International Development Research Centre (IDRC)

Agriculture and Food Security (AFS) Program Canadian International

Food Security Research Fund

Project Title: Alleviating Poverty and Malnutrition in Agro-Biodiversity Hotspots

IDRC Project Number: 106505-001

Research Organizations involved in the study:
M.S. Swaminathan Research Foundation (MSSRF), Chennai
and
University of Alberta (UA), Edmonton, Alberta, Canada

Location of Study:
(1) Vallapur Nadu Panchayat, Kolli Hills Block, Namakkal District, Tamil Nadu
(2) Meenangadi Panchayat, Wayanad District, Kerala
(3) Kundra Block, Koraput District, Odisha
Canada: University of Alberta, Edmonton

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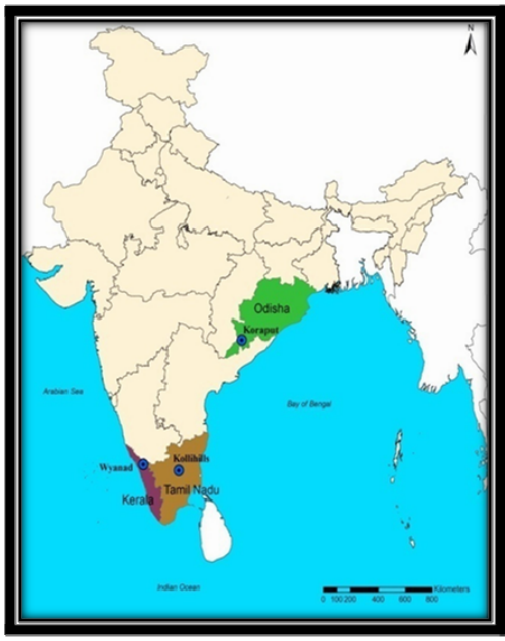
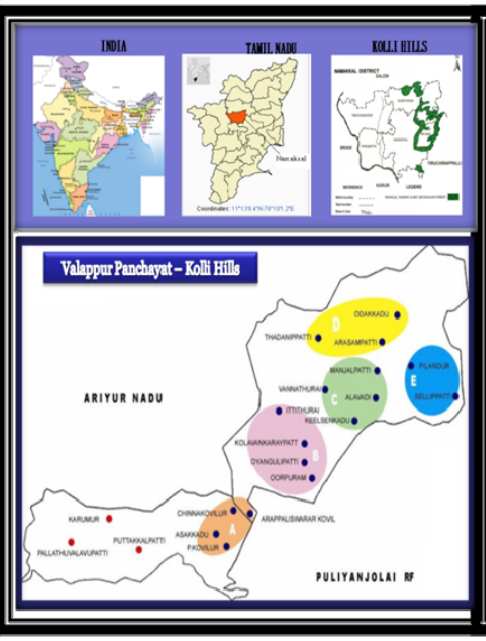
APM Project Locations

Project Sites in India



Kolli Hills, Tamil Nadu



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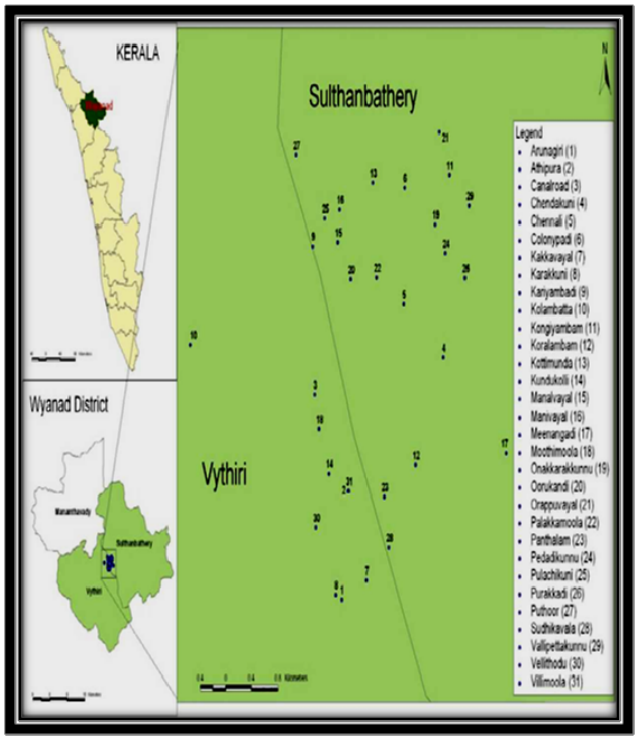
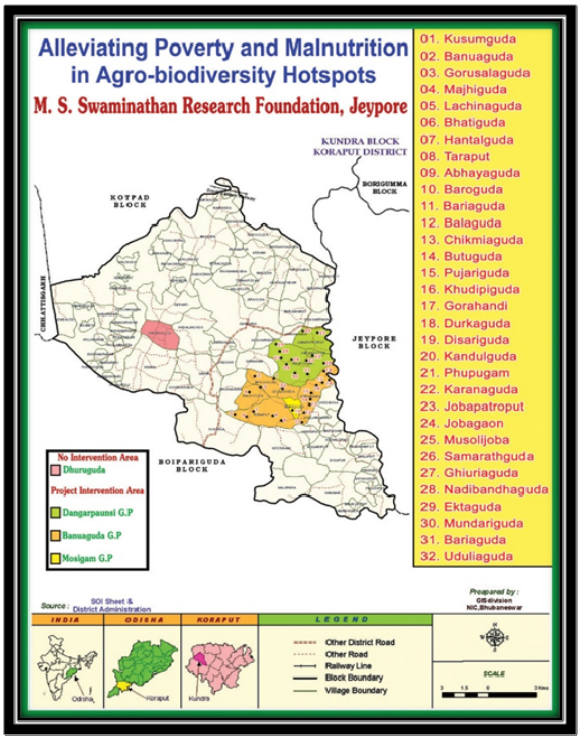
3. Periyakoviloor
4. Chinnakoviloor
5. Arappaleaswarkoil
6. Oayam
7. Oyangulipatti
8. Eerangulipatti
9. Nellukizhi
10. Oorpuram
11. Mathiya Divalavu
12. Tamaraikulam
13. Soludaipatti
14. Vallalarkottam
15. Kolanvangirai
16. Kuttikiraipatti
17. Kanjampatti
18. Alavadipatti
19. Manjalpatti
20. Keelsengadu
21. Arasampatti
22. Thathandipatti
23. Pagudipuduvalavu
24. Odaikadu
25. Sellipatti
26. Pilandur

Wayanad, Kerala



Jeypore, Odisha



01. Kusumguda
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04. Majhiguda
05. Lachinaguda
06. Bhatiguda
07. Hantalguda
08. Taraput
09. Abhayaguda
10. Baroguda
11. Bariaguda
12. Balaguda
13. Chikmiaguda
14. Butuguda
15. Pujariguda
16. Khudipiguda
17. Gorahandi
18. Durkaguda
19. Disariguda
20. Kandulguda
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Acronyms

AFS=Agriculture and Food Security Program (IDRC)

ANC=Ante Natal Care

APM=Alleviating Poverty and Malnutrition in Agro-Biodiversity Hotspots Project

CBD CoP 11=Convention on Biological Diversity Conference of Parties 11 (CoP 11)

CBO=Community Based Organizations

CHF =Community Hunger Fighters (Engagement Vehicle and Community Cadres)

CIFSRF=Canadian International Food Security Research Fund

CSC=Common Service Centre

CUSAT=Cochin University of Science and Technology (India)

EFY=Elephant Foot Yam

FAO=Food and Agriculture Organization

FC=Farmers' Clubs

FF=(Inland) Fish-Farms (APM Activity)

FG=Farmers Group

FGD=Focus Group Discussions

FRG=Farmer Research Groups

FYM=Farm Yard Manure

GIAHS=Globally Important Agricultural Heritage System

GPS=Global Positioning System

GWAS=Genome Wide Association Studies

HH=Household

IAY=Indira Awas Yojana

ICDS=Integrated Child Development Scheme

ICRAF=International Centre for Research on Agro forestry or the World Agro forestry Centre (APM Third-Party Organization)

ICRISAT=International Crops Research Institute for the Semi-Arid-Tropics (APM Research Network Member)

ICT=Information and Communication Technology

IDRC=International Development Research Center

INR=Indian National Rupees

IPM=Integrated Pest Management

KAU=Kerala Agricultural University

MDM=Mid Day Meal

MDMS=Mid Day Meal Scheme

MGNREGS=Mahatma Gandhi National Rural Employment Guarantee Scheme (Indian Poverty Reduction Public Policy)

MSE=Madras School of Economics (India)

MSSRF=M.S. Swaminathan Research Foundation

NG=Nutrition Gardens (APM Activity)

NGO=Non Governmental Organization

NIN=National Institute of Nutrition (Hyderabad, India)

NPK=Nitrogen, Phosphorus and Potassium

NUS=Value Addition for Wild and Neglected and Under-Utilized Crop Species (APM Activity)

PAC=Project Advisory Committee

PDS=Public Distribution System

PNC=Post Natal Care

PRA=Participatory Rural Appraisal

PRI=Panchayat Raj Institutions (India)

PSC=Project Site Committees

PVS=Participatory Varietal Selection (APM Research, Outreach and Engagement Tool)

RDA=Recommended Dietary Allowance

REES=Resource Economics and Environmental Sociology (University of Alberta Department)

SC=Scheduled Castes (Indian Official Classification)

SEARCH=Sustaining, Enhancing, Activating, Relating, Capitalizing, and Harnessing

SB=Seed Bank (APM Activity)

SHG=Self-Help Group

SRI=System of Rice Intensification

ST=Scheduled Tribes (Indian Official Classification)

TEACH=Testing, Evaluating, Assessing, Characterizing, and Hypothesis testing

TPDS=Targeted Public Distribution System

UA=University of Alberta

VKC=Village Knowledge Centre (APM Outreach and Engagement Vehicle)

VKD=Village Knowledge Disseminator (Community Cadres)

VRC=Village Resource Centre (APM Outreach and Engagement Vehicle)

WHO=World Health Organization

YET=Yield Enhancement Trials

1.0 Executive Summary

The Alleviating Poverty and Malnutrition in Agro-biodiversity Hotspots (APM) project was supported by the Canadian International Food Security Research Fund and implemented jointly by the M.S.Swaminathan Research Foundation and the University of Alberta in three agro-biodiversity rich regions of India - Jeypore in Odisha, Kolli Hills in Tamil Nadu, and Wayanad in Kerala. This research-for-development project investigated the possibilities for interventions in integrated agricultural systems to contribute towards alleviating poverty and malnutrition among small-holder farm families. Over a period of 42 months, the project worked in close partnerships with communities and established that integrated agricultural systems with concurrent attention to knowledge transfer and harnessing local agro-biodiversity can provide cost-effective and sustainable solutions to poverty and nutrition problems.Through extensive primary surveys and analysis of secondary information, it was established that rural poverty persists in these areas as a result of low agricultural productivity among small and marginal farmers thus declining *on-farm* incomes, limited opportunities for *off-farm* employment and isolation from markets and public services. These areas are characterized by having 60-85% of households below the official poverty line category with low nutritional status (malnourishment, anemia, stunting or underweight) especially among women and children. The project also attempted to enhance capacity and human skills for making appropriate choices and decisions on farm management, family diet, and adoption of new enterprises.

Given the above context, the APM project took an innovative approach to resolve the enigmatic contradiction between prosperity of nature and poverty of people, involving multiple actors with comparative advantages to integrate technological, policy and institutional components that respond to changing poverty, nutrition, market and policy conditions.

Towards achieving the multiple objectives of poverty alleviation, improvement in nutrition, food security and social protection, the APM project worked with local project participants to test new production technologies, new techniques for crop and animal husbandry, *on* and *off* farm enterprises, improving nutrition literacy, as well as social and institutional innovations. The APM project had five distinct objectives:1) increasing farm productivity, 2) improving food and nutrition security, especially for women, 3) diversification of *on*- and *off-farm* livelihood sources, 4) training and capacity building and 5) knowledge management and policy advocacy through carefully defined, environmentally sustainable, location specific and gender sensitive interventions.

The APM project partnership adopted the SEARCH-TEACH model to integrate experiential learning with farm families with research on processes and general trends. SEARCH represents Sustaining, Enhancing, Activating, Relating, Capitalizing, and Harnessing local resources, while TEACH represents Testing, Evaluating, Assessing, Characterizing, and Hypothesis testing.

The key APM project outputs and outcomes: APM project benefitted 3845 households from 94 hamlets covering a population of 16,552 members (8304 male and 8248 female) across the three project sites over a period of 42 months. APM project interventions have made a difference in terms of enhancement in income, nutrition, knowledge and above all the quality of life among participant households. The specific interventions of the project led to significant outputs and outcomes of the following types:

Through participatory research, farmers have adopted quality seed production in locally-adapted varieties of cassava, millets and paddy. This boosts agro-biodiversity while enhancing yield and income. In Wayanad, farmers identified two elephant foot yam varieties with better disease resistance and drought tolerance, and achieved a 20% increase in yield over current farmer practice. By intercropping cassava with millets, pulses and onion, in Kolli Hills, farmers realized up to 27% (millet), 35% (pulses), 45% (onions) increases in income compared to cassava mono-cropping.

The adoption of integrated and improved scientific practices in cultivation of finger millet in Jeypore enhanced productivity by 82% and monetary returns by 46%. Women and landless farmers have gained access to land for cultivation of short-duration crops and benefited from cultivation of suitable varieties, consumption of diverse species, including vegetables, through intercropping across sites.

Sustainable management of crops, soil and water was achieved through conservation and use of landraces of native crops, participatory varietal selection, quality seed production, vermi-composting, green manure application and promotion of percolation and farm ponds. In Kolli Hills, application of green manure to improve soil health has resulted in an increase of 25-30% in paddy yield from 2.96 Metric tons /Ha to 4.2 Metric tons/ Ha. In Jeypore, conventional practice by farmers in pure crop of finger millet yielded 7.4 Quintal /Ha while, improved agronomic practices yielded 13 Quintal /Ha. In addition to yield, farm women and men identified a set of desirable qualities for rice, including straw yield, pest resistance, low shattering, and cooking quality.

Action-based nutrition literacy was integrated with the promotion of nutrition gardens in all sites. Nutrition gardens provide farm families with legumes, vegetables, tubers, leafy greens, gourds and fruits. The availability of home-grown vegetables per family per annum increased from 56 kg to 135 kg in Jeypore; from 48 kg to 90 kg in Kolli Hills; and from 26 kg to 96 kg in Wayanad. This is more than double the quantity of vegetables that families were previously buying from local markets. Households who adopted nutrition gardens had access to more nutritious and diverse food, reduced their reliance on local markets, and shared more food with others than non-participating households. Across the three sites, more than 50% of households consumed all of the produce generated from their nutrition gardens. 75% of sample households benefited by consuming more green leafy vegetables, while 67% household benefitted from fruit trees. Across sites, nutrition gardens increased from 11% to 58% in Kolli Hills, 36% to 77% in Wayanad and 26% to 78% in Jeypore. Men recognized the role and contribution of women in managing nutrition gardens across sites.

Communities have adopted fish farming in local water bodies, thus generating a new source of animal protein in their diet. Promotion of fresh water aquaculture across sites in 71 underutilized water bodies has led to collective action at the community level and also increased the per capita consumption of fish by 47%. Likewise, meat from poultry farming provided additional animal protein which led to an increase of 29% in animal protein consumption.

The APM project provided a basket of livelihood options comprising technologies and activities through *on-farm* and *off-farm* enterprises to add value to time and labour and increase income. For instance, millet pulverizers promoted in Jeypore and Kolli Hills reduced the drudgery of women in finger millet processing. The small scale pulverizers are able to process 20-25 kg of grain per hour, compared to one kilogram processed manually. Paddy dehullers helped in reducing drudgery and time of women besides enabling food processing at the household level. The country chicken model promoted in Kolli Hills with women

groups generated INR.1500/group member per cycle. Tamarind processing in Jeypore generated additional net income of INR 1400/ group member, while honey bee keeping in Kolli Hills increased net income by Rs.800/group member per cycle. The collective yam cultivation by landless women in Wayanad enabled them to earn additional income of INR.3000-13,000/ group member.

The project supported knowledge empowerment of communities through Information, Education and Communication by formal and non-formal methods. Seven new Village Knowledge Centres and three Village Resource Centres facilitated physical access to information technologies by 7391 individuals (3288 women and 4103 men), in addition to benefitting 4243 members (2181 male and 2062 female) through virtual access such as voice messages, phone-in-programmes and audio/video conferences. Knowledge empowerment focused on contents in the domains of integrated agriculture, conservation, nutrition, health and entitlements, which had forward linkages to and adoption of practices such as inter-cropping, seed management, soil health management, nutrition gardens, inland fisheries, health, sanitation, credit linkages and functional literacy. Besides, Community Hunger Fighters played a pivotal role in creating awareness and knowledge dissemination on nutrition, social entitlements and *on-farm* and *off-farm* livelihood options. Nutrition volunteers and Village Knowledge Disseminators helped in increasing the nutrition related awareness at the household level.

To enhance sustainability, the project anchored all its efforts in community based organizations. The project supported the formation of 23 Farmers Clubs, 20 Farmer Research Groups, and 46 Self Help Groups, involving 1546 farmers. Women made up 47% of the general membership of these groups and were equally represented in the management committees.

National and international events such as Dialogue on International Food Security at the University of Alberta and the Asia Pacific Regional Consultation of Family Farming, Chennai, India were supported by the project platforms for disseminating research results for researchers, graduate students, practitioners, government officials, think tanks and policy makers. Farmers-to-farmers learning events were facilitated through Project Site Committees. Two key policies were advocated in these events: the 4C (Conservation, Cultivation, Consumption and Commercialization) approach for improving sustainable food security and eliminating hunger, and the effective procurement and distribution of nutri-millets through the Public Distribution System.

Dissemination and communication of results was mediated through the Website (www.ua-mssrf.org), press coverage and nearly 100 posters, paper presentations and peer-reviewed published research papers.

The 42 months project was implemented at a budget of CAD $ 5 Million.

2.0 The Research Problem

The APM project focused on the contradictions observed in many parts of India between the persistence of extremely high rates of chronic malnutrition and poverty despite high rates of economic growth and abundant natural capital (Ramalingaswami *et. al* 1996; The Lancet, 2013). India is one of the world's 17 mega-diversity countries[1] and a major center of crop

[1] The three APM sites specifically are all located in threatened agro-biodiversity hotspots in the Eastern and Western Ghats plateaus, of which parts of the former are included in the Jeypore hotspot and the entire latter area has been designated as one of the world's 35 biodiversity hotspots.

domestication, yet Grebmer *et. al* (2014) estimates that Indian malnutrition rates are 31% for children under the age of five.

The overall objective of the APM Project was to address this problem by conducting research, implementing interventions and evaluating development interventions which were designed to enhance the food, nutrition and income security of the rural poor at the project sites. Its guiding proposition was that integrated agricultural systems which harness local agro-biodiversity can provide cost-effective and sustainable solutions to the poverty and nutrition problems that persist in those areas.

The project had five specific objectives: (1) Increased farm productivity by promoting integrated and sustainable use of local crop and livestock diversity with attention to under-utilized crops and breeds, vegetables and fruit trees; (2) Enhancing food and nutrition security at individual, household and community levels, understanding gender dimensions of poverty and socio-economic empowerment of women: (3) Enhancing *on*- and *off*-farm livelihood diversification options; (4) Need based capacity building of focal farm families involving *panchayats*, governmental, non-governmental and service providing institutions and policy makers; and (5) Developing tools and processes including Information and Communication Technology (ICT) for information/knowledge management and policy advocacy. The research process SEARCH-TEACH was broad in its approach – multiple methods were tested with rural families in the three sites and evaluated for impact. Interventions were categorized as searching for solutions via participatory research and teaching lessons from farmers' experiences.

Figure 2: APM Objectives, Theory of Change

During the project, research shifted in focus from particular methods of integrated agriculture towards methods and combinations of interventions which had potential to influence development trajectories in a positive manner. For example, the dominant development trajectories for such rural areas imply that economic advancement will come at the cost of biodiversity loss. Ironically, the isolation of these communities which has slowed economic progress in these marginalized areas has also helped to protect their inherent natural wealth. The Theory of Change underlying this project was that alternative development trajectories are possible for families and communities in areas similar to our project sites: they can better harness available crop, tree, water and soil resources in ways that simultaneously increase

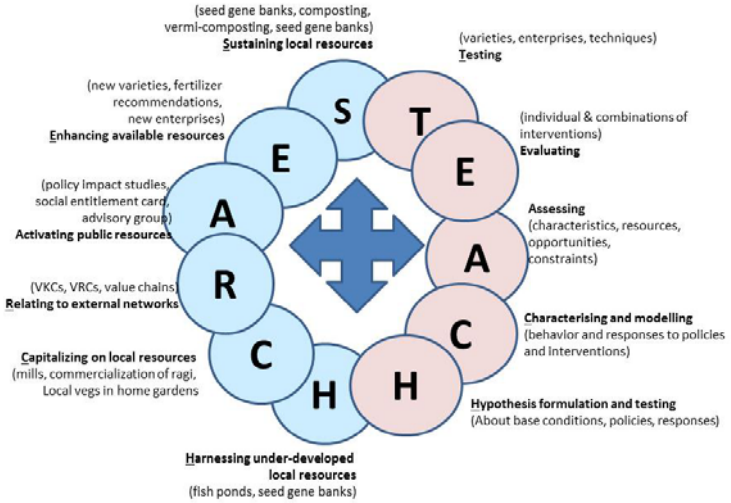
productivity, diversifies diets and conserves rich agro-biodiversity in a socially equitable and environmentally sustainable manner. In this context, the agriculture sector is considered as an enterprise that provides multiple opportunities for sustainable *on* and *off*-farm livelihoods.

The progress of research and development in this project has global implications for poverty reduction and agro-biodiversity conservation. The rigorous research underlying such conclusions is of benefit to the scientific community, while the development community will gain from increased knowledge and practical results obtained from implementation activities in the project sites as well as at regional levels, which could guide policy recommendations. Finally, government policy makers at panchayat, state and national levels will benefit from the lessons learned to address social and environmental issues by adopting the recommended policies to ensure sustained growth and development in these communities.

The Theory of Change (Figure 1) articulates the context, assumptions and drivers underlying the project, as well as the five project objectives and results framework. Poverty, historical disadvantage, political marginalization and relative isolation in addition to agro-biodiversity wealth characterizes all three APM project sites, with levels of income and nutrition lowest in Jeypore, intermediate in Kolli Hills and highest in Wayanad. Given the multiple challenges faced in these areas, the assumption is that there will be no single solution that is best for all households or all locations. That assumption underlies the decision to offer participants an array of farm-level and community-level options for increasing and diversifying income and to improve connections between the communities and the external environment.

The SEARCH-TEACH (Figure 2) model was developed to explain the connections between the development-oriented work that was carried out by APM project staff with individual people and households in the study locations and the research-oriented work that was undertaken in order to learn from people's experiences with those technologies, information and empowerment. SEARCH stands for Sustaining local resources (seed banks, vermi-composting), Enhancing available resources (new varieties, fertilizer recommendations, new enterprises), Activating public resources (social entitlement card, advisory group), Relating to external networks (VKCs, VRCs, value chains), Capitalizing on local resources (mills, commercialization of minor millets like finger millet (*ragi)*, local vegetables in nutrition gardens), and Harnessing under-developed local resources (fish ponds, seed banks, nutrition gardens). TEACH represents Testing (varieties, enterprises, techniques), Evaluating (individual and combinations of interventions), Assessing (characteristics, resources, opportunities and constraints), Characterizing and modelling (behavioral responses to policies and interventions), and Hypothesis formulation and testing (about base conditions, policies, responses) Almost all of the SEARCH work was implemented by M.S. Swaminathan Research Foundation (MSSRF) field staff, while the University of Alberta (UA) staff and students were primarily involved in TEACH work. Senior MSSRF field staff and Chennai-based staff tend to be involved in both SEARCH and TEACH work. Local participants in the three sites had two roles; to work with MSSRF staff to "Search" for options to improve their well-being and nutrition status, and to "Teach" others about their experience by providing data and feedback to the researchers and local decision-makers.

Figure 2: SEARCH-TEACH Model



3.0 Progress towards Milestones

Table 1: Summary of Progress towards Milestones

Milestones	Reporting Periods			
	1st Period: 1-6m. Mar. 11.-Aug. '11 (6 Milestones)	2nd Period: 7-18m. Sept.'11-Aug.'12 (7 Milestones)	3rd/4th Period:19-30m. Sept.'12-Aug.'13 (9 Milestones)	5th Period: 31-42m. Sept.'13-Aug.'14 (8 Milestones)
Organization (planning, monitoring & evaluation)	Project inception workshop	Annual PAC meeting	Annual PAC meeting	Annual PAC meeting
	Personnel & PAC			
	Project Site Committees	Project Site Committees	Project Site Committees	Project Site Committees
Concept-ualization	Gender indicators &strategy		Policy analysis for sites/regions	
		Participatory community nutrition-action plans		
		Value chains identified		
Data Collection	Benchmark survey	Soil assessment & GPS maps	Bi-annual nutrition monitoring survey	
	Farmer participatory trials		Agronomics of climate-resilient local varieties	
Farmer-Researcher SEARCH-TEACH-		Training program (nutrition, value-addition, small-business man.)	Off-farm & value-addition businesses developed & productsmarketed	Organic certification & marketing of natural & farm products
		NGs, vermicompost units & livestock operations	Integrated livestock-small farm production systems	Mechanical post-harvest processing centers
		Nutrition gardens	Participatory seed production	
Results Analysis			Early result analysis & dissemination	Integrated agriculture model for South Asia
Results Dissemination			Early result analysis & dissemination	Travel workshop (policymakers/major stakeholders, S. Asia)
				Fact sheets, audio, video & digital material
				Final dissemination conference(India)
				Joint peer-reviewed articles

3.1 Objective 1: Increased farm productivity by promoting integrated and sustainable use of local crop and livestock diversity, with attention to under-utilized crops and breeds, vegetables and fruit trees

The farmers in agro-biodiversity hotspots operate on minimum resources of land, water and finance. Holistic approach is the only pathway to enhance farm productivity of these small holders for increased income, livelihood, food and nutrition security.

3.1.1 Provision of quality seed materials: Quality seed materials were made available for the major groups in conjunction with the Community Based Organizations (CBOs) and Farmer Research Groups (FRGs). A total of 112 quality seed production trials were conducted focused on production of paddy (rice), millets and cassava.

Paddy is the most commonly grown staple food crop across three project sites. Analysis of findings from Focus Group Discussions (FGDs) and Participatory Rural Appraisal (PRAs) revealed that paddy productivity was low due to lack of access to quality seeds of drought and pest tolerant varieties. Therefore, quality seed production of paddy varieties for lowland (8), medium land (5) and upland (4) was promoted in Jeypore. In Kolli Hills and Wayanad, 10 and 9 varieties were promoted in lowland for quality seed production.

In the case of finger millet, quality seed production trials were promoted for 13 and 14 varieties in Kolli Hills and Jeypore respectively. Three little millet varieties were promoted in Kolli Hills and two little millet varieties were tested in Jeypore. In the case of cassava in the Kolli Hills, 9 varieties were provided to farmers to promote cassava mosaic disease resistant crops and higher starch yield. In Wayanad, 3 field-tested and high-yielding varieties of elephant foot yam were provided to farmers as seed material. The variety of elephant foot yam, *Gajendra,* was multiplied by farmers and 2294 kg of planting materials produced. Grafts of *Lucknow 49* guava, *BSR 1* gooseberry and *Red lady* papaya were distributed among 500 HHs each in Kolli Hills and Wayanad and 1000 HHs in Jeypore. Planting materials of orange flesh sweet potato varieties namely *Varun, Kanjangad local, Kanaga* and unnamed landraces were provided to farmers in Kolli Hills and Wayanad.

3.1.2 Soil Health Management: For optimum soil health to support sustainable agriculture, soil health analysis was carried out for 440 samples in Kolli Hills, 330 samples in Wayanad and 714 samples in Jeypore and were analysed for available Nitrogen (N), Phosphorus (P), Potassium (K), organic carbon and micro nutrients (Eg.Ca, Mg, Zn, Cu).

Organic manure application by vermi-compost and green manure was also undertaken. 400 vermi-composting pits in Kolli Hills and 500 pits in Jeypore were established that benefited 1356 farming households. Green manure crops like *Sesbania* species were demonstrated in wetlands and seeds were provided to 57 paddy farmers in Kolli Hills, 28 farmers in Wayanad and 32 farmers in Jeypore. A well-known fertilizer tree (*Faidherbia albida*) was introduced to 10 farmers in Kolli Hills and 22 farmers in Jeypore.

3.1.3 Farmers' participatory research and demonstrations: Improved local adaptation, enhancement of genetic diversity and empowerment of rural communities are inherent advantages of participatory varietal selection (PVS). PVS also facilitates evaluation of subjective traits like taste, aroma, texture and other characteristics in accordance to local community preferences. PVS trials were undertaken involving Farmer Research Groups (FRGs), collections of progressive farmers who tested new approaches and shared their experiences with other farmers. For example, in the Kolli Hills, the FRGs were used as a platform for communicating with the District Administration and also with research institutes (land to lab), thereby playing a significant role of agricultural extension. FRGs comprising of

1014 farmers undertook 70 PVS trials on six crops (paddy, millets, cassava, yam, green gram and horse gram) and 85 varieties.

3.1.4 Village Seed Banks: Seed Banks (SBs) involved participatory seed production, storage and timely supply of planting material through community. SBs provided a means for community groups to exchange quality seeds of landraces and improved varieties of paddy, millets, local Neglected Underutilized Species (NUS) varieties and a few vegetables. Twenty SBs managed by Farmers Clubs (FCs) and FRGs were established in Kolli Hills and Jeypore. To better harness the potential of Nutritious Underutilized crops, 131 participatory quality seed production trials with native varieties were undertaken.

3.1.5 Crop Livestock Integration: Twenty trials, 10 each in Kolli Hills and Jeypore with integrated animal husbandry, fish farming, and fodder promotion were undertaken.

3.1.6 Drudgery reduction and post-harvest processing: The APM project has contributed to the improvement of post-harvest food processing and storage techniques for food security through promotion of small scale pro-poor mechanization. Individual farm families were provided with a variety of farm equipment to improve productivity and reduce drudgery, including 400 treadle (water) pumps for small scale irrigation, 25 row markers, 342 sprayers, 193 mechanical winnowers, 400 ploughs, 60 puddlers, 500 garden rakes and 500 trench hoes. Farmer groups were provided with other equipment for co-operative management, including 18 power tillers-fitted-with-trailers to aid in the transportation of produce to processing centres, 3 harvesters, 5 mechanized paddy dehullers, 8 millet pulverizers, 18 tamarind decorticators with press machines, 7 sealing machines, 5 electricity operated multi grain thresher cum winnowers. This farm mechanisation support was extended to farmers across three sites through CBOs such as FCs and Common Service Centres (CSCs).

3.2 Objective 2: Enhancing food and nutrition security at individual, household, and community levels; understanding the gender dimensions of poverty and the socio-economic empowerment of women

The key milestones for the objective were: 1) Ensuring quality planting materials of vegetables and fruits, 2) Establishment of nursery of fruit seedlings, 3) Analysis of data from the nutrition surveys, 4) Identification of major interventions and development of action plans in consultation with communities, 5) Identification of appropriate species of vegetables and fruit trees for each site and seeds, 6) Supply of saplings for the establishment of 1600 nutrition gardens, 7) Gender-disaggregated nutritional intervention strategy determined for each location, 8) Vegetable production from nutrition gardens and use reviewed with the active participation of farm women, 9) Preparation of food and nutrition entitlement cards and their distribution, and 10) Expansion of nutrition gardens to 75% of HHs in all sites.

Nine of these ten milestones were achieved in full during the project period, with some delays in analysis of data from the nutrition surveys 58% of farm households adopted nutrition gardens in the Kolli Hills site. Establishment of nurseries for fruit seedlings was not undertaken at significant scale.

3.3 Objective 3: Enhancing *on*- and *off*-farm livelihood diversification options

Identification of *on*- and *off*-farm livelihood diversification options was undertaken in consultation with communities and agribusiness professionals, site specific market studies and value chain analysis. This also involved the study of access of communities to natural resources and the willingness of farmers and farm groups to participate in value addition and marketing of agricultural produce. Valuable suggestions by members of the PAC and

regional project site committee played a vital role in planning and implementation of these initiatives. Activities included: (1) tamarind processing; (2) value addition to processed crop products, country chicken, and goat rearing; and (3) research into the role of social networks in the diversification of income sources. Several of these businesses were managed by women's self-help groups (SHGs). Facilitation of these activities included the continued development and establishment of mechanical post-harvest processing centers, which particularly benefited women in terms of drudgery-reduction, and the continued marketing of processed farm products.

For the first 12 months of the project, the focus of this activity was on the development and marketing of specialty and new value-added products for external markets. Several of these options that were explored (eg. direct marketing of hill banana from Kolli Hills) were deemed to be too high risk relative to the potential gains. Instead the focus shifted to products that already had assured markets, especially those that could be undertaken by people with little or no access to land.

Tamarind is an important farm produce in Jeypore that serves as a source of additional livelihood. It is collected and manually processed that involves substantial time and efforts on the part of women. Manual processing also results in relatively shorter shelf life of the product. The APM Project in consultation with the community, identified Tamarind processing as an *off* farm livelihood. Eighteen tamarind manual decorticators and manual tamarind compactors were provided to women SHGs. The shelf life of the processed material has improved with hygienic value addition and packaging.

The Kolli Hills and Jeypore sites assisted members of SHGs to establish *on*- and *non*-farm enterprises like value addition to millets, raising of country chicken, goat rearing, processing of fruits, vegetables and medicinal plants and integrated livestock (primarily backyard poultry) businesses.

The highlights of the promotion of these livelihoods centered on mechanization developments: the establishment of five processing centers for rice, ten millet pulverizers and six sealing machines. This was further facilitated by community managed provisions for economic transportation facility to processing centers by employing six power tillers and tillers-fitted-with-trailers. Periodic capacity building of women entrepreneurs was undertaken by holding training programmes on post harvest processing of agricultural produce, value addition, packaging and sealing, improved animal husbandry and financial management of small businesses operated through community based organizations. This was further supported by promoting financial and market linkages.

Landlessness restricted the participation of 36% households in agronomic interventions. Hence, research initiatives with little dependence on land were designed to alleviate poverty in landless households. Stress was laid on promoting community managed freshwater fish farming, backyard poultry farming and mushroom cultivation among landless households.

3.4 Objective 4: Need-based capacity building of focal farm families involving *panchayats*, government, non-governmental and service providing institutions and policy makers

Multi-stakeholder capacity building on many of the interventions listed under objectives 1 to 3 are essential for (a) individual farm women and men, their groups or cooperatives; (b) members of local Panchayats, local government officials, non-governmental and service providing institutions working in the project area; and (c) policy makers on the impact of the

project in alleviating hunger and malnutrition apart from those on the economic, ecological and equity aspects of rural life.

To identify the specific areas of need based capacity building, tools like participatory rural appraisal, focus group discussion and structured questionnaires were employed. While collecting data, questions were designed in each section for problem identification with respect to the thematic area. Based on the findings from these social tools, capacity building programmes were planned and suitable content development in local languages were undertaken.

3.5 Objective 5: Developing tools and processes including ICT for information/knowledge management and policy advocacy

APM developed tools and processes for information/knowledge management and policy advocacy through the following activities: (1) Dissemination of project results and learning; (2) Organizing side events at international meetings, policy makers workshops and meetings and (3) Monitoring and Evaluation.

3.6 Project Monitoring Milestones

Meetings of Project Site Committees (PSC) were organized at regular intervals that provided an opportunity for the members of local communities participating in the activities and their representatives to learn about the progress of the project and steer it for increasing its effectiveness. At the project level, regular Project Advisory Committee (PAC) meetings were held in which expert members, third party organizations, donors participated and provided their inputs to steer the project and offer mid-course corrections that ultimately shaped the outputs and outcomes of the project.

4.0 Synthesis of Research Results

4.1 Objective 1: Increased farm productivity by promoting integrated and sustainable use of local crop and livestock diversity, with attention to under-utilized crops and breeds, vegetables and fruit trees

4.1.1 Provision of quality seed materials: Adoption of good seed material and improved agronomic practices resulted in increased productivity of paddy in upland, medium land and low land by 37%, 10% and 32% respectively thereby increasing economic return from paddy cultivation by at least 17%. Focus on integration of improved scientific practices in the cultivation of nutritious underutilized crops such as finger millet enhanced the productivity by 82% thereby enhancing the monetary return from finger millet cultivation by 46%. Adoption of improved scientific practices in cultivation of landraces registered highest enhancement in productivity with decreased disease incidences. The quality seeds were accessed by 1546 farmers through 23 FCs, 20 FRGs and 46 SHGs across three sites.

4.1.2 Soil health management: Awareness was created on application of recommended levels of organic and inorganic fertilizers suitable for local crops as per land types and seasons. Fertility status of soils distinctly differs across the three sites; however, soils were largely acidic across the sites. With regard to nitrogen, the majority of soils range from medium to low. This necessitated recommendation of ample application of nitrogenous fertilisers and use of farm yard manure or vermicompost to ensure a good crop growth. With regard to phosphorus, majority of the soils are high, providing a pathway for promotion of pulses that require high amounts of phosphate. With regard to potassium, majority of the soils in Wayanad and Jeypore are low, while almost half of soils in Kolli Hills are high. Crop specific and site specific recommendations for each site, for example in the case of Kolli

Hills, application of inorganic fertilizers at the rate of 100:50:50 NPK/Ha for paddy, 100:50:100 NPK/Ha for Cassava and 80:40:40 for millets were recommended. Soil health cards were provided to all households. Each vermi-compost pits in the Kolli Hills were able to provide 40 to 50 kg of harvest per month which the farmers used in their paddy, banana, coffee, pepper, millets, cassava and nutrition gardens. In Jeypore, the 500 pits yielded on an average 126 kg / pit per year. Of this 4589 kg were sold for a sum of INR 27,534/- and the rest used for raising crops including little millets, finger millet, paddy and vegetable crops. By application of green manure to improve soil health in paddy fields, the farmers were able to notice an increase of 25-30 percent in the paddy yield from 1280 kg/ac to 1700 kg/ac.

4.1.3 Farmers' participatory research and demonstrations: Site specific suitable varieties of paddy, millets, cassava and elephant foot yam were identified and promoted for optimum productivity under respective regional agro-climatic conditions. The findings from pure crop yield enhancement trials of finger millet in Jeypore registered a 137% increase in the net return. The farmers' practice in pure crop of finger millet yielded 740 kg/ha whereas the adoption of improved agronomic practices yielded 1,346 kg/ha enhancing the productivity by 82%. The improved package of practice carried out in paddy, millets and cassava resulted in yield increase of 25% to 30% over farmers practice. The System of Rice Intensification (SRI) trials have shown increased yields of average of 5789 kg/ha in the variety *Athira* and an average of 4811 kg/ha in comparison to scientific cultivation practices. The project also developed genetic markers that can be used in the selection of drought tolerant varieties using molecular markers for discovery and assessment of high genetic variation in the varieties of millet from the different geographic regions of India.

Intercropping trials in Kolli Hills revealed that 27%, 35% and 47% higher income in millet intercropping in cassava, black bean and onion respectively compared to cassava monocropping. Intercropping of finger millet with pigeon pea in 6:2 and black gram 6:2 ratio yielded an increased net return of 194% in Jeypore. Promotion of intercropping of millets with legumes further added dietary diversity to household nutrition. Results from the Kolli Hills indicate that cassava-legume intercropping and rice row planting have both resulted in 30-80% increased in yields. Experience with the intercropping trials in Kolli Hills contributed to many households adopting the cassava with millets, pulses and onions (Cassava + Legume, Cassava + Millet, Cassava + Onion and Millet + Blackgram). An initial estimate suggests 30-40% of households adopting intercropping. The intercrop of millets and cassava recorded an average increase in yield of 20-30%. An inter crop of cassava, millet and pulses recorded over 20% increase, while adoption of split doses of NPK and Farm Yard Manure (FYM) in the same inter crop combination recorded a 30% increase. Intercropping and more effective utilization of land and organic inputs provided not only an additional income but also generated nutrition rich crops for food and fodder.

With regard to Elephant Foot Yam in Wayanad, there are significant differences in pit size, quantity of seed material used, spacing and the use of fertilizers. Parameters like germination rate, pest and disease attack, cooking quality (farmers' preference), yield etc. were documented and shared with farmers. The germination percentage was 80% for *Gajendra* and 75% for *Padma* and *Wayanad* local varieties respectively. Germination rate was observed to be higher in the research plots as compared to the conventional method. The Yield Enhancement Trial (YET) of Elephant Foot Yam (EFY) in the conventional method was 46 tons/ha while in the improved method was 73 tons/ha.

The cost of input is high in farmers' practice as it is evident that they apply five times more chemical fertilizers recommended in the package of practices (KAU, 2011). Farmers are

using either factomphos (Ammonium Phosphate Sulphate) or 18:18:18 in huge quantity. Excess applications of chemical fertilizers, especially factomphos could be making the soil deficient in potassium and excess in phosphorus. The research plot incurred more labour cost while fertilizer cost is higher in farmers' plot. The total cost of cultivation was INR 2,71,241 in farmers' practice while it was INR 2,57,823 in the trial plot. The gross return from one hectare (Ha) in the farmers' plot was INR 3,57,900 while it was INR 4,36,100 in the research plot. The net return from farmers' practice was INR 86,659, while it was INR 1,78,277 in the research plot. The cost-benefit ratio was 1.32 in farmers' plot while it was 1.69 in the research plot.

The results showed that intercropping of cassava with millet can reduce crop yields and have both negative and positive impacts on soil nutrient levels. (Harms and Dick, 2013) Application of fertilizers and mulches to cassava with legume intercrops can have both positive and negative impacts on soil nutrient content in some locations. Surprisingly, application of organic fertilizers appeared to have negative impacts on both yields and soil. In cassava, farmers' interest in shifting to high yielding, starch rich varieties like *CMR1* and *CMR73* over the local *H165* and *Co-50*, *ADT45* varieties in another example. Adoption of intercropping practices between potential local nutritious crops and annual crops like cassava or banana shows increasing awareness among farmers on effective utilization of land in the era of climate change.

4.1.4 Partcipatory Varietal Selection: PVS (Paddy): The PVS at Jeypore showed a preference towards *Jajati*, *Puja* and *Geetanjali* in the lowlands, *Pratikshya*, *Sapuri* and *MTU1001* in the medium land while *Sahabhagi* and *Pandukagura* were preferred in uplands. In terms of characters, *Pratikshya* was preferred for its medium slender grain, good taste, higher yield, and uniformity. *Sapuri* was preferred for its slender grain, good panicle and tillering density and good tall and strong straw. *MTU1001* was preferred for high weight grain and good panicle with compact spike-lets. *Sahabhagi* was preferred for its good yield, less chaffs, very good tillering with long and healthy panicle. *Pandukagura* was preferred for good taste, low water requirement, early maturity and maturity during lean period and long straw that could be used for thatching in huts.

The PVS in the Kolli Hills showed that *ASD16* and *ADT45* were the preferred varieties in the *Kharif* season due to better yield performance, while for *Rabi,* the preferred varieties were *ADT36*, *ADT45* and *ASD19* with a yield of over 30 quintals per acre.

At Wayanad, the farmers preferred *Sampatha* variety for higher yield of 4900 kg/ha and its non-shattering character even though the yield was lesser than the *Uma* variety whose yield was around 5300 kg/ha. *Deepthi* variety was preferred for higher yield and higher straw yield and good cooking quality.

PVS (Finger Millet & Little Millet): In case of finger millet, *GPU28, GPU45* and *GPU67* were preferred by the farmers at Jeypore while the Kolli Hill farmers preferred *GPU66, L5* and *PR202* due to their superior yield performance. In case of Little Millet, *Vellaperunsamai* was preferred in Kolli Hills while *Suan* was preferred in Jeypore due to their superior yield performance.

PVS (Cassava): PVS was taken up for Cassava at Kolli Hills. *CMR1, H165* and *CMR73* gave the best yield performance, though the farmers preferred *CMR1* for consumption, while *CMR73* and *H165* were preferred for their higher starch content.

PVS (Elephant Foot Yam): Elephant Foot Yam is a widely cultivated crop in Wayanad for its commercial value. The PVS trial for Elephant Foot Yam showed that the farmers preferred

the *Gajendra* variety over other varieties like *Wayanad local* and *Padma* due to its superior yield performance, cooking quality, shape and susceptibility to disease.

4.1.5 Village Seed Banks: In Kolli Hills, quality seeds of three varieties of paddy (*ADT45, ASD19* and *white ponni*), three varieties of finger millet (*GPU66, L5* and *Sundangi kelvaragu*), and one variety of little millet (*Sadanchaamai*) were accessed by farmers through twenty SBs. In Jeypore, farmers received access to 44 landraces of paddy, 19 landraces of finger millet and 2 landraces of little millet. This initiative benefited 1546 farmers across three APM project sites.

Researchers sequenced the finger millet (*Eleusine coracana)* transcriptome, identifying over 40,000 gene pairs, the most complete set of gene identifications available for this species to date. In the longer term, this information can be used by plant breeders in developing superior varieties of finger millet which would result in mitigating some of the risks posed by climate change. Genetic markers were identified that can be used to evaluate the diversity of finger millet germplasm in India (Ramados, Deyholos and Kav, 2014). The genomics experiments has also generated a large volume of data on transcriptome changes associated with water-deficit stress, in relatively tolerant and sensitive finger millet lines, which can be mined for additional information relating to messenger RNAs as well as non protein encoding RNA molecules including micro RNAs (miRNAs) and long non coding (lnc) RNAs. This information can be used to identify potential markers for the finger millet breeder to select lines from a breeding population in the longer-term. since it has been found that there is significant variation in mineral and protein content of finger millet accessions, a study will be conducted to develop Oligonucleotide primers using 83 of International Crops Research Institute for the Semi-Arid-Tropics (ICRISAT) finger millet accessions for MSSRF to use to screen local millet accessions for variation in calcium, iron, zinc and protein content in order to provide farmers with recommendations of finger millet varieties with the greatest micro-nutrient and protein content. The methods used in developing these primers include transcriptome sequencing and SNPs--Genome Wide Association Studies (GWAS)--identification.

4.1.6 Drudgery reduction and post-harvest processing: The APM Activity of promotion of small-scale pro-poor mechanization included the implementation of studies on the factors affecting women's adoption of mechanized milling technology at the Kolli Hills site (Miller-Tait *et al.,* 2013) and the impact of willingness to pay on the adoption of pro-poor technologies at the Jeypore site (Hossack and An, 2013). Women often suffered from physical exhaustion, safety hazards and time poverty as a result of drudgery related tasks such as manual weeding, irrigation, paddy hulling, millet pulverization and tamarind processing. With the introduction of new technologies, women were able to complete these tasks with relatively less physical suffering and in a timely manner. Drudgery reducing technology helped women to reduce physical exertion and operational risks and saved 67-95% of their time based on the activity in question. A small users fee was levied by the community managed CSCs towards repair and maintenance of farm and post harvest food processing machineries.

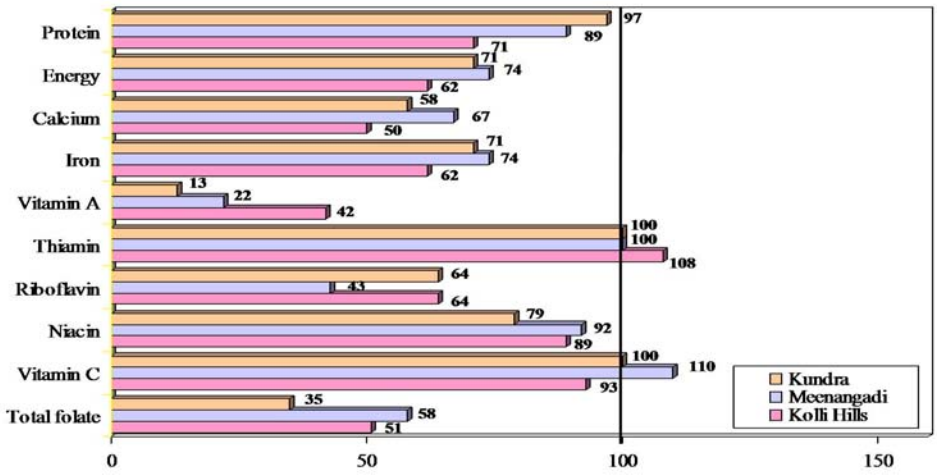
4.2 Objective 2: Enhancing food and nutrition security at individual, household, and community levels; understanding the gender dimensions of poverty and the socio-economic empowerment of women

With a set of interlinked activities, APM project could enhance food and nutritional security at the individual, household and community levels. The project gained an understanding of both the gender dimensions of poverty and the factors affecting the socio-economic

empowerment of women. The major activities included: (1) Assessment of Food and Nutrition Security; (2) Promotion of Household Consumption of a Better Balanced Diet; (3) Strengthening the Culture of Conservation of Genetic Resources through Seed Banks (SBs) and (4) Reduction of Drudgery in Production and Post-Harvest Processing Technology Adoption and Gender Roles. The activities helped to achieve the milestones mentioned in the project proposal to enhance food and nutrition security.

4.2.1 Assessment of Food and Nutrition Security: Food and nutrition assessment surveys were carried out along with the detailed survey. In each of the project sites every 5th household was chosen for assessment. As far as food groups were concerned, people across three field sites consume pulses and legumes; green leafy and other vegetables; milk and milk products; fats and oils; and fruits less than the recommended dietary intake. People across all sites consumed cereals above the recommended dietary intake. People in Wayanad consumed roots and tubers; and sugar and jaggery above the recommended dietary intake (Raghu *et al*., 2014)

Figure 3: **Daily Median Intake of Nutrients (per CU/day) as percent of RDA**



Source: (Raghu *et al*., 2014)

Other than Vitamin C and Thiamin, daily median intakes of nutrients are lower for most of the households surveyed across three project sites.

4.2.2 Major research findings in the area of food and nutrition security: Huang and Farmer (2013) assessed the food situation in Kolli Hills and based on food security, nutritional status, and dietary diversity indicators; they found that there is a decrease in dietary diversity over the past 25-30 years. Minhas and Goddard (2013) assessed different types of food security indicators and compared across Canada, the United States, and India. They also developed models for caloric adequacy and healthy dietary diversity for the rural populations in the three states of the APM project.

Goddard and Minhas (2013) examined the dietary diversity on a count basis to illustrate differences across three regions. Results show very clear trends across the three sites, with lowest dietary diversity in Jeypore, intermediate in Wayanad, and the highest diversity in Kolli Hills. Paul *et al* (2014) analyzed the role of nutrition gardens in reducing the risks in household decision making and improving the livelihoods in Wayanad.

Athreya *et al* (2014) reviewed the functioning of Public Distribution System (PDS), Mid Day Meal Scheme (MDMS), Integrated Child Development Services (ICDS), Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) in providing food and income security to rural households across three sites.

Using both quantitative and qualitative data, Girigan *et al* (2014) found that establishment of nutrition gardens helped to increase vegetables, tuber and fruit consumption at household level; increased women's choice and sharing of vegetables with neighbours.

Manjula *et al* (2014) assessed the issues pertained to the collection and consumption of wild edibles in Wayanad and Odisha. A case study by Kalaiselvan *et al* (2014) found that low income households in the Kolli hills depend on wild leafy greens for meeting their nutritional requirements during rainy seasons and fruits during summer.

4.2.3 Establishment of Nutrition Gardens (NGs): Nutrition gardens were established in backyards to meet household food and nutrition requirements by ensuring availability of a diversity of leafy greens, tubers, fruits and other vegetables. A total of 1646 nutrition gardens were established over a period of three years across three project locations. Impacts survey showed that average vegetable consumption across three sites increased significantly after establishing NG (from 56 kg to 135 kg in Odisha; from 48 kg to 90 kg in Kolli Hills; and from 26 kg to 96 kg in Wayanad). Across the three sites, more than 50% of households consumed all the produce from the nutrition gardens. A miniscule percent of the households surveyed in Kolli Hills and Wayanad sold all their produce. 80% of the households are of the opinion that establishment of nutrition gardens helped to a greater extent in increasing women's choice over vegetables. Increase in household vegetable consumption has a positive impact on the women and children who rarely eat away from home. Among the three sites, a significant number of households surveyed reported that they consumed more leafy vegetables, fruits, roots and tubers in their diets after the introduction of NGs. Households also expressed satisfaction with the fact that that the produce from the NGs were free from chemicals.

The survey conducted in Wayanad indicated that nutrition gardens have had a positive impact on the quantity and quality of food consumed. 75% of sample households benefited by consuming more green leafy vegetables as a result of establishing nutrition gardens, while 67% families benefitted from fruit trees planted and 24% families reported increased consumption of roots and tubers. 43% families identified that they share vegetables with their neighbours and relatives thereby increasing their social bonding. In Jeypore, about 47% of the households consumed as well as sold excess produce. Another interesting feature from Jeypore is the bartering of NG produce for other products, indicating the largely subsistence orientation of the households surveyed.

NGs provide insights into the gender focus of the research for development. Such gardens are not to be looked at merely as a source of increasing the availability of additional food and nutrition but an attempt to expand the food basket and also as an effort to build the knowledge of women related to nutrition, balanced diets, health and well-being. Within the tribal context this also means exchange of foods including vegetables as gifts and sharing between households.

4.2.4 Inland fish farming in community and private ponds: A total of 71 inland fish farms have been established across the sites to enhance nutrition and income. The process of establishment included the formation of pond users groups, resolution submitted and approved by the local administration for pisciculture in local ponds, release of fingerlings,

training and dissemination of knowledge in the VKCs, and continued production and consumption of fish. In the case of Kolli Hills, the community pond, a total of 460 kg fish was produced of which 113 kg was shared among users and rest sold, while a total of 63 kg of fish was harvested from 8 private ponds and consumed by 46 individuals.

4.2.5 Backyard poultry: Backyard poultry was promoted with an intention to increase household consumption of eggs among the poorest households in Wayanad and Jeypore. A total of 954 backyard poultry units have been established in Jeypore (734) and Wayanad (220).

4.2.6 Pulse cultivation and its impact on household consumption: The impact of promotion of improved cultivation practices in green gram is summarized below: a) increase in income from an average of INR 2805/ac to INR 4170/ac and b) increase in consumption from 0.88kg/week to 1.15kg, on a weekly basis from 2 days per week to 3 days per week and from 25-35 gm/person to 34-50 gm/ person per cooking. These results are encouraging in a scenario when according to World Health Organization (WHO) per capita availability of pulses has reduced from 69 gm per day in 1961 to 30 gm per day in 2011 against a recommendation of 80 grams per day.

4.2.7 Nutrition literacy: Apart from food based interventions, the project also imparted knowledge based activities to address the issue of malnutrition in the project sites. Nutrition literacy programmes initiated in Kolli Hills and Wayanad sites targeted general public and those families vulnerable to or affected by iron deficient anemia. There were 173 cases of anemia reported from Wayanad and 190 cases from Kolli Hills. Intensive awareness programmes were conducted among adolescent girls and young mothers. Awareness/training/ learning materials were prepared, circulated and exhibited. Further, with the support of health departments, iron and de-worming tablets were distributed and a self-monitoring system was put in place to monitor the regular intake of tablets through regular personal and family counseling, local level conventions etc. An impact assessment study conducted in both sites showed that awareness on anemia, regular consumption of iron tablets etc increased among adolescent girls and young mothers. Community Hunger Fighters (CHFs) programme initiated in five villages in Odisha covered 620 households. The 25 CHFs played a pivotal role in creating awareness and knowledge dissemination on nutrition among most vulnerable population.

4.2.8 Strengthening the Culture of Conservation of Genetic Resources: Seed Banks: To promote and enhance genetic diversity, 20 seed banks were established across the project sites. Currently the seed stock register is being maintained and quality seed produced will be provided to farmers.

4.2.9 Reduction of Drudgery in Production and Post-Harvest Processing Technology Adoption and Gender Roles: Several activities that promote small-scale pro-poor mechanization have been facilitated. These activities include: treadle (water) pumps; row markers; power tillers; mechanized dehullers; Seed Bank (SB) pulverizers; processing centers for rice, millet and tamarind; and power-tillers-fitted-with-trailers to aid in the transportation of produce to processing centers.

Provision of power tillers has reduced the cost of cultivation for small holders. Earlier farmers in Wayanad used tractors for the first ploughing followed by power tillers for subsequent ploughings. Currently, farmers use power tillers for the both the ploughing bringing down the cost of cultivation by 41% and by 10% in Kolli Hills while in Koraput it has reduced the time of cultivation by 65%, replacing animal traction. In Wayanad, the

thresher has reduced the time of operation by 70%. Millet pulverizers in Koraput and Kolli Hills has reduced the drudgery of women, while the small scale pulverizers are able to process 20-25 kg of grain in an hour, compared to about 1 kg manually. Paddy dehullers were also provided for reducing drudgery and time of women as well as enable food processing at household level. Manual processing of paddy and millets for home consumption is traditionally the role of women, a time consuming task that entails drudgery. The project has attempted to address this aspect by establishing small-scale mills that enable women to process food faster and release time for other pursuits including leisure. Miller-Tait *et al.* (2013) found that 60% of the visits to mills are made by men, indicating an increased role for men in household food provision.

In some village of Jeypore, water is manually lifted from dug wells by women using traditional contraptions made of bamboo poles, leading to body pain, drudgery. In addition only a small area can be irrigated using this technology and is time consuming. As an alternative, the project team introduced pedal pumps, reducing the time and drudgery.

4.2.10 Research findings on pro-poor technology adoption: Hossack and An (2013) evaluated the ex-ante willingness to pay and adoption rates for pro-poor technologies in Jeypore. Farmers are willing to pay more for yield stabilizing seed traits like pest or drought resistance.

Miller-Tait *et al.* (2013) found that despite the fact that finger millet is largely stigmatized as a "poor person's crop" and a "famine food", it is not an inferior good. Everything else being equal, people with higher incomes do consume more finger millet (*ragi*). However, it is primarily the disadvantaged households, and households headed by females, which adopt the new technology and consume more finger millet flour.

4.2.11 Constraints and learning: Implementation of nutrition interventions across three sites gives valuable learning about constraints and inputs for future course of action. Establishment of NG is constrained by diverse socio-economic, environmental and technological factors like lack of water in Odisha, heavy rains in Wayanad; space constraints and competition from other lucrative crops in Wayanad; landlessness across sites; short span of harvesting; lack of awareness etc. Low cost technological interventions are needed to overcome the environmental hazards for establishing NGs and increasing the time span of harvesting vegetables. Local level advocacies are needed to establish community garden to take care of the needs of the landless people.

4.3 Objective 3: Enhance *on* and *off*-farm livelihood diversification options

APM has contributed to improving the ability of vulnerable/poor people to purchase larger quantities of better quality food that benefited women and children, through income savings provided by increased subsistence production of better quality food, as well as *on*- and *off*-farm income-generation and diversification activities for small-scaled landed and landless households. APM Objective 3 contributed to Agriculture and Food Security (AFS) Outcomes, including: Dietary Diversity and Nutrition, Engaging Southern Organizations, Strengthening Research Groups, Equitable Food Distribution, Risk Mitigation, Resource Access, Income Generation, Gender, and Environmental Sustainability.

The shelf life of processed tamarind improved due to hygienic value addition and packaging. This entrepreneurship undertaken by 24 women entrepreneurs generated a monthly income of INR 874 per person. The project explored the possibility of expanding the enterprise, establishing market linkages, facilitating groups to lease in trees and enabling households increase their incomes.

Country chicken rearing in cage and shed system by women self help groups in Kolli Hills helped earn a supplementary net income of INR1500/month/person from two batches of sale. Goat rearing initiative with local goat breeds by two women groups demonstrated an additional net income of INR 2000/head/year. The fruit processing (pineapple, mango), cassava crisps making unit, medicinal herbs powder unit owned by a group of 4 to 6 women members, each member earning an average income of INR 500 to 700 per week based on the purchase orders raised by local shops in Kolli Hills. Value addition to finger millet promoted with 27 women entrepreneurs in Odisha provided an additional monthly income of INR 788 per person. In Wayanad, elephant foot yam was cultivated in rice fields during the fallow season. The project facilitated landless women and farm labourers to gain access to such lands for cultivation of elephant foot yam using high quality seeds enabling them to earn an income in the range of INR 3000-13000.

Promotion of fresh water aquaculture in underutilised water bodies not only led to collective action at the community level and transfer of new technologies to farmers, but also increased the per capita consumption of fish by 47%. Backyard poultry farming, an age old practice in ancient communities, was reintroduced, bundled with modern animal husbandry practices for greater sustainability. Meat from poultry birds provided additional protein supplementation in the household diet by 19.3 kg/annum which accounted for an increase of 29% in animal protein consumption. This led to additional income generation of INR 316 per month by women in the household, enhanced access to common resources and knowledge empowerment of the community through technology transfer.

Availability of wild edible mushrooms is restricted to three months a year. Mushroom cultivation reinforced household nutrition security by making mushrooms available throughout year. The average harvest of 3.6 kg of mushroom per bed over a period of three months became a vital source of vitamins and essential minerals in the household diet and marketing of mushroom in nearby markets @ INR 90 per kg provided additional income to women. Crop intensification with provision for several beds in rotation in storage area was strategically promoted to overcome the obstacle of landlessness in addressing malnutrition and provide additional income. To enhance understanding of the manner in which households operate, a study on Role of Social Networks in Diversification of Income Source was carried out in Wayanad among 301 households spread across 9 villages. A summary of the study is provided below for the benefit of the reader.

4.3.1 Research on the Role of Social Networks in Diversification of Income Sources: UA REES graduate student Judit Johny undertook research on the *Role of Social Networks in Diversification of Income Sources in Rural India.*A census of 301 households in 9 villages was conducted of the strength of households' connections with other local households. Descriptive results show that the villages vary considerably in terms of overall density of connections and connections between households of different social communities. There are differences in social networks between social strata. On average, Scheduled Caste (SC) households have the most social connections, followed by Scheduled Tribes (ST), followed by Other Backward Castes and the general population. Combined with data from the baseline survey, the social network analysis shows that people with stronger social networks are likely to be more diversified in sources of both *on* and *off*-farm income. Communication strategies can be more effective if they successfully tap into those networks.

4.4 Objective 4: Need-based capacity building of local farm families that involves panchayats, government, non-governmental and service providing institutions and policy makers

The APM project worked with local community groups to establish or revitalize VKC facilities in all three project sites to increase access to information and capacity building. New content particularly on nutrition cast in the form of video films, voice messages, booklets, pamphlets, folders were developed for dissemination through the VRCs and VKCs. Village Knowledge Workers, CHFs and community based organizations were linked to line departments.

Establishment of FCs, FRG, SHGs, VRC and VKCs were an important component of the project that provided a positive lead for working closely with communities. 23 FCs (872 members), 20 FRGs (158 members) and 46 SHGs (516 members) involving 1546 farmers across three locations had 47% representation of women in general membership and equal representation in management committees in these grass root level community managed institutions. Training using ICT tools through VKCs is a vital mode of capacity building and knowledge sharing in APM project. Training content for delivery at these centres was determined from FGD with the farmers group, women's groups and the project site committees. The capacity building training programmes of the APM project were facilitated through VKCs. A new ICT application called *i-Crop* was developed for assisting farmers in making weather based cropping decisions. The application was envisaged to have packaged contents and related photographs on the diseases and pests for major crops and linked to automatic weather stations. It uses weather parameters for predicting possible occurrence of diseases or attack of pests, and provides crop protection solutions through alerts to enable farmers make rational choices. The application captures local specific information on crop cultivation practices and its management using ICTs and can be upscaled in other locations.

These programs are categorized either as *knowledge empowerment* (health, gender, social entitlements, personal hygiene, family nutrition, child nutrition, healthy culinary practices and improved agronomic practices) or *skill empowerment* (income generation, agriculture, fisheries, nutrition, animal husbandry, bio-char preparation, use of energy efficient cook stoves and value addition to local crops); both categories build capacity that, if properly communicated, lead to behavioral change.

4.4.1 Community Hunger Fighters (CHF): The major objective of the CHF action education model was to empower representatives selected by the community to understand the causes of hunger and malnutrition and help their own communities to take remedial measures.The CHF Training Module consisted of three components: i) Food availability included concept of a balanced diet, integrating nutrition concerns in agriculture, safe drinking water and sanitation. ii) Access to food dealt with class, caste and gender issues and iii) Exposure visits to working models of external agencies as well as to MSSRF sites. 25 CHFs played a pivotal role in creating awareness and knowledge dissemination on nutrition, social entitlements and *on*- and *off*-farm livelihood options in Jeypore. The initiative resulted in good representation of villages in the *Palli Sabha* and *Gram Sabha* meetings, demand for equal wages, laying of roads, proper distribution of ICDS porridge mix, submission of list of households for latrines under the *Nirmal Gram Yojana*, entitlements under horticulture mission, old age pensions, housing under *Indira Awas Yojana* (IAY) and vocational training were the other entitlements claimed.

In total, 227 training programmes were conducted in which 10294 (5802 women and 4492 men) farmers participated. Most participants benefited under different training programmes

but were reported as a single entity thereby avoiding double counting in reports. The topics varied in agriculture, horticulture, in-land fisheries, animal husbandry, health and nutrition as per the needs of the community inviting subject experts from the institutions such as Farm Science Centres (*Krishi Vigyan Kendra*), Agricultural University and its Research Stations, Department of Agriculture, Horticulture, Animal Husbandry, Fisheries, Health and individual experts. The experts shared detailed information using ICT tools and carried out demonstrations for higher understanding such as vermi-composting, establishment of nutrition gardens, healthy cooking practices, integrated pest management (IPM), nursery bed preparation, quality seed production, maintenance of farm machineries and organization of community based organizations. The interactive sessions were followed up with feedback meetings individually and collectively in group and outcome documented as case studies.

The APM project provided need-based capacity building to direct beneficiary local farm families through the development and dissemination of 7 customized, local language (i.e., Malayalam and Odiya) training and educational tools. Priorities for training were established in consultation with local service providers and community groups. Nutrition literacy using a behavioral change communication methodology comprising of three components namely knowledge interventions, attitude interventions and access interventions was adopted in the Kolli Hills and Wayanad with the aim of addressing desired dietary behavior among the target group. Posters, wall painting, street theatres, voice messages were the preferred tools used for communication. The other stakeholders who underwent capacity building initiatives under APM project since its inception are: 127 extension staff; 68 policy makers (including representatives of local governments); 18 civil society organizations (e.g., NGOs); 57 other academics; and 29 school teachers, VHN, and members of CARE NGO (APM Final Questionnaire, Tab: Training and Implementation). APM also trained 384 men and 468 women from other organizations to support the dissemination of APM technologies, methodologies, or practices (i.e., line sowing/transplanting, participatory varietal selection (PVS), seed treatment, mushroom cultivation, and value addition to millets). Significant change in knowledge and awareness was achieved, while improvement in practice change was observed.

Project site committees were established and eighteen meetings were conducted across three sites during the project tenure. These meetings offered opportunities for members of local communities to learn about the project and its activities from those participating in the activities and make suggestions for further action.

Gender integration in the project was especially facilitated by the contributions of a need based training and capacity building to the team members through external and internal resource persons, engendering the Logical Frame Work plan of the project especially in goal, objectives, outcomes, outputs and activities. Impact on women was key to selection of focal agricultural techniques and corresponding training, especially nutrition gardens, and income-generation activities, especially processing. Women and adolescent girls are specifically focused through trainings on health issue such as anemia, reproductive health, and sanitation. Gender integration was paid due attention in all PSC meetings and capacity building programmes in involving community based organizations.

4.4.2 Training and Educational Events for Direct Beneficiaries: (1) Certificate training programme on Food Security Army, (2) Three-day residential training certificate programme on Capacity building of youth women and Panchayati Raj Institutions, (3) Nutrition and Health awareness, (4) Training on Organization and Strengthening of Community Based Organizations, (5) Two Day Certificate Training on Off-Farm Business Development,

Production, and Market Management, (6) Training on Fish farming, (7) Training on Mushroom Cultivation, (8) Training on Integrated Pest Management, (9) Training on Nursery development and Quality seed Production, (10) Training on Value Addition to Millets Training on Value Addition to Millets, (11) Zero-Budget Farming, (12) Farm Productivity Trainings (Plant protection, Quality Seed Production, Integrated Farming System, Neglected and Underutilized crops, Soil Health, Nursery development, Farm Mechanisation), (13) Off- & On-farm Livelihoods Trainings: Inland Fisheries, Vegetable/Nutrition garden, Post-Harvest Technologies, Goat Rearing, Backyard Poultry, Bee Keeping, Value Addition to Farm Produce (Millets, Tamarind) and (14)Health Related Trainings for Targeted Population (including Anemia/Behavioral Changes for Adolescent girls, Mothers, and Ante Natal Care (ANC) / Post Natal Care (PNC).

4.4.3 Research on Social Practices of Knowledge Mobilization–UA graduate student Suraya Hudson, conducted a study in the Kolli Hills on the topic. Qualitative research techniques were used to evaluate common practices for sharing knowledge about nutrition gardens and fish farming. One key finding were that people now rely primarily on MSSRF for information about nutrition gardens and fish farms despite their long history of gardening and river fishing. Another key finding was that most people prefer face-to-face communication about home gardens and fish farming, although they are interested in other forms of communication to complement face-to-face interactions. Finally, new communication techniques that rely on cell phones and computers were seen as most relevant to younger and more educated people.

4.5 Objective 5: Developing tools and processes including ICT for information/knowledge management and policy advocacy

4.5.1 Communication Strategy: Synthesis and Dissemination of Project Results and Learning

APM's Communication Strategy involved synthesis and dissemination of project results and learning through meetings, publications and other dissemination material. The project results and learning have been disseminated through 92 Research Outputs: 6 Reports, 12 Project Documents, 35 Poster Presentations, 28 Paper Presentations, 11 peer-reviewed journal articles (8 of which have been published and 3 of which are under development or in press); and 210 Local Language Training and Educational Tools for Direct Beneficiaries-Online Communications (6 Items), Print Media (11 Items), Radio and Television Appearances (2 Appearances), Exposure Events Organized (7 Events), and Conference and Exposure Event Participation (28 Events), 10 fact sheets/pamphlets; 130 audio, 36 audio-visual, and 11 interactive Power Point presentations have been produced.

4.5.2 Review of Indian Policies related to Food Security

Athreya *et al* (2014) used primary and secondary data to analyze the PDS, MDMS, ICDS and MGNREGS in the three project sites. The four programmes being implemented in the three sites had positive impacts on the lives of the sections of populations that accessed these schemes, although there were site-specific and scheme-specific issues, relating to access and functioning of the schemes:

a) PDS. In the Kolli Hills, supplies were regular, the products sold in PDS retail outlets were seen as being of good quality, the outlets were within a kilometre of the habitation, a range of commodities such as pulses, edible oil, kerosene, dhal and wheat were available at the notified price and in adequate quantity as per the norms. In Jeypore, rice was in regular

supply, and all card holders bought it from PDS. Malpractices in weighing and black marketing of PDS grains were also reported.

b) MDMS. The MDMS seems to be functioning relatively smoothly and regularly in all three sites. Other problems reported in Jeypore include poor infrastructure for cooking, costs of firewood and raw food materials, lack of a separate staff for running MDMS and uneven quality of meals. In all three sites, variety in food served in MDMS was desired by respondents to identify local sources of nutritive foods including millets.
c) ICDS is also functional in all the three sites but reported implementation problems, requiring improvements. The demographic composition is such that Jeypore sees the highest proportion of sample households availing ICDS. Given the workload of the ICDS field functionaries, it is not possible for them to ensure that all adolescent girls, pregnant women and lactating mothers receive their supplementary nutrition entitlements.
d) MGNREGS. Using policy claim literature and 12 focus groups (in the three project locations), Brietkruetz *et al* (2014) found that: a) The scheme offered employment as a last resort, but the wages were too low; b) There was a differentiation of wages paid to MGNREGS workers, despite the assertion in most groups that there was a common wage for all workers; c) The method of payment for MGNREGS work varied both between and within sites, d) Unemployment insurance was not mentioned by participants in any of the sites, even though it's a key component of MGNREGS policy; e) The implementation of MGNREGS seemed to provide labourers with more power, thus influencing labour relations in ways that were advantageous for "at-risk" workers, f) Women were more likely to use MGNREGS, but substantial barriers to this program meeting their needs was evident. In particular, the type of work and lack of adequate child-care were evident.
e) As part of the study on Policy Determinants of Household Economic Development (PDHED), Rajasenan *et al* (2014) undertook an analysis of poverty in Wayanad for five time periods (viz. 2013-14, previous year, five years ago, 10 years ago and 20 years ago). An inter-temporal comparison of households that were beneficiaries of the government programmes/welfare schemes in relation to their income, expenditure and poverty status throws light on the fact that there has been a shift in the poverty levels over the last five years. There is a continuous decline in the number of the poor, indicating that some of beneficiary households have indeed escaped the poverty trap. The risk factors associated with the households falling back to poverty needs to be identified and analyzed in tandem with the role and relevance of these poverty eradication policies.
f) An important input for enhancing food and nutrition security is the provision of safe drinking water. Given the critical importance of safe drinking water in ensuring biological utilization of food intake which relates to the absorption dimension of food security, it is strongly recommended that access to adequate quantities of safe drinking water must be ensured in all the ICDS and MDM centres. Moreover, only seven out of the fifteen ICDS centres accessed by our sample respondents have toilet facilities. Our strong recommendation is that all ICDS and MDM centres should have adequate, functioning toilet facilities with assured access to water for ensuring cleanliness.

4.5.3 Organizing side events at international meetings, policy makers workshops and meetings

In October 2012, a series of events at the Convention on Biological Diversity (CBD) COP 11 in Hyderabad were organized. A satellite event on Biodiversity and Nutrition was held at the National Institute of Nutrition (NIN) inaugurated by the Governor of Andhra Pradesh was attended by over 60 students from NIN and other universities in Hyderabad. A side event on Globally Important Agricultural Heritage Sites (GIAHS) was organised in collaboration with

the Food and Agriculture Organization (FAO) in which tribal and farmers' representatives from Koraput and Kuttanad participated.

The Policy Makers Consultation on Alleviating Poverty and Malnutrition in Agro-biodiversity Hotspots was held in New Delhi on 27 September 2013. It was attended by a range of senior government officials, civil society organisations, donor agencies and researchers from the University of Alberta, Canada. Lead speakers highlighted the importance of community-based management of agro-biodiversity and natural resources and the possible method of creating an economic stake in conservation. A presentation was made about the small farm situation in India which stressed the need for increasing productivity and thereby incomes to deal with poverty and malnutrition. A brief overview presentation on the APM project highlighted the link between agriculture and nutrition.

The University of Alberta organised a Dialogue on International Food Security during 30 April – 2 May 2014 at Edmonton, Canada with the objective of providing a platform for exchange between the Canadian International Food Security Research Fund (CIFSRF) and related projects in Canada, and to discuss ways in which research can lead to action. The Dialogue provided an important forum for the direct exchange between researchers, graduate students, practitioners, and government officials. The Dialogue drew 224 participants from 16 different developed and developing countries, and representatives from 8 Canadian research-for-development organizations, 17 non-Canadian research-for-development organizations, 4 Canadian government agencies, and students and scholars from 27 universities (13 Canadian universities and 14 non-Canadian universities). The dialogue was organized into four broad themes: Sustainable Agricultural Systems, Nutritional Security, Gender and Livelihoods, and Economics of Value Chains and Policy. Researchers and practitioners from 20 CIFSRF projects from Africa, Asia, Latin America, the Caribbean, Middle East and Canada participated. The positive relationship between gross and net incomes from farming and scale of operations, where scale of economic size of the cultivating unit is measured in terms of value of owned means of production, levels and sources of household income and pattern of labour deployment rather than physical extent of landholding. The need to raise levels of crop incomes to make farming a viable and sustainable activity as outlined in the National Commission on Farmers were also stressed.

The Banff Write-Shop was held in Banff, Alberta, at the Juniper Lodge, May 3-6, 2014. Two groups were in attendance: the Gender Group: 18 individuals representing 11 organizations and the APM Project Dissemination Group: 27 members of the APM team representing both MSSRF and the University of Alberta. At the writeshop, substantial work related to the preparation of research papers based on the data generated by the APM project was carried out.

To commemorate the International Year of Family Farming, a Regional Consultation for the Asia-Pacific region on "Role of Family Farming in the 21st Century: Achieving the Zero Hunger Challenge by 2025" was organized in Chennai during 7-10 August 2014. The Chennai Declaration released during the valedictory advocated the 4C Approach (Conservation, Cultivation, Consumption and Commerce) for addressing sustainable food security and elimination of hunger among family farmers.

A National Level Consultation on 'New Opportunities for Nutritious Foods and Climate Smart Agriculture' was held in New Delhi on 21 August, 2014, and attended by agriculture and nutrition experts from various parts of India. The consultation was attended by researchers, public policy advocates, government agencies and non-profits. The consultation helped in sharing knowledge and experiences of promoting sustainable agricultural practices

that helped small-holder and family farmers move towards food and nutritional security. One of the recommendations that emerged at the consultation was that PDS should be more focused on alleviating poverty and malnutrition among the small-holder and family farmers. One of the pathways of achieving it was to promote effective procurement and distribution of millets in the PDS. PDS is the single largest mechanism to reach the most-at-need vulnerable populations. Therefore it is essential to put in place mechanisms for production, procurement and distribution of millets to help the nation move towards nutrition security. In addition, the inclusion of millets in the MDM and the ICDS would help increase the nutritive value of the dietary intake of vulnerable groups. Besides, they need less water to grow and can provide high productivity even under difficult climatic conditions. The consultation demanded that the government should ensure access to appropriate seeds for farmers for the nutrition gardens through PDS and provide financial and other support to them for nutritious underutilized crops.

4.5.4 Monitoring and Evaluation

The Monitoring and Evaluation of the project was carried out at three tiers: a) Implementation level, b) Site level and c) Project level Monitoring and Evaluation Survey

Surveys: A Detailed Survey Questionnaire developed jointly by the UA and MSSRF was field tested and finalized. A team of staff were exclusively recruited for the purpose in each of the three sites. This included staff for data entry as well and the whole team provided with hands on training in Chennai and each of the field sites. A separate data entry template (using Visual Basic) was developed to enable direct data transfer into Excel and conversion to SPSS software and the team trained in its use. These initiatives have significantly improved the quality of data collection and reduced errors. The Chennai team has conducted regular field visits to all the three sites to review the progress of work and improve the performance of the field teams.

Project Site Committee (PSC): PSCs were constituted in each site comprising of men and women famers from diverse socioeconomic backgrounds, representatives of Panchayati Raj Institutions (PRI), local administration, officials of state government line departments, regional research stations owned by state and central governments and APM project staff. The PSC meetings were conducted at six monthly intervals allowing a regional platform for discussions, capacity building, experience sharing, project activity planning and monitoring. The research outcomes from APM project were periodically shared with the policy makers at regional level through PSC meetings as a policy advocacy initiative.

Project Advisory Committee (PAC): A PAC consisting of experts from relevant fields, third part organizations and donors was constituted for steering the project at the commencement of the project. The PAC met three time over the project period to review and monitor the project, undertook field visits, offer mid course corrections and played an advisory and steering role in improving the overall performance of the project.

5.0 Synthesis of Results towards AFS Outcomes

The five objectives of the APM project align closely with the AFS program's outcomes. The sections below synthesize the ways in which various APM objectives have contributed to each AFS Outcome. Evidence is provided to support this synthesis. Specific explanation is provided as to how the research results are being used, and how those results have impacted specific communities or populations in APM's targeted country of India.

5.1 New Technologies and/or Farming Systems and Practices

APM developed new and improved agricultural technologies and/or farming systems and practices that increased food production and food security through developing agricultural technologies, farming systems and practices including: the establishment of 1,646 NGs; 525 cassava-legume intercropping, millet promotion trials/demonstration, green manure trials and rice and finger millet row planting resulting in minimum of 30% to maximum of 80% increases in yields; construction of 900 vermicompost pits at two of the three sites; *completion of* 70 participatory varietal selection (PVS) trials with both indigenous and developed varieties and establishment of 20 quality seed production units, soil health cards based fertilizer application adoption community seed banks (SBs) benefitting over 400 farmers; and sequencing of finger millet (*Eleusine coracana)* transcriptome and identification of over 40,000 gene pairs, the most complete set of gene identifications available for this species to date. The positive uptake by local communities in the project locations is expected to expand in the coming years into other comparable communities across India with the potential application to other comparable regions.

5.2 Dietary Diversity and Nutrition

APM enhanced dietary diversity and nutrition through: Nutrition Gardens, NUS species and Wild Edibles. Evidence of the impact of the APM project on nutritional outcomes is provided by independent studies showing an increase in dietary diversity and increased nutritional awareness among women (both ANC & PNC), adolescents, adoption of nutrition gardens by landless, small and marginal farmers. A wild food study was conducted to understand the role of uncultivated species in the nutritional and food security of the community. Leads from the study can support inclusion of species from wild in the dietary diversity for fulfilling food and nutritional needs.

5.3 Engagement of Canadian Researchers with southern Researcher Organizations

Canadian knowledge and resources have contributed greatly to address environmentally sustainable agricultural productivity and nutrition problems in developing countries. Collaboration between UA and MSSRF staff have facilitated this contribution as evidenced by : the 32 UA APM staff made a total of 67 trips to India[2]; field visits by 9 graduate students and 10 professors; the visit of a delegation of 12 MSSRF staff and Chairperson to UA. The research results from this collaboration have led to: 10 joint communication outputs Global Food Security Conference UA Canada, 5 posters and 4 oral presentation 2 publications, 1 policy brief, 2 paper and 5 poster presentations); MSSRF APM staff attended 3 conferences organized by Canadian organizations and provided 12 presentations in Edmonton, 1 in Ottawa and 1 in Toronto; UA APM staff attendance 2 conferences and delivered 3 presentations organized by southern organizations; and the provision of a Canadian education to two Indian graduate students who were members of the APM staff. UA APM researchers have also interacted extensively with three other Indian research organizations (Cochin University of Science and Technology (CUSAT), the Madras School of Economics (MSE), and the National Institute of Nutrition (NIN)), as well as various civil society, private sector and public sector organizations. As this research has been conducted with marginalized populations in agro-biodiversity hotspots in India, the immediate impact is on these populations – in particular women in such areas and among the tribal and landless people.

[2] This number is a summation of the number of times each individual from the team traveled to India. Comprised of 18 research trips by graduate students and research assistants and 49 research and management related trips by professors and APM staff.

The positive impacts of this collaboration are already in evidence and expected to continue into the future.

5.4 Research Groups

The APM project has contributed to strengthening research groups for improved food security policies and decision-making. Research was carried out by two types of researchers: (1) inter-disciplinary research groups within and between MSSRF and UA. Also inter-institutional teams were identified for various APM themes with designated co-leaders from both institutions; and (2) third-party research groups: Studies carried in collaboration with three Indian research organizations namely CUSAT, the MSE, and the NIN. In addition, a third and advisory type consisted of collaboration with three international research organizations (Bioversity International (BI), International Centre for Research on Agroforestry or the World Agroforestry Centre (ICRAF), and International Crops Research Institute for the Semi-Arid-Tropics (ICRISAT), who contributed to the Project Advisory Committee (PAC) meetings and interactions during the Dialogue on International Food Security 2014. Joint publications are arising from this collaboration will ultimately impact marginalized populations across India, and the relationships established are expected to continue into the future.

5.5 Equitable Food Distribution

APM has contributed to creating a more equitable distribution of access to quality food for food security through cross-cutting emphasis across all project activities on gender and equitable governance, and a specific focus on the marginalized women, smallholders and the landless. APM's governance activities have included facilitation of women's SHGs and FCs some of which have been used by marginalized households to access resources for food production and income generation for food security. APM's choice of production initiatives, such as the NGs, IFF, and SBs, small-scale, pro-poor mechanization, and small-scale and landless income-generation initiatives, such as value addition to crop products and backyard poultry raising, have assisted in the promotion of food security among the poorest of the poor in the communities in the three project sites. The landless have even benefited from these activities through the use of community commons such as ponds and other water bodies and common lands for vegetable cultivation and governance of VKCs and VRCs managed by local government / panchayat. These community based infrastructure are managed by FCs, women's SHGs and FGs. Land for mills were purchased by the group members and are managed by the SHGs, who pay the electricity bills. APM's study of India's public policy including its Targeted Public Distribution System (TPDS) has also contributed towards increasing the equity of food distribution at the project sites.

5.6 Food Processing and Storage

Improvement of post-harvest food processing and storage techniques was through *:* promotion of small-scale pro-poor mechanization like mechanized dehullers helped in the establishment of processing centers for rice, millet and tamarind; adoption of power tillers-fitted-with-trailers supported in the transportation of produce to processing centers; as well as the implementation of studies on the factors affecting women's adoption of mechanized milling technology at the Kolli Hills site and the impact of willingness to pay on the adoption of pro-poor technologies at the Jeypore site and through Promotion of Seed Banks (SBs) assisted with the processing (pulverizers) and storage of quality seeds of traditional and other species Small-scale pro-poor mechanization dramatically reduces the time and drudgery requirements of food processing, especially for women.

5.7 Risk Mitigation

Risk-mitigation was addressed through value addition for NUS, promotion of small-scale pro-poor mechanization, intercropping, promotion of bio-char and sequencing of finger millets. A study on food and nutritional security and the role of NGs in reducing risks in decision making was also conducted. NUS included facilitation of the increased use of traditional rice varieties, small millets, elephant foot yams, and indigenous vegetables and farmers implemented over 50 participatory varietal selection (PVS) trials with indigenous and developed varieties and established 20 local SBs benefitting over 400 farmers. Researchers sequenced the finger millet *(Eleusine coracana)* transcriptome, identifying over 40,000 gene pairs, and the most complete set of gene identifications available for this species to date. In addition, agronomic trials have been implementation for disease and drought-tolerant varieties of crops, farmer preferred varieties and through intercropping of local varieties of millets and pulses with cash crops. Seed Banks (SBs) help mitigate loss due to dry weather or flooding immediately following sowing, supporting in re-sowing. Small-scale pro-poor mechanization has mitigated risk of crop losses due to labour shortages. Research on bio-char was aimed to facilitate changes in better fuel wood use, improved soil fertility and water retention capacity and reduced exposure of women to smoke.

5.8 Access to Resources

Although the APM project did not attempt to impact household and community land tenure or financial credit, it did contribute to improving access to resources for food production and security by facilitating access to: natural resources (use of communal land and ponds by the landless and self-help groups (SHGs) and farmers' groups (FGs); physical resources (e.g., row markers for paddy planting, millets mechanized tilling machines, dehullers, millet mills, and tamarind processing equipment); human resources (extension of production, marketing and nutrition information); and social resources (sharing and bartering of NG produce between households, women's SHGs and farmers' clubs (FCs), VKCs, and VRCs). Targeted populations have included agricultural producers, landless households and women. Increased accessed and better use of health services provided by PNC, ICDS and Panchayats. The probability of this increased access to resources to remain over the next several years will be community specific and may rely on MSSRF facilitation.

5.9 Income Generation

APM has contributed to improving vulnerable/poor people's ability to purchase more and better quality food, for the particular benefit of women and children, through income savings provided by increased subsistence production of more and better quality food, as well as *on-* and *off-farm* income-generation and diversification activities for small-scaled landed and landless households. For the landed, income generation has primarily been facilitated through promotion of higher yielding varieties of rice and millet; for the landless, it has been facilitated through community inland fish farms (FFs) and the provision to SHGs and FGs of small-scale pro-poor machinery like power tillers and threshing machines. Focused project Activities included: (1) Tamarind Processing; (2) Value Addition to Crop Processed Products, Country Chicken, & Goat Rearing; and (3) Research into the Role of Social Networks in the Diversification of Income Sources.

5.10 Policy Options

The APM project attempted to influence the development and implementation of food security policies in India, South Asia, and internationally through the three Activities within Objective 5: an Indian Social Policy Review; Communication Strategy; and Direct

Engagement in Indian Policy Makers' Networks. Recommendations from policy analysis and review are categorized in terms of *Provision for land as* an important determinant of health in India; *Skill development* in MGNREGS: building the skill capacity of labourers through MGNREGS would enhance rural community development; *Indexing for inflation:* increase the financial benefit of some of the programs by mitigating the extra costs for individual end-users; *Integration of major schemes:* convergence of MGNREGS with other government programs could increase the effectiveness and enhance outcomes; *Technological enhancement* increasing the use of technology to implement schemes could enhance monitoring; *Information dissemination:* increased utilization of these highly accessible methods of communication can greatly increase knowledge and awareness of program policies and activities. Currently the use and measurable impact of these research activities on marginalized populations within is uncertain, however the unique position of the MSSRF within the Indian political arena creates the opportunity for future influence over the next three years and beyond.

5.11 Information and Communication Technologies

ICT has been used to increase the access to information in order to improve food security for the most vulnerable through establishment of 6 VKCs and 3 VRCs, and Development of Informational Audio-Visual Presentations. The research results of ICT interventions will help poor and marginalized households and communities adapt to the changing environmental and technical climate. Equipping farmers with technology to be aware of market prices for commodities, social networks, climatic change and other factors will allow them to make decisions based on real time information. Training workshops has impacted over 5,000 people. Special attention was given to promote equity of access to ICT by ensuring women and tribal populations were particularly targeted As MSSRF will maintain a presence in these communities after the completion of APM, these centers will continue to be used by the local communities and facilitate learning over the next three years and beyond.

5.12 Gender

As gender has been a theme cross-cutting all APM objectives and activities, the project has taken into consideration women's specific preferences, priorities, constraints and needs in research design (problem, objectives, activities, implementation process, output and outcome), participation, and potential impact, and has created indicators to monitor progress in these areas. APM has addressed women's needs through the following activities: (1) improved women's access to and control over income, women decision making; (2) reduced women's drudgery and workload (time spent) in agriculture; and (3) improved women's and children's access to adequate and diversified diets, 4) provided opportunities for managing nutrition gardens and provided additional income from *on* and *non-farm* activities. The impact on women was key to the selection of agricultural techniques, especially nutrition gardens, and income-generation activities, especially processing. Also significant were the use of gender-specific indicators and design of surveys with sex-disaggregated data, and an emphasis on women's SHGs and farmer's groups (FGs). Women and adolescent girls were the specific focus of training on health issues such as anemia, reproductive health, and sanitation. Gender integration in the project was specifically facilitated by the contributions of a gender consultant, participation of key personnel in the International Development Research Center (IDRC) gender workshop in South Africa, a mid-project gender mainstreaming workshop, and a write-shop addressing gender issues across CIFSRF projects paralleling the APM write-shop in 2014. The focus on women and men for activities and education will

facilitate change, but it is expected significant change at a community and population level will take more than three years.

Contribution and Supporting Evidence: Nutrition gardens added dietary diversity by planting of an average of 18 species of vegetables by women. As a result, at the outcome level, the average consumption of vegetables, particularly green leafy vegetables and tubers in a household increased from 4 to 9 kg per month. The existence of the nutrition gardens helped the women gain intangible benefits like confidence, satisfaction in taking the lead role in garden management, recognition from family members especially husband and in-laws and more control over the harvested products and foods eaten in the household. Meat from poultry birds provided additional protein supplementation to the household diet of 19 kg/annum which accounted for an increase of 29% in animal protein consumption. This led to additional income generation by women in the household, enhanced access to common resources and knowledge empowerment of the community through technology transfer. Community fish culture was carried out across the Agro-biodiversity hotspots covering 1273 farm families. Among the pond users 84.9 % are marginal and small farmers while 10.6% were land less. Women constituted 43% of the total pond user groups.
Collectives are formal or informal groups where women, especially those from the socially and economically marginalized sections, band together to gain greater access to resources, technology, credit and the market. The APM project has specifically focused on the collectivization of landless and marginalized women to enhance their entrepreneurial capabilities for livelihood options. Efforts across our sites have helped rural and tribal women organize themselves into collectives and increased their access to land, quality seeds, capital, machinery, and the market. Collectivization has resulted in empowering women through; a) increasing their skills and knowledge; b) creating linkages with social networks; c) control over their income and time. More than 1000 resource poor women are now part of the network of collectives in the three sites working towards achieving quality changes in their lives. 67 landless women in Wayanad were facilitated to lease fallow land through collectives for cultivation. The project supported them with quality seeds, providing them with improved cultivation practices. Areas under cultivation by each group varied from 0.15 acres to 1 acre resulting in a net profit of INR 3000 to 13,000 per person. Enthused by this, the women have now started yam cultivation independently and moreover the results have encouraged other collectives to engage in yam cultivation as a supplement livelihood option for landless women.

In the processing front, food processing machinery like millet pulverizers and paddy dehullers reduced the workload of women and saved up to 95% of time traditionally devoted for these activities. Access to treadle pumps for small scale irrigation allowed small and marginal tribal women farmers to expand their vegetable gardens up to 85%, increase yield of vegetables by 24% that contributed to increased dietary diversity and increased consumption at household level, increased marketing and enhanced household income by while reducing drudgery, saving time (by 67%) and energy of farmers.

During the project period, 28 Phone-in programmes were conducted in which 41.5% participants were women farmers. Women were trained to use mobile phones to avail information through voice messages. In all 1250 voice messages were disseminated to 989 registered farming families during the project period with the increasing proportion of women users. In 2013, 19% users were women which increased to 28.8% in 2014. In collaboration with Apollo Super Specialty Hospital in Chennai, 13 tele-education and tele-medicine programmes have been conducted in Kolli hills of Tamil Nadu for the tribal population who were at vulnerable situation for access to health services in the hill region in which 52%

participants were women. Twenty audio and video conference programmes enabling farming families to talk to the expert virtually directly describing the problems and showing the samples in the web camera, benefited 376 farmers which included 219 women. The final survey reveals that out of the sample of 756 households across three sites, 476 (63%) said they have access to the household income. The existing tools did not help to an extent required to assess the proportion of the income.

Through the project, resource poor women from marginalized communities have been facilitated in accessing resources such as knowledge, credit and technology which has helped them increase income, has provided a safe working environment and developed entrepreneurial skills. Further, it has boosted their self-confidence and status in their family and society.

5.13 Environmental Sustainability

The APM project has focused on integrated agriculture that offers cost-effective, sustainable solutions to poverty and food and nutrition security challenges in an environmentally sustainable manner. Throughout the period of the project, environmental impacts were tracked, measured and reported on through regular monitoring and evaluation of environmental indicators and participatory reporting of end-users. Environmental sustainability was supported through the following Activities: Increasing Agro-Biodiversity (i.e., through training on the nutritional and income-generation benefits and encouraging the cultivation of neglected and under-utilized crops local land races such as millet and the protection of the natural habitats of and use of wild edibles); Enhancing Eco-System Services (i.e., through encouraging protection of the natural habitats consuming wild food crops, greens, tubers in nutrition garden, and revitalization of traditional cropping systems); Improving Soil and Water Management native crops in agriculture millets landraces PVS and quality seed production (i.e., through facilitation of the practice of integrated agriculture such as NGs and intercropping, soil health monitoring using soil health cards, and reducing chemical use (i.e., through the promotion of good agricultural practices and eco-technologies for fertilizing-vermi-compost units--and pest control).

6.0 Problems and Challenges

Project of this nature and size is not without problems and challenges. The key problem and challenge are both at the program and institutional levels. Given the low literacy, poor communication, poverty and poor understanding of the challenges imposed by climate change, specific problems /challenges encountered relating to program areas in positioning APM interventions are a) inability to factor the importance of high value crops within the framework of APM b) the fact of genetic erosion of local land races of millets, paddy and nutritious vegetable crops, despite serious efforts in conservation and sustainable use, acting as a limiting factors in 4C initiatives c) to address the behavioural changes for adoption of best practices in key livelihood domains (food, water and sanitation) d) sustaining the interest of farmers in cultivation of nutrient rich crops in the event of fluctuating market prices e) sustaining labour force in agro-biodiversity conservation in the event of large scale seasonal migration and f) planning interventions suitable to location specific soil , crop and water requirements g) positioning of APM project interventions in a mismatched situation of drought and crop calendar f) a narrow focus on a few staple cereals was a problem in ensuring number of calories and that adequate protein and micro-nutrients g) Positioning of APM interventions posed a challenge as current understanding of plant nutrition largely focused on monoculture situations as still it is not well understood how agricultural systems and the benefits derived from agro-biodiversity affect nutritional quality, consumption

patterns, and nutrition and health status, in particular of people in the developing world h) the real crisis is also one of a narrow food base and imbalanced diets as high-yielding production often reduces the diversity of foods that are produced in small scale agriculture systems.

There are several constraints that prevent presenting the result of gender impact assessment. These constraints are i) the final round of survey data not being analysed ii) non availability of temporal data to measure redistribution of the workload between the genders or impacts of dietary diversification on nutrition and iii) availability of only 2 agricultural cycles due to drought years or were affected by floods, depending on the field site.

Also, there seems to be lack of synchronisation the qualitative and quantitative data as collected through schedules and questionnaires. This is primarily because of a prejudice in many people's mind the qualitative is not rigorous enough, but merely anecdotal. We believe that there is a link and synchrony between the two, qualitative data as collected for instance from FGD's and in-depth interviews can provide not only deep insights in to the processes involved and also potential indicators grounded in contextual realities. The frequency of the occurrence of such indicators then can be gathered through surveys and questionnaires. From our constant interactions with men and women in the field we could discern the potential indicators in each of the three locales. Additional issues that need to be kept in mind in such as exercise that each of those variables weights have to be given in accordance with local preferences and other contextual preferences.

Institutional problems /challenges: The major challenge faced by the APM project was gaining an understanding of institutional differences and establishing a relationship based upon mutual understanding and trust between the UA and MSSRF. This project was the first collaboration between the two institutions, and the different institutional cultures and purposes – research and teaching as opposed to research and development – created a very steep learning curve for staff from both institutions in order to build trust and working relationship. Over the project's life span of 42 months, this relationship began very positively, faced a number of serious obstacles, and then improved significantly to the point that we are currently looking for future possibilities to further our productive collaboration not only in APM type projects, but also in other areas including biotechnology and water research. Specific challenges that were faced and overcome by this project are described below.

Project timelines outlined in the grant agreement partially influenced the outcomes. The mandatory start date of March 01, 2011 did not align with the Canadian academic calendar – professors and student were fully engaged in classes and term work and could not travel to India until May – and delayed the formal inception workshop by three months. At conclusion of this project, there were no provisions for no-cost extension which was very limiting for graduate student thesis outputs. The management change in the MSSRF team and some challenges in recruitment and retention of staff also influenced the progress. As the project sites are located in remote and often inaccessible areas, recruitment of significant numbers of personnel to these regions was a challenge. Further, at the inception of the project it was not expected that full time project managers from both institutions would be required. There were challenges of communication due to time zone differences, busy schedules, and multiple responsibilities amongst project staff and leadership.

Experience from the APM project has led us to make some recommendations on the overall administration of a project such as APM that may be of use to IDRC funded projects in the future.

7.0 Recommendations

- To engage in nutrition literacy program, demonstrations and training for promoting nutrition gardens; sustainable management of crop, soil and water; an integrated engagement approach for soil water and crop management capacity building of target population an intensive training approach in nutrition, biodiversity and climate management; and an ICT-intensive approach.
- Mainstream nutrition education in agro-biodiversity and horticulture programmes and addressing the challenges related to promoting/ enhancing consumption of a varied diet including indigenous foods/ foods offering wide variety (biodiversity) becomes important.
- It is important to recognize that bureaucratic styles of functioning and lines of command are not likely to produce the desired results. Hence a flexible and functional management structure is essential to ensure that such complex and interdisciplinary projects move towards the purpose for which they are designed.
- Face-to-face communication was an invaluable method to build partnerships and trust. We recommend that the grant agreement include as milestones a mandatory minimum number of meetings per year where the management and staff are required to be in physical attendance.

Exit Strategy: The project team had practical difficulty in evolving an exit strategy given the short time frame of the project, large intended target groups, varied socio-economic context, seasonal nature of many interventions particularly in the area of agriculture and nutrition garden, mobilizing communities for replication of successful demonstration models through training and capacity building etc. However, the project team have developed and nurtured a number of Community Based Organizations, Farmers Club, Common Service Centers to address the concern for sustainability and long term development effectiveness. With regard to this, exit strategies were designed and implemented in such a way that the positive enduring effects of donor support are maximized and possible negative effects minimized. We have prepare ourselves to developing a model of role changing and let the community lead the programmes with active support and guidance from the project teams. We strongly believe that the Site Management Committee that steered the programme during the last few years at each of the three locations, with representatives drawn from different stakeholders including the local governance bodies, will help continuance of some of the successful initiatives. Since MSSRF has been working in three sites for over last 15 years, and with the availability of trained and experienced human resources we hope to provide technical support to these communities who have successfully initiated many interventions for improving their food and nutritional status. However, a more concerted effort will be required for developing an effective exit strategy in due course of time, as many of these interventions are in different stages of development.

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Note: In addition to the above, other citations mentioned in the running text of the report are project outputs (posters and oral presentations in conferences and published articles).