants for salt tolerance.



DEVELOPING STRESS TOLERANT CROP VARIETIES

Global agricultural productivity is severely affected by the increasing impact of abiotic stress factors such as drought, salinity, water stress, etc. Research initiated at MSSRF employing modern biotechnological tools aims at developing location-specific crop varieties with resistance/tolerance to abiotic stress conditions. MSSRF has begun an anticipatory research programme for developing location-specific crop varieties offering tolerance/resistance to coastal salinity which has now become a serious issue of concern in about one-third of farmland. Novel genetic combinations isolated and identified from mangrove species (*Avicennia marina, Porteresia coarctata*) were characterised and mobilised into rice for developing transgenic crop varieties. Limited field trials of the transgenic rice varieties containing mangrove genes have been undertaken under contained conditions. MSSRF has isolated 50 full-length genes from the mangrove species, *Avicennia marina* as also a number of partial clones, for abiotic stress conditions.

Isolation of novel genetic combinations

AmSOD1, a cDNA encoding a cytosolic copper zinc superoxide dismutase was isolated from the mangrove *A. marina* and cloned into a plant expression vector (pCAMBIA 1300) and transformed into *indica* rice. Southern hybridisation analysis of transgenic rice plants revealed stable integration of the *Am*SOD1 transgene in the rice genome. The transgenic plants withstood salinity stress of 150 mM of NaCl whereas the untransformed control plants wilted at the end of the stress treatment in hydroponic assays. The transgenic plants also revealed better tolerance to drought stress in comparison to untransformed control plants.

For pot experiments, untransformed control and homozygous transgenic plants were used for assessing extent of tolerance to salinity and drought stress. Forty-day old plants grown in pots were watered with salt water (100 mM NaCl) every 4 days. For drought stress treatment, the transgenic plants were grown in pots for a period of 50 days under a normal watering regime. Drought stress treatment was by providing irrigation every fourth day. Transgenics generated with SOD1 were crossed using plant breeding technologies and were introgressed into locally-adapted rice varieties (IR 20, ADT 43, IR 60 and Ponni). BC4F1 plants were analysed through PCR analysis for identification and selection of positive plants. Homozygous plants have been identified and analysed for their morphological, molecular and physiological traits. Three limited field trials were also conducted with the approval of the

regulatory authorities of the Government of India. This is the first report on the transfer of a gene isolated from a mangrove to rice that has showed increased tolerance to salinity stress and drought stress.

Following the same approach, transgenic rice varieties have been developed for a number of novel genetic combinations isolated and characterised from mangroves and *Prosopis juliflora*. They include transgenic rice with antiporter gene NHX1 from *Porteresia coarctata,* overexpression of two antioxidant genes through pyramiding, ascorbate peroxidase and monodehydroascorbate reductase (APX and MADR), glutathione S transferase (GST), transcription factor genes (NAC, MYB), dehydrin, Am 244, etc. Encouraging leads were obtained in pot experiments conducted

with transgenics which expressed both APX and MDAR from A. marina. The idea was to study the tolerance to salinity of transgenics overexpressing both these genes. The rice plants could withstand 200 mM salinity in greenhouse experiments. Transgenic rice with transcription factors and dehydrin genes and membrane proteins like Am 244 are at various stages of screening for efficacy in conferring saline tolerance to rice plants.

Biofortification of rice

Iron deficiency is estimated to be prevalent in about 30 per cent of the world's population, making iron by far the most widespread nutrient deficiency. MSSRF used endosperm specific promoter for transformation of elite indica rice varieties with the ferritin gene from *A. marina*. Homozygous pure lines in local rice varieties have been raised. Assessment of iron content in polished rice revealed three times more iron compared to the non-transformed lines. Currently, the focus has been on isolating and transferring genes involved in transport of iron.

Metallothioneins in heavy metal accumulation

P. *juliflora* grows well in heavy metal laden industrial sites and accumulates heavy metals. To understand the possible contribution of metallothioneins (MTs) in heavy metal accumulation in P. *juliflora*, MSSRF isolated and compared the metal binding ability of three different types of MTs (PjMT1-3). PjMT1 and PjMT2 are induced by copper and zinc, respectively, while copper, zinc and cadmium induce PjMT3. Of the three MTs analysed, PjMT1 shows maximum heavy metal sequestration and is thus a potential candidate for use in phytoremediation of soils contaminated with heavy metals, apart from conferring tolerance to salinity.

Promoter efficacy in transgenic plants

Using β-glucuronidase (GUS) reporter gene fusions, MSSRF has characterised the expression patterns in transgenic tobacco of several strong constitutive promoters, several numbers of gene promoters, and inducible promoters from *A. marina*, *P. coarctata* and *P. juliflora*. Promoter sequences upstream of PcNHX (Na+/H+ antiporter) from *P. coarctata*; PR244, a salt inducible gene from the mangrove A. *marina*; MYB1 transcription factor from *A. marina*; ascorbate peroxidase from *A. marina*; lipid transfer proteins from *P. juliflora*; atypical LEA protein from *P. juliflora;* photosystem II PsbR from P. *juliflora;* and metallothioneins from P. *juliflora* are some of the native promoters cloned and transformed into model plant systems for studying their efficacy. Current work is on the comparative efficacy of these promoters with other available universal promoters under salinity and drought stresses.

Subject to Government of India approval, MSSRF has sufficient seeds of these transgenic materials for large scale multi-location trials for evaluation of the genes in different local varieties of rice.

MICROPROPAGATION OF RET AND MANGROVE SPECIES

The economic justification for preserving biological diversity is that many species of wild plants are undeveloped resources — that is, they have significant economic potential that is currently undiscovered, undervalued or under-utilised. At MSSRF, conservation of rare and endangered plants have been given priority and scientific research outputs have contributed to the conservation starting from collection to propagation, and on to re-introduction. So far, scientists of MSSRF have developed protocols for propagation of more than 15 species of plants that are vulnerable, rare and endangered, including *Casearia rubescens, Ceropegia bullbosa var lishii, Ceropegia jaini, Crotolaria logipes, Freria indica, Kaempferia glanga, Myxopyrum serratulum, Piper barberi, Rauwolfia micrantha, Rauwolfia tetraphylla, Syzygium travancoricum* and *Uraria picta*. These have been successfully transferred to the field. MSSRF carried out a comprehensive

genetic fidelity analysis of the micro-propagated plants to confirm their genetic uniformity with the parent material and also to assess their stability in the field.

MSSRF has also undertaken studies on ecological restoration of mangrove habitats that are degraded. Micropropagation protocols for 4 mangrove species and vegetative propagation protocols for over 14 species have been successfully developed and field transferred into the Pichavaram mangrove forest area. These include protocols for mangrove species such as *Acanthus ilicifolius, Avicennia marina, Avicennia officinalis, Excoecaria agallocha, Intsia bijuga, Porteresia coarctata* and *Sesuvium portulacastrum.*

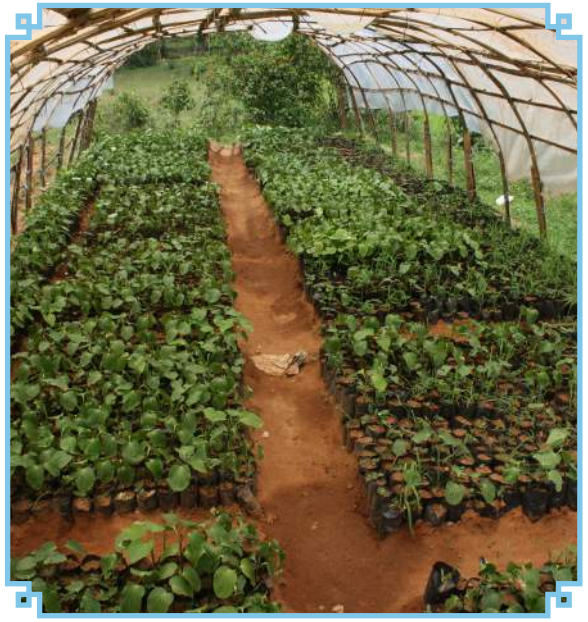
Eco-restoration initiatives

The programme on eco-restoration and dryland

agriculture was designed to integrate sustainable management of natural resources with the livelihood security of the rural communities of the coastal regions. The main objective was to evolve models of sustainable development in the coastal regions through mutually-reinforcing linkages among the rural communities with ecological security of the coastal regions. These initiatives were undertaken in the Kudankulam, Chidambaram and Kalpakkam regions in Tamil Nadu. Kudankulam is characterised by extremely low rainfall and harsh climatic conditions. The rain-shadow, water-scarce region was considered as uncultivable and left barren. MSSRF initiated the green belting of the area with economically important species (neem, tamarind, etc.) in 48 acres. An experimental-cum-demonstration plot in about 8 acres was developed specifically for rain-fed agricultural crops, based on the integrated intensive farming model that emphasised critical water use efficiency, forward and backward linkages, organic farming and low-input agriculture. Demonstration and testing the local adaptation and yield performance of the mutant varieties in groundnut (TG24, TG26), black gram (TU–1) and green gram (TARM-1) developed at the Bhabha Atomic Research Centre proved significant. Based on the detailed soil survey, a land suitability map was developed for three villages in the Kudankulam region. Three rainwater-harvesting repositories based on contour mapping have been developed along the demo plot and green belt. Seed multiplication was done in Kalpakkam and distributed to 6 surrounding villages.

Experiment in biofuel crop development

The development of bio fuel crops is an alternative source for energy production, given that India has large wastelands that can be utilised for bio fuel crops cultivation. The Department of Biotechnology's Micro Mission on Jatropha aims at identification of elite planting materials. Over 404 accessions of *Jatropha curcas* were collected from various climatic conditions in Tamil Nadu and selected for specific characters — seed yield, disease resistance, drought resistance, oil yield, etc. *Jatropha* conservation gardens have been established in Tamil Nadu (1.5 ha), Orissa (1 ha) and Puducherry (0.5 ha) with 234 of these accessions. Mass multiplication through seed, standardised tissue culture and vegetative propagation protocols were utilised for mass scale up. Seed production orchards were established in three states for evaluation. MSSRF contributed 7 accessions of the 20 accessions selected for national multi-location network trials.



BIOMONITORING FOR ECOSYSTEM HEALTH WITH LICHENS

Globally, ecological data on lichen (fungi living symbiotically with algae or cyano bacteria) diversity and lichen species distribution are used as indicators to monitor, assess and report the current status and changing trends of ecosystem conditions in response to climate change, habitat modifications and environmental contamination.

Bio-monitoring initiatives

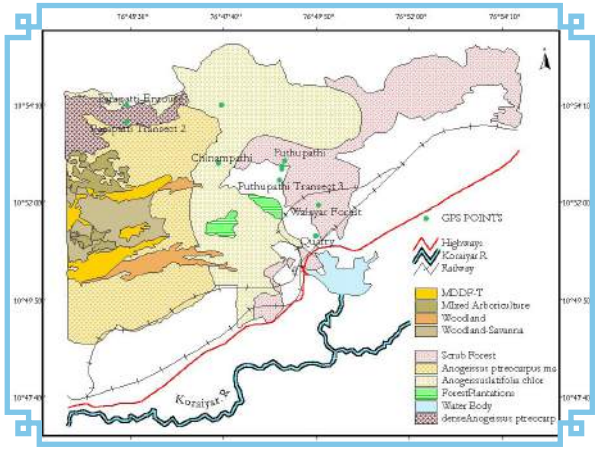
MSSRF is focusing on developing location- and perturbance-specific bio-monitoring tools using lichens to assess the health of mangroves and various forest types in the coastal Eastern and Western Ghats. At the national level, lichens have received scanty attention and checklists have been made based on cursory collections. This data was insufficient to devise a proper lichen bio-monitoring programme. Hence, at the initial stages the main focus of lichen research was to rapidly assess the lichen species diversity in the focused forest ecosystems.

Contours of lichen research sites

The chosen sites represented a sequence of ecosystems with altitudinal gradients ranging from tidal forests to forest types at an altitude of 1800 m (hill tops of the Western Ghats) and provided the baseline that gave an outline of the lichen diversity of this region. The gross distribution pattern of prominent lichen species was also revealed. Studies showed up the subsets of lichen diversity, namely, lichens colonising tree barks, rocks, soil and, interestingly, the leaf-colonising species which can be effectively used in bio-monitoring. The diversity and ecological studies have resulted in the discovery of a new species *Lichenopeltella swaminathaniana* from Kolli Hills and added several new lichen records. MSSRF maintains a lichen reference collection with around 4000 specimens, representing species from the mangrove forests and the southern Eastern and Western Ghats.

Ecosystem health monitoring using lichen diversity and distribution pattern

MSSRF used the large-scale ecological data on lichen diversity and its distribution pattern to assess the impacts of management practices in select forest types. The site- specific large-scale ecological data on lichen diversity, distribution pattern and key characteristics of the ecosystem, such as vegetation structure, were used to place the results of the lichen monitoring programme on a secure (statistically acceptable) scientific base, to

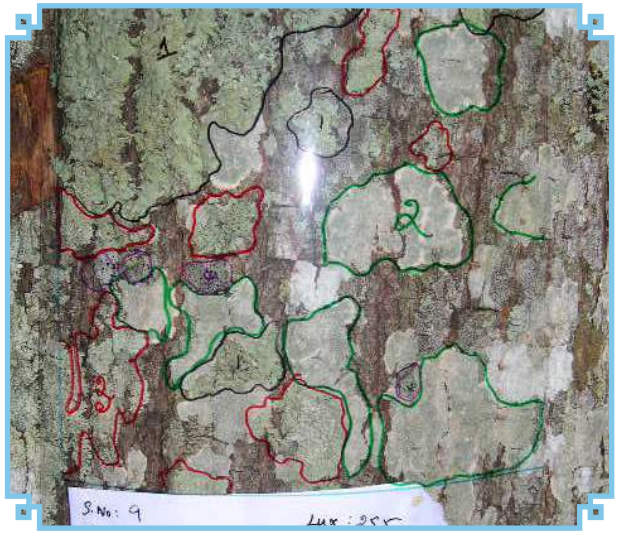


assess the status of the mangroves, and also portions of the Western Ghats. The lichens of Chennai city were surveyed to understand their relationship with air pollution and land use pattern.

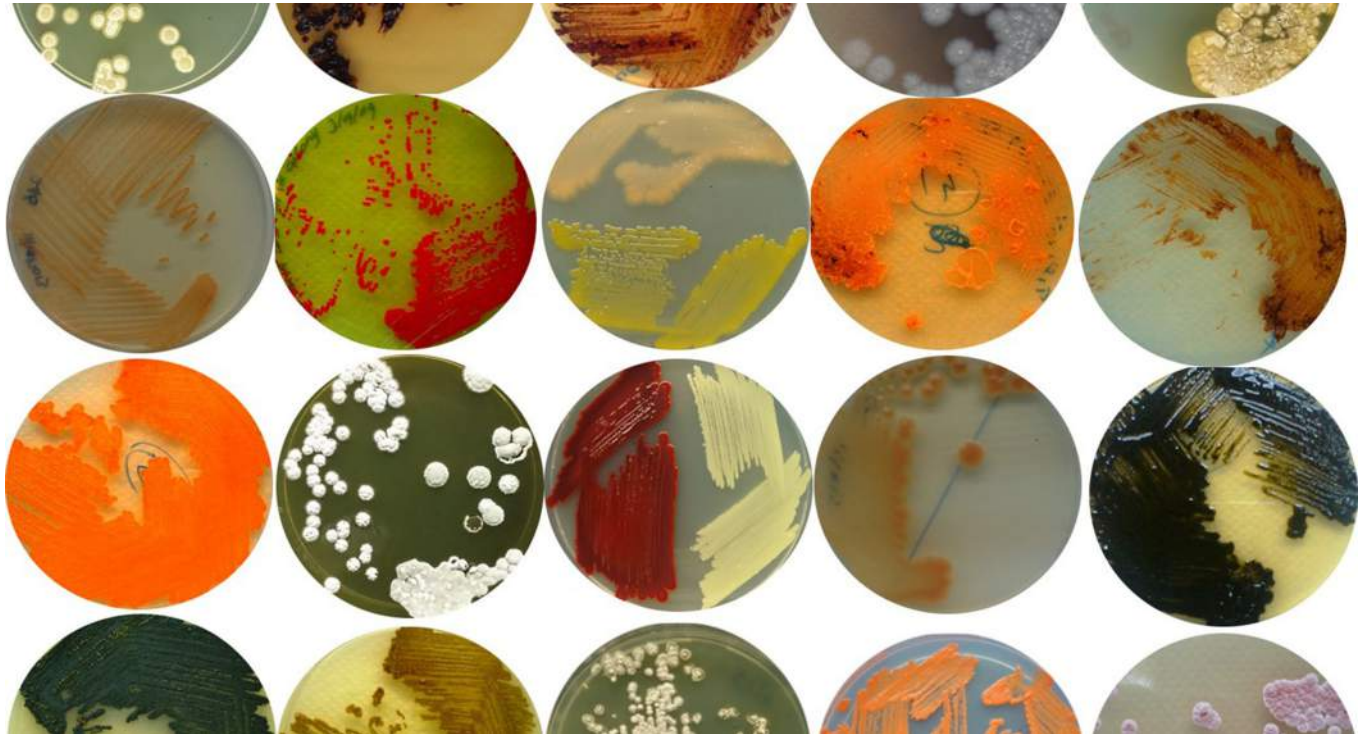
The mangrove ecosystem: A healthy mangrove forest buffers wave and wind actions and protects land and lives. The quantitative lichen ecological studies carried out in the mangroves of Pichavaram point to lichen species *Roccella montagnei, Dirinaria applanata, Pyxine nilgiriensis* as indicators of open and disturbed forest areas and *Porina interstes, Anthracothecium sp,* and *Lecanora allophana* as those of close and undisturbed locations. The seaward sides of the mangroves contain rich lichen growth.

The Siruvani Hills: Quantitative lichen ecological studies carried out in the Siruvani Hills (Boluvampatti II Reserve Forests, Western Ghats) used simple yet effective species area curves to identify species-rich sites. The mid-elevation moist deciduous forest (MDF-53 species) was identified as a diversity-rich site, with the presence of 25 rare lichen species. Factor analysis of the lichen data and forest site characteristics led to the development of a composite index for forest quality and identification of indicator lichen species/ communities. Multivariate statistical studies revealed that tree density, host tree composition, canopy coverage and substrate availability are the key environmental factors in determining lichen distribution. It is evident that the lichen community with *Sticta limbada* is a dominant member of near normal moist deciduous forest sites and sites dominated by *Parmotrema sp*. are disturbed sites in the Siruvani Hills. Foliicolous lichens, one of the subsets of lichen diversity, are an ecologically unique group that colonise the supra or sub cuticular domains of leaf/leaf-like surfaces of plants. A total of 900 samples of leaves were collected from different host trees within this region and 25 lichen species identified.

Lichens as indicators of cement dust pollution: Large-scale quantitative data on lichen diversity and distribution in the cement-dust pollution affected Walayar Madukkarai reserve forest area indicated the presence of 81 species. Further, parts of dry deciduous forest of this region are also exposed to various levels of cement dust pollution. Lichen *Bacidia beckhausii* occur only in polluted transects in this type of forest. Sixteen lichen species are specific to the partially polluted and unpolluted transects. Both the transects with cement dust contamination as well as the unpolluted transects share five species. Based on abundance and frequency of lichen species in, and between, polluted and unpolluted transects, thallus morphological deformities, membrane integrity and chlorophyll degradation were identified as sensitive and *B. beckhausii* was categorised as tolerant species against cement dust pollution. Elemental accumulation analysis carried out using SEM and PIXE spectroscopy revealed the presence of 9 elements and increased elemental calcium by 25.8 mg/kg in polluted sites and by 9.8 mg/kg in B. *beckhausii* species in unpolluted sites.



MICROBIAL DIVERSITY OF THE MANGROVE ECOSYSTEM



The mangrove ecosystem is one of the most productive ecosystems and is the habitat for a large number of organisms. The microbial community of this ecosystem contributes to the bio-geochemical cycle and nutrient transformation by various mechanisms like degradation of complex molecules, ammonification, nitrification, denitrification as well as to carbon flux and methane utilisation. The research initiated by MSSRF to explore the culturable microbial diversity of this less explored ecosystem has revealed the existence of novel genus and novel species associated with potential key functional traits.

Novel genus

Two novel genus of diazotrophic bacteria belonging to the family *Enterobacteriaceae* have been reported: *Swaminathania salitolerans* and *Mangroveibacter plantisponsor*. Both these strains were able to fix atmospheric nitrogen and solubilise phosphate, thus contributing to the nutrient cycle in this ecosystem. Four novel species of the genus *Vibrio* were also reported: *Vibrio rhizosphaerae, Vibrio porteresiae, Vibrio mangrovi* and *Vibrio plantisponsor*. The predominance of nitrogen-fixing Vibrio species in the mangrove rhizosphere suggests that these species might be involved in unknown but potentially important interactions with plant rhizosphere systems.

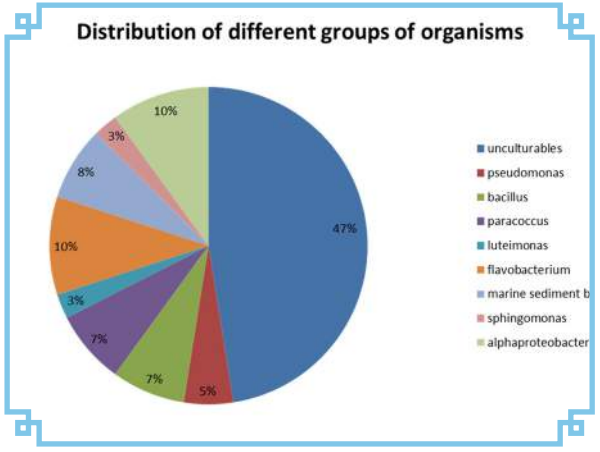
Diversity of denitrifiers

The diversity of denitrifiers was analysed by targeting marker genes such as nitrite reductase (nirS) and nitrous oxide reductase (nosZ), using specific primer pairs. The predominant denitrifiers associated with this ecosystem identified by 16S rRNA sequence analysis were *Pseudomonas bauzanensis, Pseudomonas xiamenensis* and *Pseudomonas stutzeri, Labrenzia aggregata, Paracoccus kondratievae, Nitratireductor aquimarinus, Halomonas hydrothermallis, H. ventosae H. venusta, Vibrio species and Bacillus species.* These studies helped to understand the key role played by these organisms in the emission of nitrous oxide by partial denitrification process. The *Halomonas* species were able to degrade benzene and 5 proteins/enzymes sequence linked to catabolic pathway of benzene and two differentially expressed proteins linked with the

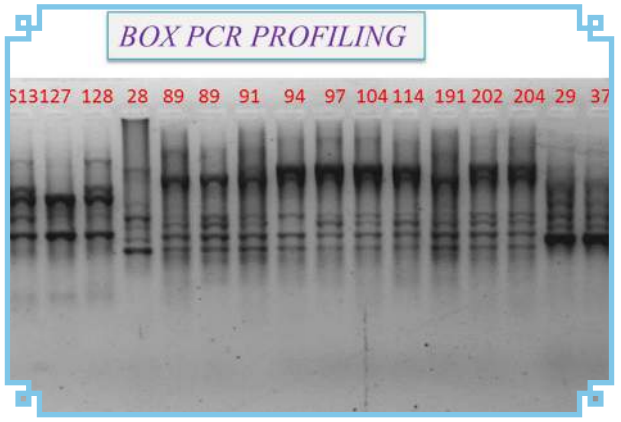
metacleavage pathway of benzene were isolated, thereby suggesting that Halomonas species contribute to degradation of complex aromatic hydrocarbons in the mangrove ecosystem.

Diversity of actinomycetes

The diversity of actinomycetes associated with the rhizosphere regions of *Avicennia marina* and *Rhizophora mucronata* mangroves was explored. Investigation of the mangrove rhizosphere revealed the existence of high species richness of the genus *Micromonospora* compared to other actinomycetes. BOX-PCR fingerprinting analysis of 120 *Micromonospora* strains revealed the existence of a high level of variation among the *Micromonospora* isolates. These isolates displayed



multifunctional properties such as production of extracellulae enzymes amylase, chitinase, cellulose, etc., and also exhibited antagonistic activity against plant pathogens *F. oxysporum* and *R. solani*. In addition, these isolates possessed the PKS gene which is the key gene for the production of secondary metabolites. Approximately 21 per cent of the Micromonospora isolates showed lowest similarity index and formed distinct phyletic lines from the existing species, thus suggesting they represent novel species The *Micromonospora*



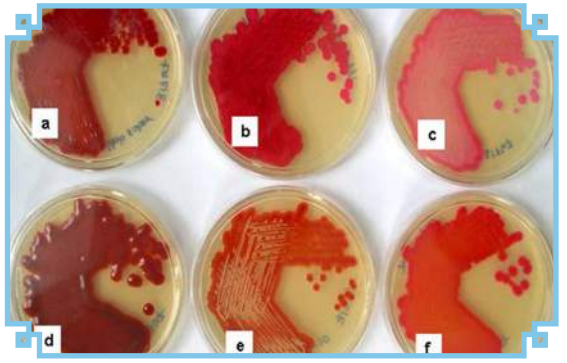
group of actinomycetes was also responsible for nitrogen fixation.

Diversity of the AHL-producing bacteria

The bacterial community coordinated through signaling molecules N-Acyl homoserine lactones (AHL) play a major role in the maintenance of bacterial community population density. Around 20 AHL producers were isolated, most of the strains being gram negative belonging to the genus *Pseudomonas, Vibrio, Serratia* and *Aeromonas*. One strain MSSRFM46, a gram-positive bacterium activated the AHL bioreporter strains and was identified as *Brevibacillus laterosporus*.

Unculturable diversity assessment

The exploration of unculturable diversity enhanced knowledge of the bacterial community. Microbial community assessments based on soil DNA 16S rRNA gene sequence analysis have made it evident that a large proportion of the bacteria is yet to be cultivated, such as the eubacteria and archaea. The dominant sequences were related to bacterial genera of root and root-free soil environments. The phylogenetic analysis of 16S rRNA gene sequences showed close relationships to a wide range of clones or bacterial species of phylum Firmicutes and unidentified bacteria.



The sequence analysis of the 245 fragments revealed the presence of members of the phyla Proteobacteria, Actinobacteria and Bacteroidetes to be predominant in this ecosystem. Among the Proteobacteria, alpha-proteobacteria was the major group representing the unculturables which included *Flavobacteriaceae, Bacteroidetes, Crypanaerobacterbacter, Actinobacteria, Staphylococcus, Pseudomonas, Bacillus, Nitrosomonas*, etc. Unveiling the diversity and structure of microbial communities in mangrove environments is the first step in understanding their role in the functioning of this ecosystem. The rhizosphere microorganisms contribute to the productivity of mangroves; and also maintain plant health and overall ecosystem resilience.

MICROBES FOR SUSTAINABLE AGRICULTURE

Agricultural productivity needs to be increased without perpetuating any related ecological harm. Rhizosphere-associated microbes play a key role in plant growth promotion by protecting plants from deleterious effects such as drought, salinity, pests and pathogens. *Pseudomonas* and *Bacillus*, which enhance plant growth through various mechanisms, are common inhabitants of the rhizosphere and phyllosphere. Hence, the research initiated at MSSRF aimed at a) exploring the diversity of different plant-growth promoting rhizobacteria (PGPR) such as *Azospirrillum, Pseudomonas, Bacillus, Rhizobia* and *Phosphobacteria* associated with different crops, and b) identifying potential PGPR strains with biopesticidal activity. The identified potential strains were scaled up, mass multiplied and formulated using cell protectants and the production technology was transferred to women's self-help groups as an ecoenterprise.

Species isolation and identification process

Different species of *Pseudomonas, Azospirrillum, Bacillus* and *Rhizobia* were isolated from the rhizosphere of crops such as paddy, finger millet, pearl millet, etc. The diversity of pseudomonads associated with the crops was studied by screening using genus-specific primers. The genetic diversity among *Pseudomonas, Azospirrillum* and *Bacillus* was determined using molecular tools. Abiotic factors such as salinity impacted the distribution of the different species of *Pseudomonas*: for example, increasing salinity in paddy soils caused a predominant selection of salt-tolerant species, in particular *P. pseudoalcaligenes* and *P. alcaligenes*, irrespective of the host rhizosphere. In semi-arid regions where finger millet is cultivated under rain-fed conditions, *P. putida* group was more dominant followed by *P. aeruginosa*. The diversity of *Azospirillum* associated with rice cultivated in the coastal agro-ecosystem was estimated and the strains were identified based on hybridisation using genus-specific probes. The predominant groups present in saline soils were *A. brasilense* and *A. lipoferum*. The diversity of *Bradyrhizobia* species associated with the soybean (*Glycine max Merrill.*) was studied using restriction fragment length polymorphism and phylogenetic analysis. A nitrogen-fixing strain MSSRFBL1 isolated from chickpea rhizosphere soil represented novel genus and was named *Ciceribacter lividus*

Functional diversity of rhizobacteria

The functional diversity of the *Pseudomonas and Bacillus* strains was studied. The *Pseudomonas* strains exhibited a number of functional properties such as ACC deaminase production, phosphate solubilisation, biofilm formation, IAA production, as well as production of the lytic enzymes chitinase, cellulase and protease; growth in IM salt stress was also evident. A number of pseudomonads showed antagonistic activity against blast pathogen *Pyricularia grisea* TN508; wilt pathogen *Fusarium oxysporum* DSM62297, *Rhizoctonia solani, Macrophomina phaseolina* and *Xanthomonas oryzae* under in vitro conditions. Further, the *Pseudomonas* strains were screened for harbouring different antibiotic-coding genes such as *phlD; hcnBC, Plt, Prnt* and phz responsible for the synthesis of secondary metabolites; 20 *phlD* gene-harbouring *pseudomonads* were identified. A potential plant-growth promoting and antagonistic strain *Pseudomonas* species MSSRFD41 isolated from finger millet rhizosphere was able to grow in 1M NaCl and produced the antibiotic 2, 4-Diacetylphloglucinol which inhibited a wide range of plant pathogens. The strains which performed well in greenhouse studies were tested under field conditions. Multi-location field trials were conducted in different seasons in different crops using nitrogen fixers and phosphate solubilisers individually and in combination. Trials conducted in the farmers' fields in rice, groundnut, sorghum, maize as well as in green gram, in soils with different salinity (0.3- 3.15 dsm-1) using saline- tolerant nitrogen fixers and phosphate solubilisers resulted in yield increase by 15-20 per cent. The *Pseudomonas* strains were tested in the experimental field of the Tirur Rice Research Station for the control of sheath blight disease in rice. A reduction of ~60 per cent in disease incidence was recorded. Liquid formulation of the *Azospirillum*

phosphate solubilisers and *Pseudomonas* were tested in hybrid rice variety Suruchi 5401 and compared with local varieties PY 7 and ADT 37 in a trial conducted at the Biocentre at Pillaiyarkuppam, Puducherry. The treatment with recommended doses of biofertilisers combined with 25 per cent of chemical fertilisers resulted in a yield increase of 15 per cent in hybrid seeds compared to the control and chemical fertiliser application. These trials clearly indicate that PGPRs are potential supplements for chemical fertilisers and pesticides in sustainable agriculture.

Innovation in demystification

The demystification of technologies and establishing low cost units for the production of biological software for the promotion of good agriculture practices (GAP), eco-agriculture and organic farming has been an area of innovation. Decentralised production units managed by WSHGs were set up at the village level as a mode of income generation so as to ensure rural job opportunities and also to supply good quality biofertlisers. The competence of the members was enhanced through training and capacity building programmes. They were trained in the production process, namely, using the weighing balance, autoclave, laminar flow, etc. They were also intensively trained in culture maintenance, inoculation, harvesting, formulation, packaging and sealing. The decentralised biofertiliser and biopesticide units are currently producing and marketing *Azospirillum lipoferum,Phosphobacteria, Pseudomonas fluorescens,* and *Bacillus subtilis*. The production technology has been upgraded with each of these units equipped with a fermentor with the production capacity of 100 l. Liquid-based formulations are being promoted. Unlike the adverse impact of the excess use of chemical fertilisers, biological inputs enhance soil texture and maintain soil health without leaving any toxic effects.

BIOPROSPECTING FROM PLANTS AND LICHENS

Bioprospecting to discover molecules and genes for product development, especially from higher plants, microbes, fungi and lichens from diverse habitats, is one of the current national priorities in India — a megadiversity country with a large section of its population dependent on natural resources. Further, a vibrant bioprospecting programme needs to be built on a strong partnership between, on the one hand, institutions having expertise on bioresources and traditional knowledge, bioprospecting screens and downstream assays, and, on the other, industries in order to convert leads into meaningful products.

Bioprospecting initiatives

MSSRF's bioprospecting programme is placed on four secure criteria: its long association with the tribal communities of Odisha and Tamil Nadu, particularly with respect to medicinal plant resources and associated knowledge; its extensive research accomplishments on mangroves, medicinal plant conservation and lichens; its scientific capabilities, specifically on molecular, tissue culture (plants, lichens and microbes) and production and purification of phytochemicals; and its collaboration with leading national scientific institutions such as the Agharkar Research Institute, Pune, the National Botanical Research Institute, Lucknow, and the Cancer Research Institute, the National Institute for Research in Tuberculosis and the Indian Institute of Technology-Madras, Chennai. Rare, endangered and threatened (RET) species, medicinal plants and mangroves were selected for bioprospecting studies based on the traditional knowledge and availability of plant biomass.

MSSRF has so far screened and isolated compounds from several mangrove, RET and medicinal plants such as *Centella asiatica, Clerodendron inerme, Dodonia viscosa, Embilica officinalis, Excoecaria agallocha, Lobelia nicotianafolia, Plumbago zeylanica, Rhizophora apiculata, Salicornia brachiata, Solanum xanthocarpum, Syzygium travancoricum,* etc. Similarly, many secondary compound rich lichen species such as *Buellia subsororioides, Caloplaca ferruginea, Dirinaria consimilis, D. applanata, D. papillulifera, Diploschistes scruposus, Glyphis scyphulifera, Graphina obtecta, Graphis inamoena, Graphis kollaimalaiensis, Heterodermia diademata, H. isidiophora, H. leucomelaena, H. dissecta, Parmotrema praesorediosum, P. mesotropum, Ramalina pollinaria, R. subpusilla, Roccella montagnei, Trypethelium eluteriae* and *Usnea*

complanata were screened for their profiles.

Plant and lichen culture

Many bioprospecting studies have demonstrated the potentialities of lichen compounds but have failed to take the lead molecules into meaningful products, primarily because of the non-availability of the bioresource as well as lack of alternative protocols. MSSRF has achieved the following in this regard:

Fungal, algal and whole thallus culture of nearly 50 lichen species have been established, despite the fact that lichens are difficult to culture. This is the maximum number of cultured lichens in repository in India.

Protocols have been standardised for true-to-type plants, and in lichens for enhanced biomass, compound quantity and novel bioactive secondary compound production.

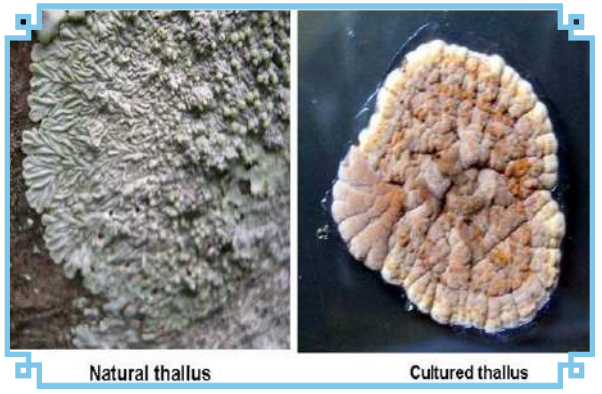
Lichen bioreactor protocols have been regularised to scale up secondary compound production of 4 lichen species.

Research insights

The fractions of *E. agallocha* exhibit 100 per cent mortality against 32 different cancer cell lines tested, and 40 µg of this extract has shown less than 50 per cent cell survival in most of the cell lines.

Two lichen compounds — DA isolated from *D. applanta* and E1 isolated from *P. prasorediosum* — are effective at mM concentration against cancer cell lines of the central nervous system, breast, lungs, colon, renal, gastric, osteosarcoma and ewing sarcoma cells. In all these cell lines, more than 90 per cent cell death has been observed.

Lichen compound TE1 showed promising antimycobacterial activity against 7 *Mycobacterium tuberculosis* strains such as H37Rv, Rifampicin- and isoniazid-resistant *M.* tuberculosis strains and clinical strains 2567 and 1338 that are prevalent in south India.



Compound TE1 on *M. tuberculosis* (H37Rv) infected THP1 cell line (human acute monocytic leukemia cell line) macrophages indicated a significant reduction in the in vitro growth of M. *tuberculosis* and not affecting the human cell line.

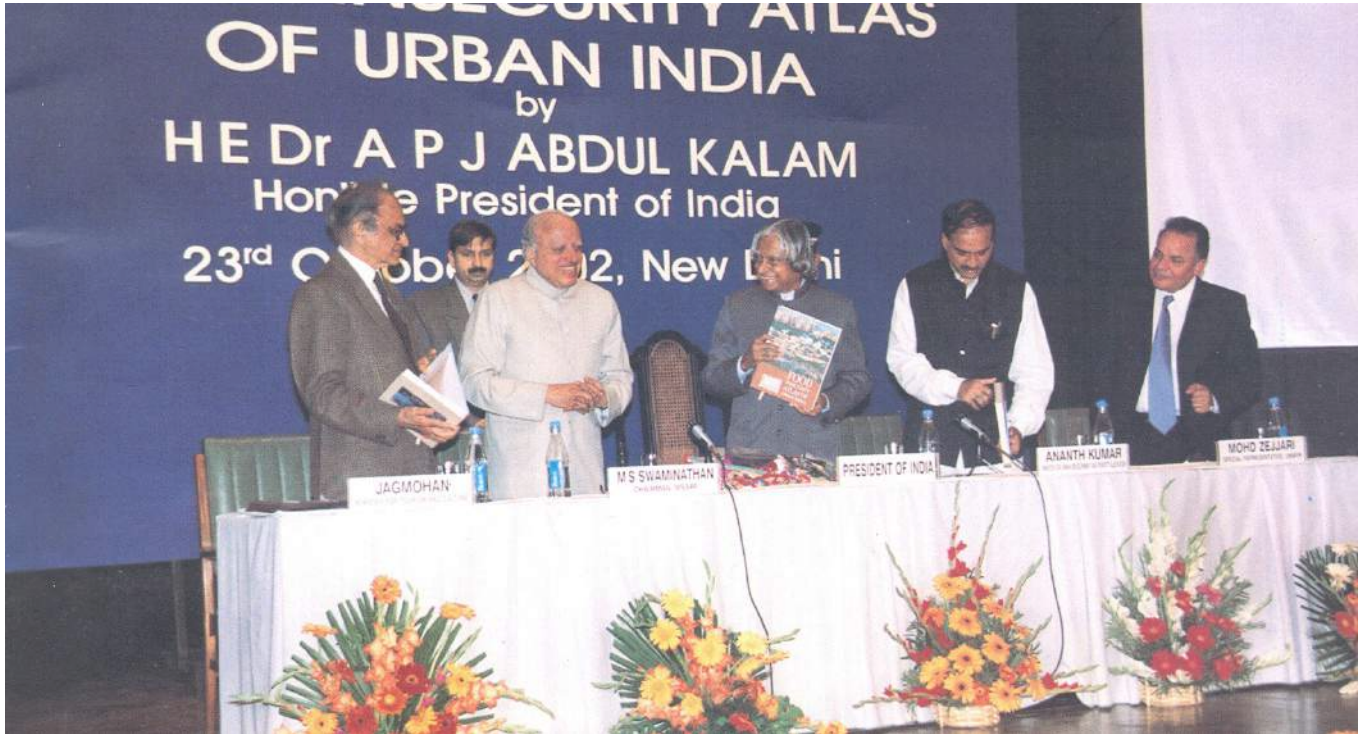
Mortality of test animals at lower doses has also been observed in response to the treatment of compound E1 isolated from *P. prasorediosum*.

Compound DA showed no acute toxicity in test animals as there is no mortality up to 5000 mg/kg body weight.

Impact

The initial phase of research on bioprospecting has provided the basis for filing a provisional patent, entitled Biosynthesis of a Compound and its Antimycobacterial Activity, by MSSRF jointly with the National Institute for Research in Tuberculosis, Chennai. Further, the Department of Biotechnology, Government of India, has launched an initiative in 2012 called the National Network Programme on Lichens: Bioprospecting its Secondary Compounds and Establishing Cultures and Collections. MSSRF coordinates this important national network and partners with the Agharkar Research Institute, Pune and the National Botanical Research Institute (NBRI), Lucknow for establishing lichen collections, cultures, genetic characterisation and biosynthesis of compound-rich lichens of the Eastern Himalayas, Western and Eastern Ghats and coastal forests, including mangroves . The Cancer Institute, Chennai, the Tuberculosis Research Institute, Chennai, and the pharmacology laboratory of NBRI are bioprospecting partners to screen the compounds, and the phytochemistry laboratory of NBRI and the Indian Institute of Technology-Madras, Chennai are involved in characterising the compounds.

FOOD FOR ALL AND EVERYONE



The multiple threats to food security are interconnected and multi-scale and robust knowledge structures are critical, given the status of food systems in our country. MSSRF has initiated the preparation of research reports on the issue of food security. These reports, as knowledge products, provide a macro perspective of the country's food security concerns, as well as propose specific recommendations for food security policy that would lead to a hunger-free India. This makes each report an important research and policy document that can aid in stimulating action and spreading a message of hope.

So far, MSSRF has published the following five reports on the state of food insecurity in the country:

Food Insecurity Atlas of Rural India, released in 2001 by Shri Atal Behari Vajpayee, the then Prime Minister of India

Food Insecurity Atlas of Urban India, released in 2002 by Dr. A.P.J. Abdul Kalam, the then President of India

Atlas of the Sustainability of Food Security, released in 2004 at the National Food Security Summit held at New Delhi

Report on the State of Food Insecurity in Rural India, released in 2008 by Ms. Mabel Rebello, Member of Parliament

Report on the State of Food Insecurity in Urban India, released in 2010 by Shri S. Jaipal Reddy, the then Minister for Urban Development, Government of India

Insights

The reports adopt a comprehensive definition. Food security is defined as the ability of a person to eat enough, stay active and lead a healthy life. Availability, access and absorption of food are the three key dimensions of food security. Food availability at the macro level is a function of domestic production, net imports and draw-down of stocks. Food access is related to purchasing power. Food absorption — its effective biological utilisation — is a function of safe drinking water, environmental hygiene, primary healthcare and education. Policies need to address all three dimensions to ensure food security at the household/individual level. With this perspective, the reports discuss appropriate indicators for food insecurity, construct an Index of Food Insecurity, compute the values of this Index for major States of

India and, based on these values, provide an analytical comparison across States. The contribution made to food and nutrition security by the three major food-related interventions of the government, namely, the public distribution system (PDS), the mid-day meal scheme (MDMS) and the integrated child development services (ICDS) have also been explored in the recent reports.

Key recommendations

The overall approach of the food delivery system should be lifecycle based and involve appropriate nutritional interventions to ensure that all stages of the lifecycle are addressed.

Availability of foodgrains in adequate quantities needs to be ensured, now and in the future. Keeping in mind the need to ensure livelihoods in rural areas, the strategy for increasing availability must place emphasis on increasing small farm production and productivity.

With a view to improve availability of foodgrains, the minimum support price (MSP) system should be expanded and farmers should have assured and remunerative price for their produce, for all major crops including millets.

Improvement in basic infrastructure like ensuring access to safe drinking water, toilets, drainage facilities, shelter and healthcare facilities will have a positive impact on health and nutrition of the population. Issues of nutrition education also need to be addressed.

Community-based food security systems such as community grain banks are relevant in remote locations.

Enhancing the skill levels of the labour force on a large-scale through massive training and capacity building programmes, both by government and private sector, is an urgent requirement in our country.

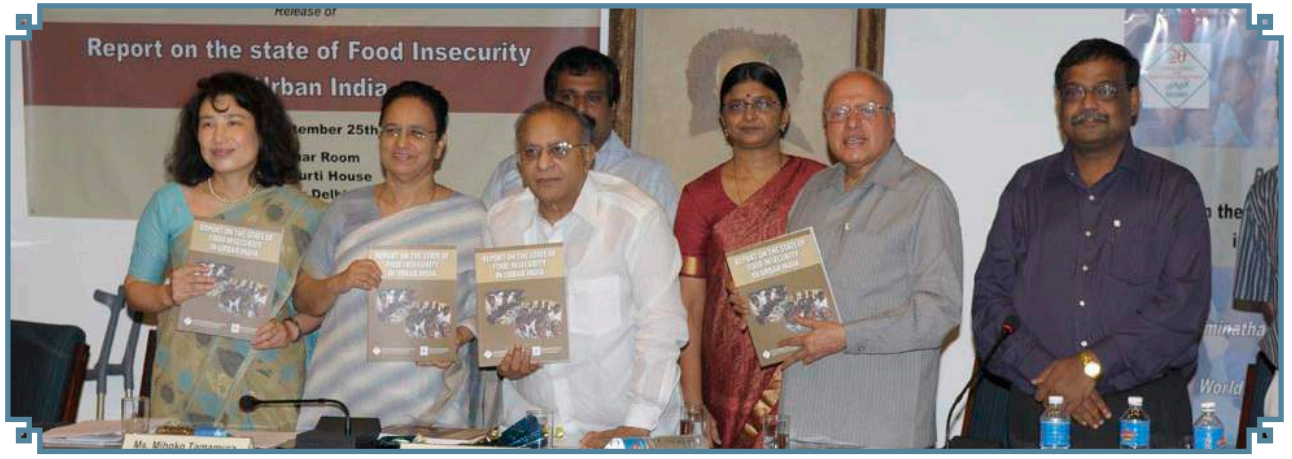
There is a real need to ensure that the workers in the unorganised sector and those in informal employment in the formal sector are provided decent wages and working conditions as well as a modicum of social security.

The National Rural Employment Guarantee Act plays a very useful role in ensuring food security for the rural poor. An Urban Employment Guarantee Act along similar lines should be enacted.

Economic policies should be reoriented to provide adequate support for India's agriculture and its vast rural population. The unfinished agenda of land reforms must be completed, and distribution of ceiling surplus land must be done on a priority basis. Food security is as much a matter of the fiscal policy framework as it is of any programme implementation on the ground. While outcomes are indeed important, a precondition for achieving targeted outcomes is adequate outlays. This is crucially dependent on the macroeconomic policy framework. Economic reforms therefore need to be 're-formed', if inclusive development that addresses the needs of food security for all is to occur.

Impact

The Reports have been received well internationally and among the academic community as well as among policymakers, and the findings have triggered Parliamentary questions.



JOURNEY TOWARDS CLIMATE RESILIENCE

The recognition of the need to conserve mangrove wetlands as anticipatory action to meet the challenge of sea level rise set the basis for the establishment of MSSRF's Coastal Systems Research (CSR) programme, which is funded by the International Research Development Centre (IDRC) and the Japanese Government through the International Tropical Timber Organization (ITTO). Both rehabilitation and restoration of mangrove ecosystems remain the mainstay of the CSR programme. The concept of CSR is a major contribution of MSSRF to the strengthening of both coastal ecological security and the livelihood security of coastal communities, nationally and internationally.

Climate-resilient initiatives

Joint mangrove management

The lives and livelihoods that were saved by MSSRF's mangrove-related intervention areas during the 2004 tsunami stood testimony to the value of promoting mangroves as natural bioshields and demonstrated how pragmatic solutions could be brought within the reach of communities through concerted and sustained efforts. MSSRF scientists and scholars have concentrated on developing a "beyond tsunami" strategy integrating ecological and livelihood security and paying concurrent attention to the needs of both the fishing and farming communities.

Kuttanadu below sea level farming

MSSRF has been instrumental in bringing recognition to the Kuttanad Below Sea Level Farming System, as an entity of the Globally Important Agricultural Heritage System (GIAHS) initiative of FAO. The Kuttanad system is the only system in India that favours rice cultivation below sea level. Through its sustained efforts, MSSRF has convinced the Government of Kerala to set up an International Research and Training Centre for Below Sea Level Farming in Kuttanad area which will have enormous significance in terms of balancing the risks associated with rice production under the changing climatic conditions.

Genes for the warming planet

The Genes for the Warming Planet programme envisioned by MSSRF is driven by cutting edge science. The scientific work related to identifying genes for saline tolerance from *Avicennia marina*, a mangrove species, and transferring it to rice and the development of a drought-tolerant rice variety through the transfer of drought-tolerant genes isolated from *Prosopsis juliflora* is widely recognised as holding promise for the future of food security, which is threatened by the emerging climate related impacts.

Biodiversity programme

Over the years, MSSRF, through its Biodiversity programme, has promoted community-based conservation practices. All along the emphasis of the biodiversity programme has been on both in situ and ex situ conservation of plant genetic resources across varied ecosystems. The Community Gene Bank, with about 1000 accessions, conserves important landraces and genetic material. Under the looming threats imposed by climate-related events, efforts such as these hold the key to disaster preparedness,

safeguarding local food security.

Information, Education and Communication programme

Information, Education and Communications (IEC) is one of the flagship Programme Areas of MSSRF and has contributed immensely to the timely delivery of vital information to the needy through a network of Village Resource Centres and Village Knowledge Centres. In the era of climate change, information and knowledge will remain as gateways, not only to empower farming communities but also to shield them from the vagaries of climate change without any substantial damage caused to their livelihood base.

Drought mitigation strategies

Some of the established strategies to moderate the impacts of the drought situation include employment generation through relief works, cattle conservation camps, fodder depots, improved animal and crop husbandry, provision of drinking water, exercising prudent water conservation measures, providing reliable weather forecasts, etc,. These approaches form the basis of several of MSSRF's climate-related interventions across Programme Areas.

Vulnerability assessment & enhancing adaptive capacity to climate change

One of MSSRF's successful programmes in the context of climate issues is the Swiss Agency for Development and Cooperation (SDC) funded initiative on vulnerability assessment & enhancing adaptive capacity to climate change, being implemented in Andhra Pradesh and Rajasthan. The interventions under this project have demonstrated how locally-generated weather information blended with both native knowledge and scientific inputs could help local communities to manage climate risks.

Capacity building and policy initiatives

MSSRF is providing basic training in climate risk management at the local level for selected farmers and panchayat leaders. On the climate mitigation side, MSSRF's work is focused on promoting carbon sequestration through appropriate soil conservation and management techniques, wetland conservation, and renewable energy sources. Over the years, MSSRF has influenced many national and state policies using its evidence-based research outcomes. The climate programme of MSSRF is continuously engaged with different stakeholders to bring in transformative changes; key policy outcomes include the empowerment of panchayats through targeted training in local-level climate risk adaptation and mitigation strategies and the facilitation of the International Research and Training Centre for Below Sea Level Farming instituted by the Government of Kerala at Kuttanad.

BIOMASS FOR ENERGY SECURITY

Biomass is yet to find a place in the overall energy balance of India probably because sufficient data and documented experience in terms of its availability and consumption patterns are not easily available. In the recent past, several small-scale, biomass-based initiatives promoted by both government and the private sector have been introduced to facilitate decentralised energy use. The outcomes of these initiatives have been mixed. A compendium of the experiences collected through a focused research study provided an opportunity to examine the linkages between crucial climate-related components such as adaptation, livelihoods and mitigation under different contexts. The study also provided an opportunity to understand the critical barriers and challenges in providing decentralised biomass-based energy services and improving livelihood access at the local level. The study involved five cases, varying in terms of the feed stock used, agro-ecological endowments, power plant capacities, livelihood opportunities, etc., which were chosen across the country to understand the realities.

Methodology

The data-gathering process covered a) literature survey of research reports, academic papers, news articles, government documents and web-based information; b) discussion with key stakeholders, including representatives of the farming community, research organisations, State Electricity Authority officials, key policy makers, etc.; and c) climate data analysis based on data from the India Meteorological Department (IMD). Household interviews were conducted to understand the long-standing impact of biomass use, procurement profiles, livelihood benefits and how bioenergy-related activities enhance adaptation options at the local level. An energy use profile of the study area was created to understand the level of energy mix at the community level. Satellite images were used to mark the cropping patterns. The study focused on eliciting information on key elements such as technological inputs, changes in access and delivery systems, and the overall mitigation potential of the individual decentralised power units.

Insights

Adaptation to climate change

In the Malwa power plant in Sri Muktsar Sahib district, the Punjab, agricultural residues, saline and water-logged land have been utilised for biomass feedstock production. Eucalyptus has been promoted in water-logged land areas. Ash has been used in raising the agricultural bed for cotton production.

Saran Renewable Energy and DESI Power, both operating in Bihar, have undertaken the promotion of Sesbania sesban in fallow land and thus reduced dependency on market feedstock.

In the bamboo charcoal making enterprises in Nagaland, the change in harvest practices, like the promotion of flowered bamboo to control rodent menace, has saved the standing crops.

In Odisha, the Vana Sanrakshana Samiti and other social networks provided livelihoods when the *Jatropha* scheme failed.

Husk Power Systems in Bihar has standardised rice husk technology to generate decentralised electricity for resource maximisation.

Livelihoods

Energy affects livelihoods in more than one way. Access to energy defines the quality of lives and livelihoods. Sustainable livelihoods require access to cheap, clean and safe energy resources. In the case studies, mostly crop residues, wastes and invasive crop species have been used in energy generation systems. The number of people obtaining economic benefits by selling feedstock to a megawatt-scale plant is more than that of a kilowatt-scale power plant. In Malwa, which is a 7.5 MW power plant, it was found that the number of people engaged in biomass procurement, biomass chipping and transporting the biomass to the power plant premises, raising biomass plantations and other activities, amounted to approximately 2500. Proportionately, the income generated is much higher in a megawatt-scale plant as compared to a kilowatt-scale plant. The Nagaland Bamboo Development

Agency (NBDA) along with the Village Bamboo Development Agency (VBDA) have successfully created village enterprises in Nagaland to manage the bamboo resources for charcoal manufacturing.

Emerging insights and their implications for policy

Long-term planning and regulation have a crucial role to play if small-scale bioenergy projects are to succeed.

The tariff offered in the feed-in tariff system needs to be adequate to meet the running cost of the biomass power plant as well as to make a reasonable profit in order to attract private investment.

Attractive financial incentives are needed to promote bioenergy crop cultivation. Profit sharing with biofuel crop growers needs to be encouraged.

Risk communication strategies and adaptation of polices for biomass plantations should be developed by local authorities.

Access to fallow land and secure demand is the key to enhancing the adaptive capacity of biomass production.

Local consultation and informed consent of farmers concerned are essential, prior to any land-based agreement for biofuel plantations.

Alternative business models need to be looked into, involving biofuel producer companies/associations, farmers' produce companies and the government.

RESOURCE CENTRE FOR MEDIA OUTREACH

The role of media is critical in shaping public opinion and influencing public policies. Therefore, the message of science and sustainable development can be best taken to the policy makers and the people through media. *The Hindu* Media Resource Centre (*TH*MRC) was established at MSSRF in July 1998 using an endowment provided by The Hindu Group of Publications, to act as a platform between the scientists and media. The Media Resource Centre aims to promote public understanding of critical developmental issues; it provides space for interaction between media personnel and practitioners of frontier science through public forums, lectures and workshops.

Key Activities

Millennium lectures

Eminent speakers and academicians are invited to present their views on sustainable agriculture, hunger, poverty, population, environment, etc., for an enhanced understanding on issues of significance to science and society. The list of *TH*MRC Millennium Lecturers over the years includes eminent personalities such as Sir John Maddox, Emeritus Editor of Nature, Prof. Harlan Cleveland, President of the World Academy of Art and Science, Dr. Norman Myers, the well-known environmental conservationist, Dr. Joseph Hulse, the Canadian biochemist, Dr Kanayo F. Nwanze, President, International Fund for Agricultural Development, and Prof. Mahendra Dev, Director, Indira Gandhi Institute of Development Research.

Public forums

Public forums are organised on subjects of topical interest led by a panel of experts, heads of international agencies, eminent scientists, policy makers, and leaders. Local media and general public participate in the public forums. A wide range of topics to spread the message of sustainable food and livelihood security has been covered in the last 15 years.

Media workshops

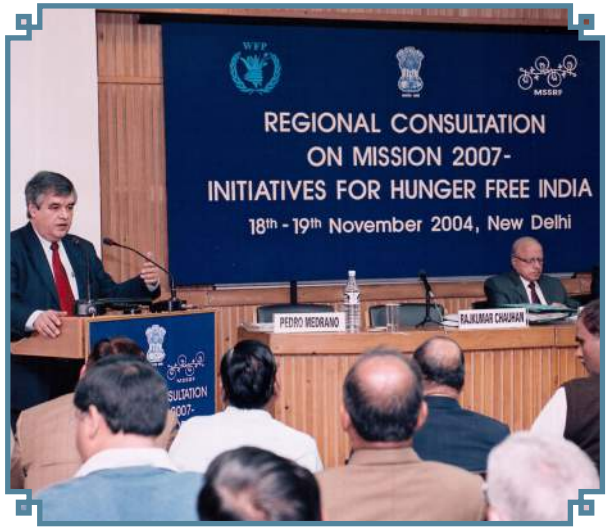
The workshops provide an opportunity for the media to directly access authentic information from subject experts on contemporary themes and provide scope for brainstorming on important ethical, social, cultural and scientific issues in a holistic manner. The purpose of the media workshop series is to develop an interactive dialogue with media practitioners over a period of time as a sustained campaign on controversial scientific issues rather than achieve immediate press coverage.

*TH*MRC has covered a wide range of issues through such platforms and has had impact at different levels. Some of the primary issues taken up by *TH*MRC since its inception are elaborated below.:

Scientific developments: A media workshop on *Genetically* Modified Organisms was organised in its first year. It was inaugurated by Prof James Watson, co-discoverer of the double helix structure of DNA. Subsequent to the recommendations of the workshop, the governments of UK and USA established broad-based consultative and policy guidance bodies. A national-level media workshop on *Media and Gene Revolution* was organised in which 32 media practitioners across India participated. The workshop helped journalists understand the pros and cons of technology. A media discussion on *Heritage of Watson and Crick* commemorated the 50th anniversary of the discovery of the double helix structure of the DNA molecule. A public forum on Future of Biotechnology: Partnerships and Public Acceptance was also held.

Hunger and poverty: The media has an important role to play in reporting hunger, food crises and anticipated famines, as also highlighting the need for sustainable development. The first public forum was on Is *Freedom from Hunger an Achievable Goal?*. In view of the Supreme Court directive to State governments to take actions for ending the hunger crisis, and the corresponding agitation, a media interaction was organised on *End the Paradox of Grain Mountains and Hungry Millions - What Now?*. A national level media workshop on Freedom from Hunger highlighted the importance of food security to world peace and economic development. In addition, a discussion on *Right to Food - the Ethical Dimensions* was held.

Water: The Centre conducted workshops on water conservation and management emphasising the need to harness water resources to fulfil people's demands. A media workshop on *Jal Swaraj: Facing the Water Emergency* was organised in May 2000 where harnessing rainwater and seawater for effective water supply augmentation, leading to more crops per drop for efficient demand management were discussed. The Centre organised the South Asia Regional Workshop Water Policy as a preparatory workshop for the third World Water Forum, held at Kyoto, Japan in 2003.



Media tours

Media professionals are taken on tours to different field sites of MSSRF for on-field experience and in-depth understanding of issues in sustainable development. To commemorate World Wetlands Day, a media tour to Thuthukudi was organised. To ensure the health of the corals that support the livelihoods of people, an artificial coral reef programme was initiated. Training programmes were also organised for media reporters on rural issues.

Impact

The Hindu Media Resource Centre was a joint recipient of the Jawaharlal Nehru Award for Science Communication for 2008 by the Indian Science Congress Association. As a result of a workshop on Radio and Sustainable Agriculture conducted by *TH*MRC, a 52-week rural development radio programme *Mannin Manam* was launched in collaboration with All India Radio in September 2003. A training programme was broadcast through *Gyan Vani* on community radio stations during 2008-09. More than 40 documentary films have been produced so far on the various programme activities carried out in MSSRF, the first one being *Farmers' Rights: from Legislation to Implementation* on the rights of tribal and rural farm families which highlights the activities of MSSRF's Community Agrobiodiversity Centre (CAbC) at Wayanad, Kerala. As early as 2000, *TH*MRC recognised the emerging scope for on-line journalism and conducted a workshop on the Internet as a source of information on sustainable development.

ACTION FOR CHILD CARE AND EDUCATION SERVICES AND STRATEGIES

In simple words, Care is education, and Education is care. However, it should be noted that Child Care is a broad terminology covering a wide spectrum of contexts, activities, social and cultural conventions and institutions as well. The crucial role of education in fostering economic growth, personal and social development, as well as reducing inequality is well recognised. There is an imperative need to ensure that children are well equipped to contribute to, and participate in, the process of social and economic development. Only **A**ccess to better **C**hild **C**are and **E**ducation **S**ervices and effective **S**trategies can enable them to face the challenges of socio-economic development.

ACCESS Project

The project Action for Child Care and Education Services and Strategies (ACCESS) targeted groups of young children, below six, belonging to the underprivileged sections of society. The project was implemented in 3 phases — Germination (1991-94), Development (1993-97), and Consolidation (1998-2001) — with a focus on children in difficult circumstances, such as children of working mothers, migrant labour, children in poverty, girls, and working/street children.

The objective underscoring ACCESS was to advocate, promote, and support services for the care, welfare, development and education of children, especially services which address the intersecting needs of women, children and girls.

Key interventions

The interventions focused on four major domains such as Advocacy, Research, Capacity building and Development of resource materials related to Early Child Development (ECD), through networking and participatory methodologies. The approach adopted was to strengthen the local groups with the support of intermediate organisations such as women's organisations, local bodies, NGOs, trade unions and academic institutions through training and links at the macro level to mainstream the policy. In the process, the need for stronger macro level organisation was felt. Networking and advocacy are closely linked, and networking was seen as a tool for advocacy. The themes selected for advocacy were maternity and childcare services, burden of the preschool child, support for breastfeeding, gender sensitisation,

women's multiple roles, decentralisation of child care services, and development of the young child (0-2 years). Field level research studies were carried out on balancing women's multiple roles, breastfeeding, female infanticide, etc., as well as a review of child care services in Tamil Nadu and child care workers, to capture and integrate the ground realities. During the consolidation phase, Operation Resource Support (ORS) was launched to enhance the uptake of resource materials, strengthen the trainers' network, generate research studies, and provide technical support to the Tamil Nadu Forum for Crèche and Childcare Services (TN – FORCES).

Key strategies

Strategies adopted were action-research, training, networking, communication, documentation, development of resource materials and leveraging expertise, in addition to the following:

Networking of non-governmental organisations, professional organisations, and academic institutions who had the collective function of identifying and working on the issues of importance that influence child care

Generating and disseminating communication materials, including issue-based resource materials and instructional materials

Addressing critical interest groups, policy makers, and the general public through several advocacy measures

Training and capacity building of all partners working with children below six years of age

Conducting research studies for generating authentic empirical information for purposes of advocacy, for understanding the issues of importance in depth and also in evaluation of the quality of early child care and development and education

Key outputs

Network formation: FORCES (Forum for Crèche and Child Care Services), a network of institutions concerned with the care and development of the young child at national and Tamil Nadu state levels

An ECD trainers' network in Tamil Nadu

Evolution of a national task force to work on the development of quality rating tools in ECD for multiple purposes

Development of resource and training materials in ECD, in print, audio and video forms

A cadre of motivated young professionals in development

Impact

The interventions influenced the recognition of child care as a social responsibility apart from its perception as a women's issue. The shift in understanding on the core concern helped all concerned stakeholders to add different dimensions to the issue. The impact of Project ACCESS in general is evident in the TN-FORCES network, the quality of training, the whole range of resource and instructional materials available, and the creation of public awareness on child care.

POLICY IMPACT AT THE NATIONAL LEVEL

Public policies and engagement with the public are central to the goal of scaling up work. It is important for policy advocacy to be based on strong research. Policy advocacy has been a major plank of MSSRF's work across all its Programme Areas. MSSRF has also been actively engaged in helping operationalise the changes effected by such policy measures through engagement in training and advocacy. A few significant contributions of MSSRF's work to policy legislation and action are highlighted.

Mangrove Forest Restoration

MSSRF's demonstration of mangrove forest restoration along the eastern coast of India in the early 1990s was studied by the Ministry of Environment and Forests (MoEF) and commended as the best available model for adoption. The MoEF notification to all state governments based on the techniques demonstrated by MSSRF helped increase the area under mangrove forests by 56000 ha from 1997 to 2000. The Coastal Regulation Zone Notification 2011, formulated by the Government of India under the chairmanship of Professor M. S. Swaminathan, incorporates the experience gained by MSSRF in integrated coastal zone management.

Biodiversity Conservation

In the area of biodiversity conservation, MSSRF has played a key role in giving shape to two important national legislations: the Protection of Plant Varieties and Farmers' Rights (PPV&FR) Act 2001 and Biodiversity Act 2002. The draft of the PPV&FR Act 2001 emphasised the need to mutually reinforce the rights of breeders and farmers and was presented and discussed at two dialogues organised by MSSRF in 1994 (Farmers' Rights and Plant Genetic Resources: Recognition and Reward) and 1996 (Biodiversity and Farmers' Rights). India is the only country where farmers' rights have been secured by law along with breeders' rights. Further, MSSRF's suggestion of recognition and reward for primary conservers led to the Government of India instituting two reward systems — the Genome Saviour Award for recognition of communities who have conserved rich genetic diversity and the Breed Saviour Award for recognising those who have conserved indigenous animal breeds. The Foundation has proposed formation of Biodiversity Management Committees at the local / panchayat level, Biodiversity Boards at the State level and a National Biodiversity Authority at the central level; the National Biodiversity Act came into force in 2002.

Biotechnology

MSSRF's work in the area of biotechnology focuses on harnessing the tools of modern biotechnology for effective use of biodiversity, with the ultimate objective of contributing to sustainable agriculture, livelihood

security of farm families and national food security. In line with this, the report of a task force on agricultural biotechnology chaired by Professor Swaminathan in 2003-04 recommended the setting up of a National Biotechnology Regulatory Authority to ensure a balanced approach with proper safeguards in deriving benefits from the progress of science. The reports of the National Commission on Farmers (2004-06), also chaired by Professor Swaminathan, have reiterated the need.

First Women's Biotechnology Park

The Foundation helped design and establish the first Women's Biotechnology Park in the country at Siruseri, near Chennai in Tamil Nadu, with support from the State Government and the Department of Biotechnology (DBT), Government of India. The initiative followed a recommendation at a meeting of women scientists and technologists in 1996 organised by MSSRF jointly with the United Nations Development Fund for Women (UNIFEM) and the United Nations Development Programme (UNDP); this was reinforced by the task force on Biotechnology-based Programmes for Women and Rural Development (1997-98) and included in the list of approved programmes by the government in commemoration of the 50th anniversary of India's independence.

'Every Child a Scientist'

MSSRF started the 'Every Child a Scientist' programme in 2001 to inculcate scientific knowledge and interest among schoolchildren. This evolved into a genetic literacy drive in 2004 with setting up of Genome Clubs in schools and vacation training programmes for students. The Department of Biotechnology, Government of India came forward in 2006 to make this into a national programme of DNA Clubs in schools across the country; the Foundation coordinates the activities of the programme in South India.

Sustainable Development Rio +20

India's position paper for presentation at the UN Conference on Sustainable Development Rio +20 held in 2012 was developed by MSSRF at the request of the MoEF. The analysis of the food security situation across the States of the country by the Foundation formed the basis of Mission 2007: Hunger Free India — a series of State, regional and national consultations in 2004-05 undertaken jointly with the UN World Food Programme and the National Commission on Farmers, to generate increased awareness and debate about the food and nutrition security situation.

Nutritious Millets

The Foundation's focused work on millets — a nutritious but neglected and underutilised crop — in Kolli Hills in Tamil Nadu and Koraput in Odisha, based on the 4Cs approach of conservation, cultivation, consumption and commerce, and advocacy at various forums alongside other organisations working on millet promotion has contributed to their getting attention at the policy level. Government of India announced a budgetary allocation in 2011-12 under the Rashtriya Krishi Vikas Yojana for promotion of millets as "nutri-cereals".

Kuttanad Below Sea Level Farming System as Globally Important Agricultural Heritage System

Research reports by MSSRF on measures to mitigate the agrarian distress in Idukki and Alapuzha districts of Kerala led to the Kuttanad package being approved by the Government of India in 2008. On the basis of a proposal submitted by MSSRF and the Government of Kerala, the FAO recognised the Kuttanad Below Sea Level Farming System as the 19th Globally Important Agricultural Heritage System (GIAHS) in the world.

Mahila Kisan Sashaktikaran Pariyojana

In the backdrop of suicides by farmers, MSSRF started working with women farmers in Vidarbha, organising them into groups and building their capacity, in order to spread a message of hope. This initiative for the empowerment of women farmers was given the name Mahila Kisan Sashaktikaran Pariyojana (MKSP). The Government of India in 2010-11 launched MKSP as a sub-component of the National Rural Livelihood Mission under the Ministry of Rural Development and provided allocation under the budget for making it a national programme. The experience of working with women farmers in Vidarbha and other States contributed to giving shape to the Women Farmers' Entitlements Bill that was introduced as a private member's bill in Parliament in 2012, by Professor Swaminathan in his capacity as a member of the Rajya Sabha.

Village Knowledge Centres

A dialogue organised in 1992 to deliberate on the use of ICT for rural development led to MSSRF piloting Village Knowledge Centres (VKCs) to provide demand-driven, need-based information to rural communities. The initiative expanded and in 2004 a national network was formed under the banner Mission 2007: Every Village a Knowledge Centre. Responding to the momentum generated, Government of India announced an allocation in its budget for 2005-06 for setting up VKCs across the country.

In keeping with the interdisciplinary nature of the Foundation's work, the contributions to policy making under the broad umbrella of sustainable rural development have been diverse. Seeing the outcome of the work having a larger policy level impact has been fulfilling as MSSRF continues its journey on the road of sustainable rural development.

POLICY IMPACT AT THE INTERNATIONAL LEVEL

MSSRF's work for sustainable rural development over the last twenty-five years has been gaining visibility internationally. There have been some significant contributions to international agreements too, especially in the area of biodiversity. Besides providing technical and training support where required, MSSRF is also engaged with international consortia of partners in working for common goals like food security and alleviating malnutrition. The seeds for a lot of the work that have evolved into key programme areas at the Foundation, like the Bio-village initiative and the Village Knowledge Centre model of using ICT for rural development, were sown at such forums.

Policy areas of international significance

The experience with coastal zone management and seawater farming has fed into the Report on Climate Change and Food Security (2012) by the High Level Panel of Experts on Food Security and Nutrition of the World Committee on Food Security, chaired by Professor M.S. Swaminathan. In the area of biodiversity conservation, the procedures for operationalising the concept of benefit sharing with primary conservers at national and international levels and of farmers' rights were developed at the Keystone International Dialogues in 1988, 1990 and 1991 under the chairmanship of Professor Swaminathan. The 1990 session was held at MSSRF and was crucial in getting the agreement of the private sector for implementing farmers' rights.

Consortium projects with international partners in recent years have helped give greater visibility to MSSRF's work as well as challenge the organisation to excel. MSSRF is the South Asia coordinator in a consortium project supported by the International Treaty on Plant Genetic Resources for Food and Agriculture (PGFRA) across 21 sites from South Asia, Latin America and Africa, to develop a strategic action plan for mainstreaming the methodologies and associated practices of community biodiversity management (CBM), and to increase the resilience of farming communities dependent on plant genetic resources for food and agriculture, as also to the impacts of climate

change. Since 2009, MSSRF has jointly with the Wageningen University and Research Centre, the Netherlands, been coordinating an annual training programme on CBM strategies for managing PGFRA; 77 participants from 24 countries across Asia, Africa and Europe have undergone the training till 2012. The increasing international focus on the agriculture-nutrition link in the face of the problem of high malnutrition levels in the region has found MSSRF taking the lead in two major research projects —Alleviating Poverty and Malnutrition in Agro-biodiversity Hotspots and Leveraging Agriculture for Nutrition in South Asia. Under both, MSSRF is working to demonstrate pro-nutrition agriculture interventions.

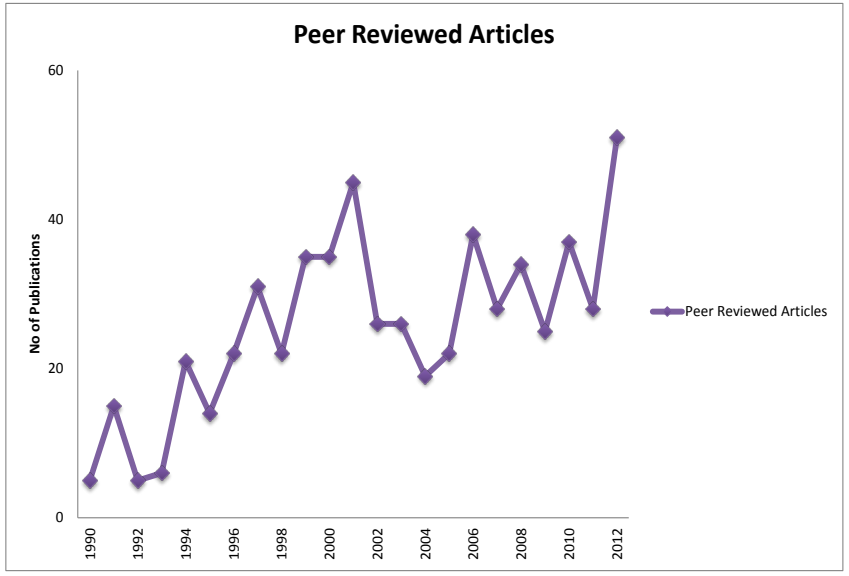
Following the preparation of food security atlases of India with support from the UN World Food Programme, MSSRF was requested to prepare a similar atlas for Cambodia. The positive experience with Village Knowledge Centres has been shared through South-South Travel Exchange workshops bringing together participants from Asia, Africa and South and Central America. The MSSRF team has extended support to promoting similar initiatives in Chile, Malaysia, Sri Lanka and Morocco, both through training and technical assistance. The national alliance of partners working on ICT that MSSRF proposed and steers has triggered similar networks in other countries such as the PAN Africa Network, ICTA in Sri Lanka, Telecentre Network in Bangladesh, PhilCeCNet in the Philippines and Mission Swabhimaan in Nepal

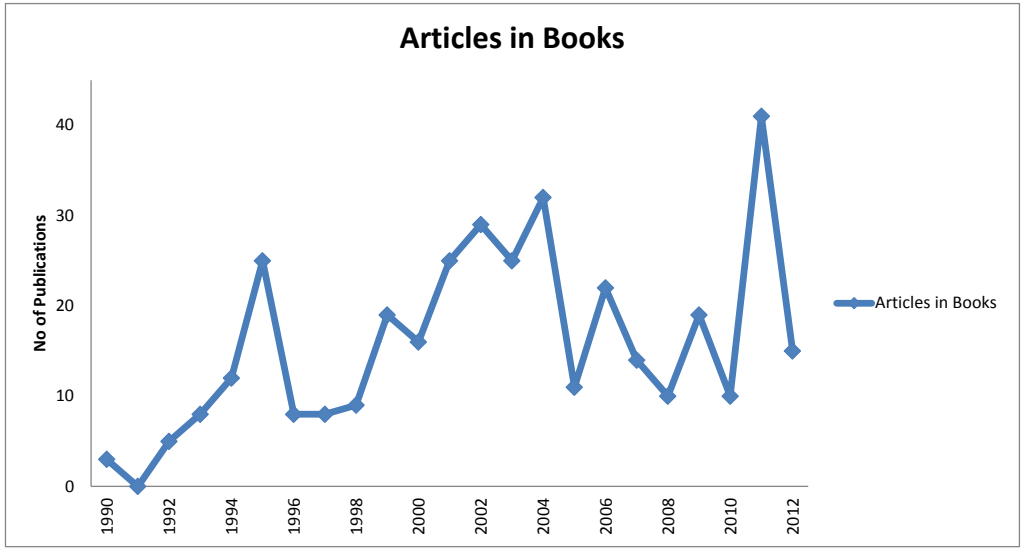
MSSRF has been identified to extend training and technical support under projects being initiated in Afghanistan and Myanmar on the basis of recommendations of a task force set up by the Ministry of External Affairs (MEA) to direct and oversee implementation of agricultural projects in the two countries. Participants from Afghanistan selected to undergo training in agricultural extension in India under the aegis of the Indian Agricultural Research Institute will be given exposure to use of ICT in agriculture and climate-resilient farming at MSSRF. The training slated to commence from 2013 will have a minimum of 25 scholars from Afghanistan.

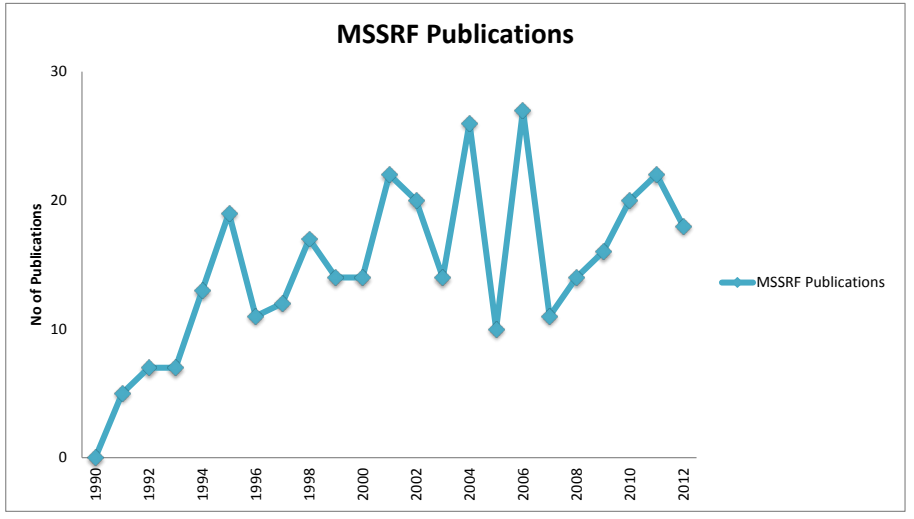
In the case of Myanmar, MSSRF has been identified by the MEA as the implementing agency for setting up a Rice Bio-park. The Government of Myanmar has signed an agreement with MSSRF and the foundation stone has been laid at Nay Pyi Taw for the commencement of the project. MSSRF will train a group of scientists and farmers from Myanmar in the different components of the bio-park. The initiative, a first of its kind, is expected to be ready for operation by December 2014 and will have the potential to trigger a rice biomass utilisation movement in Asia.

The journey of a quarter century has therefore been impactful and MSSRF hopes to sustain the momentum and work to collaborate with, and reach out, to larger numbers in the mission of linking science for sustainable development.

Publications







Scholars' Doctoral Theses from MSSRF

Subramonian, N. *Studies on Genetic Diversity in Some Rhizophora Species.* University of Madras.

Balakrishna, P. *Genetic, Physiological and Molecular Basis of Salt Tolerance in Oryza sativa L. and Porteresia coarctata Tateoka.* Osmania University, Hyderabad.

Jayanthi, M. *Saving Endangered Plants: A Case Study on Crotalaria longipes Wight & Am.* University of Madras.

Uma, G. *Dynamics of Pichavaram Mangrove Ecosystem, Tamil Nadu, India: Phytosociology, Phenology, Impacts and Management.* Central University of Puducherry.

Rao, C.S. *Studies on Clonal Propagation of Some Indian Mangroves and Species Differentiation in the Genus Rhizophora.* Osmania University, Hyderabad.

Anand, Ajith. *Studies on Genetic Diversity, Propagation and Rehabilitation of a Critically Endangered Tree Species: Syzygium travancoricum Gamble.* University of Madras.

John Joseph, S. *A Study into the Changing Profile of Sirumalai Forest Hills and Eco-friendly Restoration Plan.* Gandhigram Rural Institute.

Lakshmi, M. *Genetic Diversity in Mangrove Species of the Family Rhizophoraceae.* University of Madras.

Parani, M. *Isolation of Salt Tolerance Genes from Mangroves: Characterisation of Betaine Aldehyde Dehydrogenase (BADH) Gene from Avicennia marina and its Expression in Tobacco Transgenic System.* Anna University.

Latha, R. *Studies on Propagation, Genetic Relationship and Characterization of Salinity Tolerance in Porteresia coarctata (Roxb.) Tateoka, a Wild Relative of Rice.* University of Madras.

Senthilkumar, P. *Cloning, Characterization and Expression of Vacuolar H +-A TPase Subunit c from the Mangrove Species Porteresia coarctata (Roxb.)Tateoka.* University of Madras.

Jayashree M, *Gender and Biodiversity Correlates of Food Security: A Case Study of Kolli Hills, Tamil Nadu.* University of Madras.

Radha, R. *Studies on Conservation, Micropropagation and Characterisation of Bioactive Secondary Metabolites in Some Medicinal Plants.* University of Madras.

Eganathan, P. *Studies on Conservation, Clonal Propagation and Assessment of Economic Characters in Three Members of the Mangrove Ecosystem.* University of Madras.

Loganathan, P. *Isolation and Characterisation of Novel Salt Tolerant Nitrogen Fixing and Phosphate Solubilising Bacteria from Wild Rice - Porteresia coarctata – Tateoka.* University of Madras.

Rangarajan, Sunita. *Genetic Diversity and Salt Tolerance of Plant-associated Pseudomonas spp. and their Efficiency as Biological Disease Control Agents in a South Indian Coastal Agri-Ecosystem.* University of Madras.

Saleena, Lilly M. *Genotypic Characterisation of Rice Associated Azospirillum spp. and Identification of Efficient Indigenous Strains for the Coastal Agri-Ecosystem.* University of Madras.

Gopalakrishnan, A. *Effect of White Spot Syndrome Virus (WSSV) Disease on Shrimp Aquaculture in Southeast Coast of India.* University of Madras.

Rengalakshmi, R. *Conservation Biology of Little Millet (Panicum sumatrense Rothex Roem. A Schultz) Landraces of Kolli Hills, South India.* University of Madras.

Balaji, P. *Assessing the Lichen Diversity and its Distribution Pattern for Prospecting the Ecological and Economic Potential of Lichens within Bolampatti II Forest Range (Siruvani Hills), Western Ghats, India.* University of Madras.

Jithesh, M. N. *Isolation and Characterization of cDNA Isoforms for Catalase Gene from Avicennia Marina (Forsk.) Vierh. and its Expression in Transgenic System.* University of Madras.

Malarvannan, S. *Studies on Biocontrol of Helicoverpa Armigera using Traditional Plants.* University of Madras.

Nageswaran, M. *A Study on Integrated Intensive Farming System.* Bharathidasan University.

Prashanth, S. R. *Characterization of Copper Zinc Superoxide Dismutase Gene from Mangrove Plant Avicennia marina (Forsk.) Vierh. and Transformation into Rice for Salinity.* University of Madras.

King, E. D. Israel Oliver. *Sacred Forests of Kolli Hills, Tamil Nadu, India: A Study on Botany, Ecology and Community Interactions.* University of Madras.

Sankararamasubramanian, H. M. *Studies on Sodium Chloride Tolerance of Sesuvium portulacastrum.* University of Madras.

Mehta, Preethi Angela. *Identification of Abiotic Stress Induced Gene from Avicennia marina (Forsk) Vierh. and Over-Expression in the Transgenic System.* University of Madras.

Parasuraman, N. *Peraasiriyar Ma. Sa. Swaminathan: Vaazhvum Paniyum – Professor M. S. Swaminathan: Life and Works. (Tamil).* University of Madras.

Sivaprakash, K. R. *Identification and Characterisation of Iron Storage Protein Ferritin Gene from Avicennia marina (Forsk.) Vierh. and Tissue Expression in Rice for Iron Fortification and Ectopic Expression in Tobacco for Mitigation of Oxidative Stress.* University of Madras.

George, Suja. *Genetic Engineering for Abiotic Stress Tolerance Using Prosopis juliflora (Swartz) DC. as a Model Plant System for Gene Mining.* University of Madras.

Satyan, R. S. *Isolation, Purification and Characterisation of Bioactive Secondary Metabolites from Excoecaria agallacha L. and Jatropha gossypifolia L. against Helicoverpa armigera, Culex quinquefasciatus and Corynebacterium diphtheriae.* University of Madras.

Palled, Vishwanath. *The Process of Self-Help Groups Movement and Socio-economic Change: Case Studies from TN and Karnataka.* Karnataka University.

Gnanappazham, L. *A Remote Sensing and GIS based Decision Support System for the Effective Management of Pichavaram Mangrove Wetland, South India.* University of Madras.

Rameshkumar, N. *Isolation and Characterization of Two Novel Plant Growth Promoting Vibrio Species from Wild rice (Porteresia coarctata Tateoka): Description of Vibrio rhizosphaerae sp. nov. and Vibrio porteresiae sp. nov.* University of Madras.

Geetha Rani, M. *Plant Resources of Pachamalai Region with Special Reference to Indigenous Knowledge.* University of Madras.

Varma, Deepa. *The Sustainability of Farming Systems – Integrating the Principles of Conservation with the Economic Objectives of Farming in the Rice Farming Systems of TN.* University of Madras.

Bharat, P. *Assessment of the Lichen Diversity and Distribution Pattern in the Madukkarai Wayalar Reserve Forest Region, Western Ghats, India and its Correlation with the Disturbance Regime.* University of Madras.

Mahapatra, Sushanta Kumar. *Intricacies of Canal Irrigation Management and Water Governance in India: The Case of Hirakud Command Area, Orissa.* University of Madras.

Usha, B. *Molecular and Functional Characterisation of Metallothienein Genes from Prosopis juliflora and Over-expression in Transgenic System.* University of Madras.

Valarmathi, R. *Bioprospecting Secondary Compounds from Selected Lichen Species: In vitro Production, Characterization and Molecular Basis of Compound Production.* University of Madras,

Ratheesh Narayanan, M. K. *Floristic Study of Wayanad District with Special Emphasis on Conservation of Rare and Threatened Plants.* University of Calicut.

Sadasivam, S. *Introgression of Transgenes to Develop Location-specific Rice Varieties for Salinity Stress Tolerance and Enhanced Iron Content.* University of Madras

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