ANNEX: 2.4
Report on
On-Farm Research for Addressing Production Constraints of Small Millets in South Asia

Research Institutions:

DHAN Foundation, India
Arthacharya Foundation, Sri Lanka
Local Initiatives for Biodiversity, Research and Development, Nepal
Tamil Nadu Agricultural University, India
Watershed Support Services and Activities Network, India
University of Guelph, Canada

Location of Study

India, Sri Lanka and Nepal

Report period:

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Part of

Revalorizing Small Millets in the Rainfed Regions of South Asia

Foreign Affairs, Trade and Development Canada
Affaires étrangères, Commerce et Développement Canada

IDRC | CRDI
International Development Research Centre
Centre de recherches pour le développement international

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Acronyms

CIDA	Canadian International Development Agency
DHAN	Development of Humane Actions
DFATD	Department of Foreign Affairs, Trade and Development
FYM	Farmyard Manure
IDRC	International Development and Research Centre
kg/ha	kilogram per hectare
Kg/ac	kilogram per acre
LI-BIRD	Local Initiatives for Biodiversity, Research and Development
MASL	Meter Above Sea Level
MoAC	Ministry of Agriculture and Cooperatives
NPK	Nitrogen, Phosphorous, Potassium
RESMISA	Revalorizing Small Millets in South Asia
SAK	Sustainable Agriculture Kits
t/ha	ton per hectare
VDC	Village Development Committee
MN	Micro-Nutrient solutions
SCI	System of Crop Intensification
Sq.m	Square meter

Executive Summary

Despite their nutritional advantages and climate resilience, area under small millets has been declining very fast. This trend can be attributed to lack of competitiveness arising mainly from low productivity. In all the South Asian countries, gap between the yield of the crops on research stations and on the farmers' field is very huge. Due to various factors like poor access to information and technology, the small millet farmers have not been able to reap the benefits of the modern agriculture efficiently. The currently available technologies are either inappropriate for farmers' fields or they are not disseminated through site specific action research and evidently, lack of niche specific research and inefficient extension system are the common problems faced by the South Asian countries like India, Nepal and Sri Lanka. In this background Revalorising Small Millets in Rainfed Regions of South Asia (RESMISA) project attempted to address the location specific production constraints through on-farm participatory research. The project took efforts to revive the culture of farmers' experimentation by engaging them in diverse research activities to adapt and improve available scientific technologies. The project followed two strategies: 1) On-farm research for adapting existing technologies and agronomic practices available for small millets and 2) Identifying location specific natural resource management measures, including soil and water conservation. Both of these strategies were built on farmers' indigenous knowledge and their active participation in research process.

The project formed 292 experimental farmer groups of various forms across all the sites in South Asia and organised training programs on recommended package of practices for small millets, *Guli* method of finger millet cultivation, line sowing with seed drill, dead furrow, strip cropping, redgram transplanting and seed production in India, on field trial management, data recording, FYM improvement and home garden management in Nepal and on planting methods, identification and control of diseases, weed control and trial establishment in Sri Lanka. To understand the site specific constraints various surveys and studies were carried out. Soil testing was done at five sites in India, Nepal and Sri Lanka and survey of cultivation practices was done in all the sites using a questionnaire developed by Dr Manish Raizada, UG, in collaboration with NGO partners in seven sites. Data from SAK survey and other sources like base line survey and qualitative insights learned from various focus group discussions, field visits, and participant observations of project teams were used to prioritize major production related constraints for each site. Comprehensive scientific literature review of effective agronomic practices associated with small millets in both South Asia and Sub-Saharan Africa was prepared.

For addressing the various production related constraints and opportunities identified in each site, different solution options were identified considering the cropping system, agro ecological and socioeconomic context of each site for validation and acceptance by the farmers. The solution options mainly included 1) Suitable small tools, implements and low cost technologies, 2) potential agronomic practices and 3) natural resource management (NRM) interventions. For the first two on-farm trials were taken up with 852 men and 599 female farmers and split plot design was followed. The trial farmers faced many rainfall related constraints as that of PVS farmers, which led to the poor performance of a considerable number of trials in some of the sites each year. Pertinent trial data and the opinion of the farmers were analysed to understand the suitability of tested practices.

Exposure visits to effective trials sites were organised to encourage adoption of technology. Small implements, machineries and hand tools from the other locations, market and fabricated in the project were evaluated in the sites to address the site specific constraints. Location specific NRM measures like silt application for increasing soil fertility and improve soil structure, land leveling, earthen bunding, uprooting of Prosophis (a thorny shrub which spread on uncultivated land), stone bunding and home garden in India, home garden, diversity kits and signal grass introduction as fodder in Nepal and in-situ rain water conservation by using sunken beds and tied ridges and improved composting methods in Sri Lanka.

In the project 1237 men and 1257 women farmers were involved in various kinds of on-farm trials related to tools/ implements, agronomic practices, NRM activities and storage practices. By pooling the learning from these activities and along with the results of PVS trials, location and cropping system specific sustainable agriculture kit with 3 to 6 potential practices was developed and disseminated to 3848 men and 2450 women farmers and eleven practices were widely adopted in the sites in 2014. Three years of participatory research also has resulted in a comprehensive approach with a set of tools and methods for understanding site specific production constraints and identifying suitable activities for addressing production constraints and opportunities in the site and SAK manual. Further efforts are needed for wider dissemination of the identified sustainable agricultural practices and for validating some of the other promising solutions.

Report on On-Farm Research to Address Production Related Constraints of Small Millets in South Asia

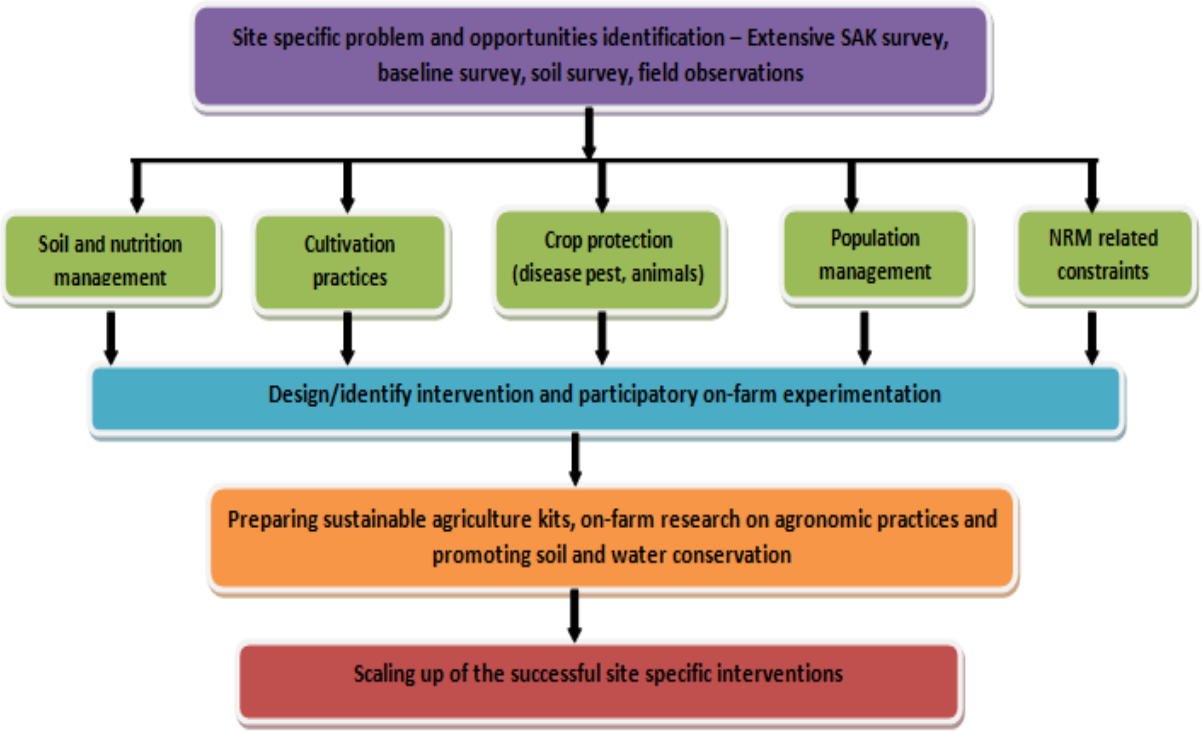
1 Introduction

Small millets are small-seeded grasses that include a group of six crops viz. finger millet (*Eleusine coracana*), kodo millet (*Paspalum scrobiculatum*), proso millet (*Panicum miliaceum*), foxtail millet (*Setaria italica*), little millet (*Panicum sumatrense*) and barnyard millet (*Echinochloa utilis*). They are hardy and grow well in dry zones as rain-fed crops, under marginal conditions of soil fertility and moisture. They are one of the oldest foods known to humans and possibly the first cereal grain to be used for domestic purposes. Small millets are the staple food of the millions inhabiting the arid and semiarid tropics of the world. They are distributed in most of the Asian and African countries and parts of Europe. They are the most important species in terms of cropped area and contributions to food security in regions of Africa and Asia. (Rao, *et al*., 2011). They are also unique due to their short growing season and can develop from planted seeds to mature, ready to harvest plants in as little as 65 days. This is important in heavily populated areas. If properly stored, whole grains will keep for two or more years.

Small millets are highly nutritious, non glutinous and non-acid forming foods. Hence they are soothing and easy to digest. They are considered to be the least allergenic and most digestible grains available. Small millets contain about 8 per cent protein and 4 per cent fat. They are rich source of vitamins and minerals. Small millets are especially rich in calcium. The dietary carbohydrate content of millets is also relatively high. Starch is the main carbohydrate component and they contain a higher proportion of non-starchy polysaccharides (dietary fiber) also. In spite of these nutritional advantages the consumption of small millets has drastically declined in the last four decades across South Asia. One of the important reasons for the decline in production of small millets is lack of competitiveness arising mainly from low productivity. In all the South Asian countries, gap between the yield of the crops on research stations and on the farmers' field is very huge. In Andhra Pradesh state of India the yield gap ranges from 66 percent in finger millet to 740 percent in foxtail millet. In Nepal potential yield of finger millet is well above two tons per hectare while the national productivity is only 1.1 tons per hectare and the total production is stagnant for the last one decade. Similar results are reported by Department of Agriculture in Sri Lanka. Due to various factors like poor access to information and the technology itself, the small millet farmers have not been able to reap the benefits of the modern agriculture efficiently. This situation is further complicated by the fact that small millets are mainly grown in highly diverse agro-environment and the constraints faced by the small farmers in these regions are mostly location specific. The currently available technologies are either inappropriate for farmers' fields or they are not disseminated through site specific action research and evidently, lack of niche specific research and inefficient extension system are the common problems faced by the South Asian countries like India, Nepal and Sri Lanka. This situation calls for the following: 1) On-farm evaluation of available small millets related technologies and issue based research in the production niches under farmer's cultivation regime by the formal research systems, 2) Evaluating potential relevant innovations and traditional

technologies, which are evolved outside the formal research systems and 3) Taking into account rich knowledge of the agro-ecosystem on the part of the local farmers, including women farmers.
The schematic diagram below (Figure-1) indicates the conceptual framework followed in the project. The project attempted to develop site-specific sustainable agricultural kit on the basis of in-depth analysis of agro-ecological contexts, agronomic constraints, farmers' innovative and indigenous practices, and alternatives available in the scientific literature. Various studies were made for assessing the existing situation of the project location in terms of production related constraints with more focus on small millets and associated crops. Intensive sustainable agriculture kit surveys (SAK Surveys) and focused group discussions (FGDs) were conducted by all the partners in three countries. Then review of literature was taken up to identify the possible solutions to the constraints and opportunities identified in the sites from other sources. The findings from the survey and FGDs, the findings from literature review and discussion with the experts were used as the base for designing the site specific interventions. The SAK survey considered existing technologies from various formal and informal sources including market and existing knowledge on diverse agro-ecology in the specific project sites. All these interventions were tested widely by each partner in India, Nepal and Sri Lanka using a participatory approach based on the local agro-environment. Location specific NRM measures were identified and tried with the farmers to know their suitability and acceptability. Based on the trial results and the response from the farmers the learning and insights were synthesized to identify the site specific sustainable agriculture practices and NRM measures. These were then disseminated to large number of farmers for wider adoption.
The following sections share in detail the various studies and trials undertaken in each site and their results.

Figure-1: Conceptual framework - On-farm participatory research to address production constraints in RESMISA Project



2 Synthesis of research activities

2.1 Formation and strengthening of farmers' research groups

2.1.1 India

DHAN Foundation has undertaken project activities with the existing women Self-help groups (SHGs) at Semiliguda and farmers group in Peraiyur and with the new groups formed in all the sites. It has newly formed 70 groups at Bero, 50 groups at Anchetty, 29 groups at Jawadhu Hills and 33 groups at Peraiyur research sites apart from the 86 existing SHGs in Semiliguda. DHAN Foundation has tried to diversify the group activities by involving them in savings and credit and linking them with banks and agriculture departments. In addition DHAN has initiated RESMISA Research Coordination Committee at five sites to involve farmers in designing, implementing and drawing inferences from various research activities.

2.1.2 Nepal

In 2011, LI-BIRD identified a total of 27 farmers groups in the three project sites with an aim to engage the farmers in a number of on-farm participatory and agronomic trials. Many of these groups were the groups formed and registered by the DADOs. Basic composition and other necessary information on these groups were compiled for record. The project conducted different on farm research and development activities with these farmers groups. LI-BIRD has tried to link the farmers' groups to Agriculture, Forest and Environment Committee (AFEC) under VDC administration, for sustainability and organized exposure visits for mutual learning.

2.1.3 Sri Lanka

Arthacharya Foundation formed eight groups in 2012 and briefed these groups about the RESMISA project. Three trainings on field establishment of finger millet were completed. Five more groups were formed during Maha Season 2012-13. Three more trainings for managing experiments and data recording were completed during Maha season 2012-13. They were given trainings on different research and development activities that RESMISA project attempts to do in the project period. In Yala season 2013 two more groups were established and trained on research methodologies.

The individuals within these groups were identified to undertake on-farm trials and other research activities. These experimenter farmers shared their experiences within and across groups in the project site.

2.1.4 Farmers' training for managing experiments

Making the farmers understand the research process was challenging as the concept was new to them. In India DHAN organised several farmers' training programs across the project sites on recommended package of practices for small millets, *Guli* method of finger millet cultivation, line sowing with seed drill, dead furrow, strip cropping, redgram transplanting and seed production with the help of TNAU, AICSMIP and experienced farmers. WASSAN organised exposure-cum-training visits to collaborating research station. Exposure visit within the locations for demonstration plot was organised for 161 male and 1311 female farmers. In Nepal, LI-BIRD organised farmer training on field trial management, data recording, FYM improvement and home garden management. In Sri Lanka, AF organised two trainings on in-situ rain water conservation and 7 trainings on, on-farm composting during this season. Six farmer trainings on field establishment of finger millet are

completed in the following season (Trainings for managing experiments and data recording). Staff/enumerators were also trained on field establishment and to conduct the baseline survey and SAK respectively. These trainings helped participating farmers to familiarize with cultivation practices developed by scientists and innovative farmers from other regions and motivated some of them to try in their farms.

2.2 Survey of soil fertility and cultivation practices

2.2.1 Soil fertility survey

All the partners did conduct soil surveys to understand the status of the soil fertility in the project sites and the result was used in determining the project interventions. The soil samples of the experimental site were analysed for macro and micronutrients for assessing the soil fertility. Soil analysis of the site locations indicates the following:

(i) Peraiyur: The soils were sandy clay in texture. Soils are calcareous and many without calcareousness. The soil colour is mostly reddish brown. The soil reaction ranged from neutral (pH 6.98) to strongly alkaline with average pH 9.38 (Annex-1). The organic carbon content of the soils ranged from 0.10 to 0.49 per cent. The electrical conductivity of the soils ranged from 0.02 to 1.76 dSm^{-1}. The higher EC values more than 1.50 dSm^{-1} was observed in a few samples. The alkaline KMnO4-N ranged from126 to 361 kg/ha indicating that the available nitrogen contents of the soils were mostly low. The Olsen's-P ranged from 7 to 56 kg/ha in the soils. The available phosphorus content of the soils was medium. The neutral normal ammonium acetate-K ranged from 31 to 838 in the soils. The available K was medium to high in these soils. The DTPA-Cu ranged from 0.92 to 2.40 ppm; DTPA-Zn from 0.13 to 1.02 ppm; DTPA-Mn from 0.58 to 8.75 ppm and DTPA-Fe from 0.43 to 7.54 ppm. This indicates that the soils of Peraiyur are sufficient in available micronutrients except Zn, which is deficient in these soils.

(ii) Anchetty: The soils were sandy clay loam in texture. Soils are non-calcareous. The colour ranges from reddish brown to brownish red through red (Annex-2). The soil reaction ranged from moderately acidic (pH5.06) to moderately alkaline (pH 8.02). The organic carbon content of the soils ranged from 0.14 to 0.49 per cent. The electrical conductivity of the soils ranged from 0.03 to0.38 dSm^{-1}. The alkaline $KMnO_4$-N ranged from 157 to 291 kg/ha indicating that the available nitrogen contents of the soils were low. The Olsen's-P ranged from 14 to 88 kg/ha in the soils. The available phosphorus content of the soils was medium to sufficient. The neutral normal ammonium acetate-K ranged from 100 to 835 in the soils. The available K was high in the soils. The DTPA-Cu ranged from 0.62 to2.81 ppm; DTPA-Zn from 0.41 to 2.76 ppm; DTPA-Mn from 2.04 to 38.30 ppm and DTPA-Fe from 2.44 to 34.60 ppm. This indicates the soils have adequate quantity of micronutrients for crop production. However few soils are deficient in Zn.

(iii) Jawadhu Hills: The soils were sandy clay loam in texture and are non-calcareous. The soil colour ranges from reddish brown to brownish red through red (Annex-3). The soil reaction ranged from strongly acidic (pH3.9) to moderately acidic (pH 6.29) due to the high rainfall and washing away of most bases. The organic carbon content of the soils ranged from 0.10 to 0.49per cent. The electrical conductivity of the soils ranged from 0.05to 0.21dSm^{-1}. The alkaline KMnO4-N ranged from 157 to 244 kg/ha indicating that the available nitrogen contents of the soils were low. The Olsen's-P ranged

from 30 to 90 kg/ha in the soils. The available phosphorus content of the soils was high. The neutral normal ammonium acetate-K ranged from 106 to 908 in the soils. The available K was high in these soils. The DTPA-Cu ranged from 0.26 to 1.59 ppm; DTPA-Zn from 0.32 to 2.12 ppm; DTPA-Mn from 2.34 to 37.30 ppm and DTPA-Fe from 5.04 to 40.96 ppm. This indicates that the soils are sufficient in micronutrients.

(iv) Semiliguda: The soils were red and loamy in texture at Semiliguda site. The soil reaction ranged from slightly acidic (pH5.3) weak base (pH 6.7). The electrical conductivity of the soils ranged from 0.03to 0.14dSm^{-1}. The availability of phosphorous ranged from 2.85 to 42.8 ppm. Similarly, the availability of exchangeable potassium rages from 110 to 552 ppm. The DTPA-Cu ranged from 0.03 to 2.98 ppm; DTPA-Zn from 0.43 to 1.22 ppm; DTPA-Mn from 0.12 to 4.2 ppm and DTPA-Fe from 0.75 to 22.66 ppm. The details report has been attached in the (Annex-4)

(v) Nepal: LI-BIRD collected 45 samples comprising 15 samples from each project VDC and the samples were analyzed in LI-BIRD plant and soil laboratory. All these samples were the representative samples of the project sites considering different altitude, aspects and soil types. The result showed that soil of the project sites is mainly sandy loam type (Annex-5). The range of various soil nutrients analyzed is presented in Table-1

Table 1: Summary of soil analysis

Range	pH	%OM	% N	Available		Boron	Soil texture		
				P mg/kg	K mg/kg		Sand %	Silt %	Clay %
Maximum	8.35	7.44	0.37	447	810	0.92	93.5	44	9
Minimum	4.38	1.91	0.11	2.8	31	0.08	48.5	2.5	2.5

According to the result of the survey, the soil in the project sites was found mostly sandy to sandy loam with very low clay in the soil. The amount of nutrients indicated that the soil is low to medium in fertility. Farmers need to apply additional manure and fertilizers for better crop yield.

(vi) Sri Lanka: In Sri Lanka, Arthacharya collected 42 samples from the project sites and did the analysis in 2012. Fertilizer recommendation was prepared for different sites based on the result obtained from the soil analysis (Annex-6 to Annex-10)

2.2.2 Sustainable agriculture Kits survey/survey of cultivation practices

Sustainable Agriculture Kits (SAKs) represent a comprehensive, holistic approach to sustainable agriculture, with one main goal i.e. to generate profit locally in the world's most desperate nations. Each SAK kit is developed not by top-down but by bottom-up approach i.e. by the grassroots. What goes into each SAK is determined locally and each SAK is designed and built locally using local experts, and then sold locally using local salespeople. Women, especially, will be involved in each step of the process, especially to determine what the local needs are. As an initiative to promote the livelihoods of the farmers by promoting SAKs, a survey was designed by Dr Manish Raizada (University of Guelph). All the implementing partners of the RESMISA contributed in refining the survey interview schedule (Annex-11). The important production constraints identified in the sites is shared below:

(i) Jawadhu Hills

At Jawadhu Hills site, a group of farmers (21 individuals), identified following a structured random sampling procedure, were interviewed individually. The sample comprised 11 males and 10 females with representation from different age classes. Most of the females were of middle aged while only one aged woman was included in the sample. Literacy was very low (33.3%) among the participants, all the households having a small family with only, on an average, 2 children and dependents each. Ownership of lands mostly rested with the men and in only one case woman owned the land. Jawadhu hills is a remote hilly site with tribal farmers characterized by light sandy to red loamy soils, high rainfall, small land holding size and limited adoption of technologies. Little millet and finger millet are the focus small millet crops here. Based on the data collected and also the observations made by the surveyor the following issues related to SMAC production are identified.

1. Most of the lands at Jawadhu Hills project site are on rolling hillocks with sandy-loam soils. As a result of which they are subjected to soil erosion. Low fertility of soils is also due to lack of proper nutrient management practices.
2. Absence of mixed cropping and intercropping in the case of focus crops.
3. Low varietal diversity at farm and hamlet level.
4. Very high plant population.
5. Harvesting and threshing operations pose serious problems due to non availability of labourers at right time, lack of facilities to store the produce after harvest, especially when rains are received during harvesting period. Processing of little millet grains for consumption is also tedious and time consuming.

(ii) Peraiyur

At Peraiyur site, a group of farmers (32 individuals), identified following a structured random sampling procedure, were interviewed individually. The sample comprised 14 males and 18 females with representation from different age classes. Out of the key informants, 28.12 % farmers are illiterate. The soils are sandy clay in texture and lands are calcareous in nature. This is a site with non-tribal farmers. Plain lands with black soil, low rainfall, medium land holding size, and limited adoption of technologies are the main characteristics of the site. Barnyard and kodo millets are the focus small millet crops here. Based on the data collected and also the observations made by the surveyor the following issues related to SMAC production are identified

1. There has been a change in rainfall pattern with late onset of monsoon and also reduction in frequency of rainfall.
2. Alkalinity problem in small millet plots.
3. Low crop and varietal diversity; proso millet and foxtail millet disappeared.
4. Farmers were not applying FYM regularly due low availability and high price.
5. Weeds namely Mallai, Korai and Amalai were causing economic loss up to 20 – 25 %.
6. Smut is a problem stated by 6 farmers causing economic loss from 20 to 25 % and green bug was a problem in barnyard millet.
7. Harvesting and processing (threshing) was time consuming and laborious in kodo millet and barnyard millet.
8. Scarcity of labour faced during weeding & harvesting period.

(iii) Anchetty

At Anchetty site, a group of farmers (20 individuals), identified following a structured random sampling procedure, were interviewed individually. The sample comprised 11 males and 9 females with representation from different age classes. This is a site with non-tribal farmers and characterized by undulating land with light sandy to red loamy soil, low rainfall, moderate land holding size and high adoption of technologies. Finger millet is the focus small millet crop here. In terms of efficient agronomic practices related to land preparation, line sowing, intercropping and plant population management, this site is the learning ground for the other sites. Based on the data collected and also the observations made by the surveyor the following issues related to SMAC production are identified

1. Change in the rain fall pattern, delayed on set of monsoon, decrease in the total quantity of rainfall and erratic rain fall- has resulted in uncertainty.
2. Low soil fertility – sandy and sloppy lands
3. Decrease in crop and varietal diversity- crops like foxtail millet, little millet, kodo millet disappeared. Even in finger millet, local varieties like *karun gatti ragi, gatti ragi*, etc. are not being cultivated now.
4. Reduction in use of FYM, due to decline in livestock population; only few have the practice of regular use of FYM (no green manure, mulching or penning is observed in the site)
5. Field bean and Redgram pod borer is a serious problem.
6. Harvesting of finger millet was labour intensive.

(iv) Semiliguda

A group of farmers (23 individuals), identified following a structured random sampling procedure, were interviewed individually. Age of the participants is comprised of 11 male and 12 female farmers with an average of 38.34 years. The sample of the survey represented mostly of working couple as the positions of all males in the family were as husbands and those of women as wives. Most of them were illiterate as their literacy level was found to be only 26.08 per cent. Their family size happened to be moderately small with average number of two children and two dependents. All of them owned their land except one who is a tenant farmer and in most of the cases the ownership rested officially with grandfather or grandfather-in-law, as the case may be. Based on the data collected from SAK survey and also the observations made by the surveyor the following issues related to SMAC production are identified.

1. Sloppy lands lead to soil erosion as the area receives high rainfall and some lands are with high slope rocky type. Uplands and a few lands which are near river banks are affected by flash floods due to heavy rains causing soil erosion and siltation, but such situations are rare.
2. There were good number of finger millet local varieties but many of them are low yielders, late in duration and their seed quality is poor (contain lot of mixtures).
3. Fertilizers and FYM were being applied only to finger millet. The farmers were not able to get sufficient quantity of manure due to less number of animals.
4. The usual practice of sowing seeds is by broadcasting, which leads to uneven and most of the times too dense plant population, resulting in poor yields.
5. High weeding cost in small millets and associated crops.

6. Harvesting and post-harvest operations also consume lot of labour as these operations are more tedious and time consuming.

(iv) Dumriguda

A total of 32 key informants were interviewed of which 5 farmers each from Kothavalasa and Amala guda, 4 from Bijumara valasa, 4 from Dhani rangini, 3 farmers each from Pakana guda and Thumdrumguda , 2 each from Nandi valasa Sandi valasa and Kodipunju valasa and one farmer each from Logili and Isukagaruvu interviewed as key informant farmers. The constraints are very similar to that of Semiliguda. Important constraints identified include,

1) High plant population,
2) Competition with vegetables for labour

(vi) Nepal

LI-BIRD conducted a total of 45 interviews have been planned consisting of 15 interviews in each project VDC in Nepal. The findings from the survey were used in designing and testing various interventions in the project sites of LI-BIRD. A total of 45 farmers were surveyed during the course of SAK study. Out of these farmers 75% of them were literate. The average farm size for the farmers of Kaski and Dhading is 18.67 and 12.14 ropani respectively. The soil colours of farms in both the districts vary from light brown to dark brown. The result obtained showed that farmers practice mixed cropping for various SMACs and mixed cropping is more common in Dhading site compared to Kaski sites. It was found that farmers are well aware of benefits of mixed cropping. Farmers are using farm saved seed for most of the SMACs. Only few farmers are buying improved seed of maize and few legumes. There is no mechanization for land preparation in both the project districts. Wooden plough, wooden planks, spades, harrows are commonly used in land preparation. Farmers reported that they apply FYM before sowing maize in the field at the time of land preparation and manure is not applied to finger millet. The study showed almost 80% of households in Dhading site are practicing penning but is less common i.e. only about 30 % in Kaski sites. Farmers indicated that out of the total loss in crop production, more than 50% reduction in yield results due to weed infestation. Weeding is manual and it is one of the most labour consuming tasks during cultivation. Blast is a very common disease and white grub is the major insect in maize and finger millet. There is problem of false smut, leaf blight and dead heart in maize. Rust is very common in grain legumes. More than 80% of the farmers surveyed reported reduction in yield of crops in the recent years. Less availability of farm yard manure, scarcity of labour and low quality seeds are the major constraints to reduction in crop yield as indicated by the farmers of both the project sites. The detailed information on agronomic practices in the site is given in Annex- 12.

(vii) Sri Lanka

Similarly, Arthacharya also conducted SAK survey in the project sites and used the finding in designing various interventions. According to land availability, 80% of farmers have own lands and 20% of farmers cultivate encroached lands that belongs to the government. Within the area, 83.33% cultivate under rain fed condition and 16.67% use irrigation. The farmers belong to three production levels which are small scale growers, medium scale growers and large scale growers. Out of small millet farmers 95% grow finger millet. In total, 36.67% of farmers reduced their cultivated area and

11.67% show increment while 51.67% no change. Average household production is 216.17kg while consumption is 69.93kg. In total, 66.67% are consuming less than 100kg/year and every farmer consume small millet base foods at least several times per year. Out of consumption 52% have reduced own consumption, 12% have increased and 36% no change.

Among production related constraints, crop damage due to wild animals, pest (Stem borer) and disease (Fungal) problem, lack of good quality seeds, insufficient rain and crop damage due to heavy rain in mature stage are dominant. Among the harvesting related constraints, heavy rain in the harvesting period, damages from animals in harvesting stage, labor shortage, drying the harvest and rotting the harvest due to pest and fungal attack are dominant issues in the area. Difficulty in processing and drying in rainy seasons; and consequent reduction of keeping quality are key issues of the farmers. Also difficulty in processing due to absence of machineries for the harvesting and threshing; animal damages (rats) and pest attacks (*kedali panuwa, gulla*) are the major constraints related to post harvest practices. According to information of the respondents, low price for their production in harvesting period, high price fluctuation and consequent price uncertainty, absence of organized market are the main market constraints of small millet cultivation in the area.

2.2.3 Joint review paper based on the scientific literature on small millets

Dr Raizada and his doctoral student did a comprehensive scientific literature review of effective agronomic practices associated with small millets in both South Asia and Sub-Saharan Africa. TNAU and AF has prepared a review of the literature on the best agronomic practices relevant to small millets and associated crops in India and Sri Lanka. The information generated helped in identifying the possible interventions to address the location specific production constraints. Dr Raizada has prepared a practical field manual for Sustainable Agricultural Kit (SAK) for global audience.

2.3 SAK and on-farm experimentations

For addressing the various production-related constraints, different solution options and opportunities were identified considering the cropping system, agro ecological and socioeconomic context of each site for validation and acceptance by the farmers. The solution options broadly included 1) Suitable small tools, implements and low cost technologies, 2) potential agronomic practices and 3) natural resource management (NRM) interventions. For the first two, on-farm trials were taken up with 1120 men and 690 female farmers and split plot design was followed. The trial farmers faced many rainfall related constraints as that of PVS farmers, which led to the poor performance of a considerable number of trials in some of the sites each year. Pertinent trial data and the opinion of the farmers were analysed to understand the suitability of tested practices. Exposure visits to effective trials sites were organised to encourage adoption of technology. The following section gives the details of on-farm trials taken in each site.

2.3.1 Jawadhu Hills, Tamil Nadu

i) Study to assess the effect of line sowing on yield in little millet (2012, 2013): The local farmers usually sow little millet by broadcasting using high seed rate, resulting in high density and uneven plant population. Farmers have a notion that higher seed rate checks weed growth and also help to maintain sufficient plant population even if the rainfall fails. Hence the trial on line sowing of little millet was introduced to demonstrate its effectiveness over broadcasting. Line sowing was done

using seed drills, Anchetty and *Kayatharu* models, and farmers' practice of broadcasting was considered as control treatment. The study was done during 2012 and 2013.

Though 8 trials were planned during 2012, the data was available only for 3 trials only. Out of 3 trials, there was increase in grain yield by more than 30% in 2 trials and decrease by just 11% in one trial. However, the results indicated that on an average, farmers could realize yield advantage from 17 to 30 percent by adopting line sowing method using seed drill. Basically line sowing method helps to attain uniform plant density throughout the field at optimum level as compared to broadcasting method. By using bullock drawn hoes for inter-culture, weeds can be controlled with minimum cost. In addition, inter-cultivation helps in conserving soil moisture and creates optimum environment for better crop growth (Annex-13)
During 2013, 15 farmers from 9 villages in 4 panchayats participated in conducting the trials. Data was available only from 9 trials and the results from the same data are presented here.

Under broadcasting method of sowing the plant population was as high as 1800 plants per square as against the population of 933 plants/sq.m when sown by Anchetty model seed drill and 756 plants/sq.m by *Kayatharu* model seed drill. (Annex-14). As expected the plant population density was reduced by more than 50% in line planting. As a result weed population in line sown plots was almost twice and 2 and ½ times more in Anchetty and Kayatharu methods, respectively, as compared to control plot. However weed population density reduced considerably in all the treatments at flowering stage but the trend remained same, weed population in line plantings were about twice than that of control plot. Moreover it could be seen that variation in weed biomass was also not much among the treatments. So it could be possible to reduce the adverse effects of weeds on plant growth and yield if one hand weeding or inter-cultivation is followed during initial stage of plant growth. Though mean values for plant height and number of tillers per plant were slightly higher than in broadcasting method, due to availability of wider growing space in line sowing, the same was not reflected in enhancing the yield. Mean values for grain and straw yields recorded in control plot were higher than those of line sown plots, but the differences were not significant statistically. This could be due to too low plant population in line sowing treatments which needs to be improved with practice.

ii) Study to find out optimum seed rate in little millet (2013): In the study, conducted during 2013, seed rate practiced by the farmers was considered as control treatment and the quantity of seed in other treatments was 75%, 50% and 25% of the control. Data from 13 out of 18 trials (un-replicated) were available and the results on growth and yield parameters are presented in Annex-15. As expected different seed rates resulted in varied plant densities ranging from 276 to 1663 plants/sq.m; which were more or less corresponding to the seed quantity used even though broadcasting method of sowing followed. Plots with lower plant density showed increased weed population and weed biomass. However, at flowering stage the differences in weed population or weed biomass among the different treatments narrowed down considerably. Interestingly the results indicated that there was gradual increase in number of tillers per plant with decrease in plant population, which in turn reflected the same trend for both grain yield and straw yield.

Results of the study showed that, the optimum seed rate could be half (12.5% increase in yield) or even quarter (17.5% increase) of the quantity presently being used by the farmers; provided the

farmers can afford one hand weeding at 25-30 days after sowing. But in reality majority of the farmers do not take up weeding and the practice of high seed rate is in a way to control the weed population in their fields. More than 60% of farmers expressed willingness to adopt lower seed rate during next season.

iii) Study on plant population management by thinning in little millet (2013): Thinning operation is usually taken up when the plant population is found too high in broadcasting or line sowing methods. The purpose is to reduce the plant population to optimum levels. Trials on thinning were tried in Jawadhu hills using bullock drawn implements after 30-35 days of sowing.

Mean values of growth and yield parameters, recorded from 10 trials, are presented in Annex-16. Plant population as well as weed population was reduced by 14 and 40%, respectively, as a result of thinning operation. Consequently there was slight increase in plant height, number of tillers, panicle length, and in grain and straw yields. Majority of the farmers were not impressed by the thinning operation as it required certain ideal field conditions to be more effective. Some of them, however, expressed that thinning helps to reduce plant population and better plant growth. They felt that reducing seed rate to have optimum population is ideal than thinning operation. However it appeared that in most of the trials the normal plant population itself was low and the treatment effect was not noticeable. This operation becomes necessary only if there is too high population than normal.

2.3.2 Semiliguda, Odisha

For addressing the constraints associated with high density plant population and labour shortage, three kinds of trials were attempted viz. 1) Line sowing using bullock drawn seed drills or sowing in furrows of wooden plough, 2) Variation in seed rate and 3) Transplanting and *Guli* method of planting in finger millet during 2011, 2012 and 2013.

i) Study on population management in little millet and finger millet (2012, 2013): During 2012, three treatments of population manipulation, namely line sowing, reduced seed rate (75% of normal practice) and transplanting of nursery raised seedlings were compared with farmer's practice of broadcasting in finger millet at Semiliguda. The trial consisting four experimental plots, each measuring 40 sq.m, was taken in the fields of 10 farmers. Data from only 8 trials were considered as the crop was damaged in other two trials. The results of the trial clearly indicated that the farmers' practice of broadcasting leads to very high plant population (139.2/sq.m), while the population in other three treatments ranged from 43.6 to 66.8 per sq.m, almost less by one third to half. It could be seen that high plant population resulted in negative effect on yield parameters, though the effect on growth parameters was not much. Transplanting method recorded maximum yield of 732.5 Kg/ac as compared to that of farmers' practice. It appeared that by line sowing or by reducing seed rate it is possible to get more yields (Annex-18). In addition, there is provision to use bullock drawn hoes for inter-cultivation in line sowing method, which helps in effective weed control at low cost. During 2013 the same study was repeated in both little millet and finger millet.

Little millet - In this study manipulation of plant population was attempted by line sowing as well as by reducing the seed quantity (by 50 and 75% of the normal quantity). For line sowing both the

methods i.e. using bullock drawn seed drills and sowing seeds in furrows opened by using wooden implements, were followed. The line sown trials with seed drills had to be vitiated due to poor germination leading to uneven plant population. Hence, the two treatments of seed rate were compared with line sowing and normal practice (control treatment) in 14 un-replicated trials. Line planting was done by opening furrows manually, while broadcasting method was followed in other treatments. The results are presented below (Annex-19). Plant population varied from 739 plants (50% seed rate) to 1137 plants/sq.m (normal seed rate). Weed population was maximum (369.6/sq.m) in line sown plots and least in control plot (183.3/sq.m) at 30 days after sowing but weed population reduced almost by half in all the treatments at flowering stage. Maximum tillers per plant were recorded in line sown treatment, while there was not much variation among the remaining treatments, values varying from 1.6 to 1.65 tillers /plant. Highest grain yield was observed in line sown crop (486.4 kg/ac) closely followed by control (478.6 kg/ac). The yields in other two treatments were considerably low. None of the treatments had any advantage over normal practice at this site but line planting using seed drills and inter-cultivation implements needs further evaluation. Majority of the farmers (about 80%) also expressed their willingness to go with existing practice.

Finger millet - Another study with the same set of treatments was under taken in finger millet also. There were 15 trials during 2013 and the results obtained from this study are given in Annex-20. With reduction in plant population there was increase in weed population at both the stages of crop growth and there was drastic decrease in grain as well as straw yields in all the treatments as compared to the existing normal practice. Hence majority of participating farmers preferred their own practice. It could be said that high plant density might not be the issue in finger millet. Since Semiliguda receives high and relatively assured rainfall, transplanting of nursery raised seedlings appears to be ideal practice to realize higher yields from finger millet crop.

ii) Transplanting and Guli method of planting in finger millet (2011, 2013): In 2011, transplanting of finger millet was demonstrated for reducing weed growth in Semiliguda. In the following season during this reporting period, 42 farmers adopted transplanting method in finger millet. This was indeed impressive intervention and plans are made for wider promotion of this method in Semliguda and adjoining Dumriguda site. This method of planting was included as one of the treatments in the study on population management, the results of which are presented above.

Guli method, a system of crop cultivation similar to SRI, has become popular among finger millet growing farmers of Karnataka state in India, especially under irrigated as well as assured rainfall situations. Transplanting of nursery raised seedlings and *Guli* method of planting were tried in Semiliguda during 2013. However, the advantage of *Guli* method was not realized by the farmers of Semiliguda (Annex-21), due to continuous rainfall during nursery stage which affected the growth of seedlings. In addition weed population was too high in *Guli* plots due to wider spacing. Farmers were unable to take up weeding at right time as it coincided with the main operations of rice cultivation. The critical factor in *Guli* method is moisture; if there is no rainfall within 4 days after transplanting then using younger seedlings becomes bane for *Guli* method.

2.3.3 Bero, Jharkhand

High density plantation and labour shortage were also the key production constraints identified for Bero site. Different agronomic interventions such as line sowing using seed drills and Guli method of planting were designed and tested during 2012 and 2013 seasons. Since trials on line sowing taken during 2012 were failed due to long dry spell after sowing. In other trials also the crop was badly affected due to scanty rainfall as the farmers were unable to take up transplanting operation at right time in many cases.

i) Guli method in finger millet (2012, 2013): There were 14 trials on *Guli* method under rain fed situations in 2012. The results of *Guli* method indicated increased yield (about 3 to 64%) in 6 out of 14 trials, depending on the availability of moisture (Annex-22).
During 2013 also the *Guli* method of planting in finger millet (transplanting of 15-18 days old seedlings with wider spacing than the normal practice) provided encouraging results (Annex-23). Average grain yields recorded from 15 *Guli* trials (810.7 Kg/ac) was 28.81% higher than the control treatment (629.3 Kg/ac). It could be attributed mainly to less plant population, almost half of normal practice, which helped younger seedlings to produce more tillers per plant in *Guli* method. Two farmers harvested as high as 1720 and 1640 Kg/ac grain yield in *Guli* method as against 1080 and 880 Kg/ac of their own practice, respectively. Most of the farmers expressed their willingness to continue with this method. The study evidently indicated that *Guli* method could be more advantageous if followed properly.

ii) Performance of finger millet in upland rice fields (2013): In Bero, upland rice fields are not suited for the common rice varieties that are usually adapted to low lands. So, the local farmers have the practice of cultivating coarse grained rice variety which has low market value besides low yielding ability. In order to better utilization of these upland rice fields, twenty farmers came forward to try finger millet in these fields along with their usual crop of coarse rice variety (*Godadhan*). Results of 14 trials indicated that rice yields were better in 12 trials than that of finger millet, the average grain yields being 931.4 and 620.0 Kg/ac, respectively (Annex-24).As far as straw yields are considered, there was not much difference between the two crops. It was noticed that farmers did not raise finger millet crop as it should have been in respect of time and method of planting; instead they followed same cultural practices for both as a result the purpose of the study was not fulfilled.

2.3.4 Anchetty, Tamil Nadu

Low fertility, crop damage by wild boar and high pesticide use to control pod borer in pulse crops were identified as the production related constraints for Anchetty site. Different agronomic interventions were designed and tested in this site during 2011, 2012 and 2013 seasons.

i) Study on topdressing treatments in finger millet (2013): Trials on top dressing with urea and Jeevamrutham (organic liquid formulation) were taken up in finger millet at Anchetty and data was available from 16 trials. Results indicated that application of Jeevamrutham recorded maximum yields (1008 Kg/ac) followed by urea application (950 Kg/ac) in finger millet (Annex-28). Top dressing with urea gave a increased yield by 19. 9 % whereas the Jeevamrutham application increased the yield by 27. 3 %.. Unlike in other sites, most of the Anchetty farmers grow high yielding varieties of finger millet like GPU28 and INDAF, which have the ability to respond well to high fertility levels. But

the farmers usually fail to apply the recommended levels of fertilizers. Under such circumstances it is possible to realize higher yields by top dressing the crop with cost effective organic manures at appropriate time. Most of the farmers were impressed by the beneficial effects of Jeevamrutham on plant growth and yield.

ii) Effect of micronutrient application on growth and yield of small millets (2012, 2013): At national level, soil nutrient status survey in different agro-climatic zones revealed that most of the soil types show depletion of micro-nutrients, especially in the areas of intensive farming practices. Soil nutrient analysis of the site also indicated that in general these soils are rich in most of the micronutrients (MN), while zinc (Zn) levels are low in some soils. Application of micronutrients, usually in the form of growth promoting agents like multiplex, is being recommended for various field and horticulture crops to overcome the ill-effects of micronutrient deficiencies on crop yields. In order to know the beneficial effects of micro-nutrient application on the yields of finger millet crop, a study was taken in the fields of 12 farmers in Anchetty during 2012. The test plot was treated with micro-nutrient application formulated by Tamil Nadu government @ 5 Kg/ac. However, the results clearly indicated that there was no effect of any sort from micro-nutrient treatment, as none of the trials showed any noticeable differences either in grain or straw yields from that of untreated ones (Annex-26). The study was repeated again with 24 trials at Anchetty during 2013 to understand any effect of MN application on growth and yield of finger millet. The results once again indicated the absence of any effect of micronutrient application on finger millet crop (Annex-29). Farmers also expressed that they were unable to notice any difference between control and test plots. Some of them opined that plants remained green and showed slight better growth due to MN application.

iii) Guli method of planting in finger millet (2012): In order to create awareness of this method through demonstration plots it was planned some trials at Anchetty during 2012, but no farmer came forward to try under rainfed condition. However, only two farmers were able to follow it systematically under irrigated situations.

In only one trial there was considerable increase in yield (50%) due to *Guli* method (Annex-25). The advantage of *Guli* method in obtaining higher yield has been proved in several instances but the success depends on timely operations and availability of moisture at critical stages of crop growth.

iv) Evaluation of bio-pesticides against insecticides (chemical) to control pod borer incidence in field bean and redgram crops (2012, 2013): Pod borer (*Heliothis armigera*) is a serious insect pest in field bean and redgram, which are commonly grown as intercrops in finger millet in Anchetty site. The extent of damage varies depending on the favourable weather factors for the insect; and according to the farmers the damage could lead to total crop loss, if no control measures are attempted. However, at present most of the farmers take up minimum of 3 sprays of insecticides as a recommended practice. As a eco-friendly measure chemical insecticides were replaced by organic formulations of naturally available materials as bio-pesticides in the trials conducted in 2012 and 2013 to control pod borer damage in field bean and redgram. Some of these organic formulations are already in use wherever farmers are strictly following organic farming.

In 2012, two schedules of organic treatment – Organic T1 (1st Chilly-garlic extract + Leaf extract of 5 plant species having insecticidal properties + Chilly-garlic extract) and Organic T2 (Same as T1, minus

the last spray of chilly-garlic) were compared with chemical and without any control measures, in field bean. The spraying of organic and chemical formulations was followed after initiation of flowering at an interval of 8 -10 days. The results of study indicated that the damage of pod borer is as high as 100% in control plot with no sprays, while chemical insecticides were found more effective than organic formulations. However the results are encouraging and there is possibility of replacing chemical pesticides with more effective combinations of organic formulations. (Annex-27).

A more systematic experiment was designed during 2013, with three treatments in the trials - T1- Farmers' practice using insecticides (2-3 sprays at an interval of 10-15 days after flowering); T2- 1st spray with 5% NSKE followed by 2 sprays of HaNPV @ 200 ml/ac; T3- Control, without any control measures. Observation on larval population, pods damaged by pod borer and grain yield were recorded in each of the treatments. The results are presented in Annex-30. In general the pest incidence itself was very low during the season; on an average the damaged pods recorded in control plots was to the extent of 27.23 and 32.82%. However, the chemical method (spraying insecticides) was found to be more effective in reducing the larval population than that of bio-pesticides, but difference in effectiveness of two methods on larval population was not much. The per cent reduction of larval population after the 2nd spray in the two different treatments were 64.5 and 58.4 in field bean and 78.1 and 76.3 in redgram, respectively. Extent of damaged pods noticed in chemical method was much lower (17.58%) and about 4% less in bio-pesticide treated plots (23.41%) as compared to control treatment in case of field beans; while it was only about 5 and 3% less in case of redgram, respectively. Though the results revealed that there was yield advantage of 13.5 and 19.3% in field bean, and about 10.2 and 3.3% in redgram, by using bio-pesticides and insecticides, respectively, but the advantages were not economically substantial. This might be the case when pest incidence itself appears to be low; and either of the methods could equally be effective in reducing the possible loss due to pod borer. Easy and timely availability of bio-pesticides is another issue which needs to be considered in case farmers prefer them over chemical method.

v) Study to reduce wild boar menace in finger millet (2011): At Anchetty, farmers are facing crops damage by wild boar, particularly in the villages near the forests. The field team did a study during 2011 to understand the issue. Experiments were designed with two local treatments: (a) spray of rotten eggs solution, and (b) tying sulphur coated threads around the field. Both treatments were found ineffective and the team started exploring available suitable methods for testing in the site during next cropping seasons. Considering many of them are impracticable and expensive, solar fencing was found to be easily accessible solution as farmers could get subsidy under government schemes. A few farmers are already adopting the method.

2.3.5 Peraiyur, Tamil Nadu

Low soil fertility and low rainfall were identified as the major production constrains for Peraiyur site. Different agronomic interventions were designed and tested in this site to address the production constraints.

i) Study on line-sowing using seed drills (2012): In this study two types of seed drill, Anchetty and *Kayatharu*, were evaluated for their suitability. Out of 11 trials in the farmers' fields, field data were available only from 9 trials in 2012. The differences noticed in grain and straw yields among the

treatments were very small and they failed to indicate any trend (Annex-31). Based on the mean values, the maximum grain yield (1253.3 Kg/ac) was obtained in line sowing using country plough. The yields recorded in other two methods were more or less same as compared to the local practice of broadcasting. The absence of beneficial effects of line sowing in barnyard millet may be attributed to the fact that farmers usually do not go for dense population in case of barnyard crop as it is practiced in other small millets, probably due to bigger plant size. However, by adopting line sowing, farmers could control weeds more effectively using bullock drawn hoeing implements. It also helps to get better plant growth apart from maintaining uniform plant population in the fields.

ii) Effect of micronutrient application on growth and yield of small millets (2012, 2013): Out of 14 trials of micronutrient application in barnyard millet at Peraiyur the data was available from 8 trials. Micronutrient fertilizer was applied in all the trials @ of 2 Kg/ac. The results showed that there were increases in grain yields ranging from 2.53 to 14.29 percent over control (Annex-32). Similar trend was observed for straw yields also, the range in yield increase being 1.47 to 13.3 per cent. However, the yield increase in most of the trials, except in 1 or 2 trials, was negligible. Considering the average values, the study revealed that the farmers did not realize much advantage from micronutrient application.

The study in barnyard millet was repeated during 2013 also, wherein 15 trials were under taken at the site. Plant height and panicle length showed higher values in MN treated plots but the effect appeared to be insignificant (Annex-33). On the other hand there was no change in tiller production. Grain yield recorded in test plot (423.1 Kg/ac) was slightly higher showing an increase of 6.15% over that of control plot. This increased grain yield could be attributed to higher plant population recorded in MN applied plots. Farmers, however, expressed that they were unable to notice much difference between the two treatments, except that plants remained green and showed slight better growth due to MN application.

2.3.6 Dumriguda, Andhra Pradesh

i) Study on date of sowing in finger millet (2013): The objective of the study was to understand the impact of different sowing time on the crop performance. Two sowing date ranges – early (between 4th week of April to 4th week of May) and on time (June) were tested with 7 farmers each. Two improved varieties- Srichaitanya and VR 900- and a local variety –*Pedda chodi*- were included in the trials. Similarly two little millet varieties namely OLM203 and *Pedda sama* were also evaluated for their adaptability as well as performance under both early and on time sowing. Result showed that the farmers who raised nursery by first week of June got good yield from their fields (Annex-34).

ii) Study on inter-cropping of redgram in small millets (2013): The trial of inter-cropping of redgram by transplanting method was taken up in the fields of 8 selected farmers. The farmers raised redgram saplings in poly bags (3 x 5 inches size) and transplanted them in rows in the fields of finger and little millets after sowing. In the Gatherajilleda, redgram seed was sown on 29th June 2013 where as in Kollaput seed was sown in the poly bags on 7th June 2013. Two farmers from Kollaput transplanted red gram in 8:1 ratio within the finger millet crops (Srichaitanya). In an acre about 1860 redgram saplings were planted and the farmers were able to get on an average 100 kgs of redgram

from them. The farmers said that though transplanting of saplings of redgram is easy, raising them in individual poly bags involves more labour.

iii) System of crop intensification (SCI) in small millets (2013): Little millet, finger millet and foxtail millet were raised through System of crop intensification (SCI), which is similar to SRI (System of Rice Intensification in Paddy) in the biodiversity block at Billapur village. The nursery for respective crops was raised and the 16 days old seedlings were line transplanted with wider row and plants spacing, than normal. The tested varieties were *Pedda sama* (Little millet), Bharati (finger millet) and ISE 1575 (foxtail millet). Nursery was raised at the end of third week for little and foxtail millet whereas at the last week of June for Finger millet. Application of farmyard manure and vermicompost was done for the crops and the growth and yield parameters were recorded periodically. The yield through SCI method was found to be significantly higher than the traditional method. The yield of *Pedda sama* was only 1.5 kg/cent through traditional method while it was 6 kg/cent by SCI method. Average yield of finger millet by SCI was 12 kg/cent through SCI, while the yield from traditional practice was only 4 kg/cent

2.3.7 Nepal

In 2012, LI-BIRD designed 5 agronomic interventions which were tested in controlled split plot experiments on farm. There were 15 replications for four of the interventions i.e. one farmer acted as one replication while there were only 2 replications for date of sowing trial. In all these SAK trials line sowing of maize and line sowing of finger millet between maize lines were common. A total of 62 trials were conducted by 54 farmers in the three project VDCs. The detail results are given in Annex-28.

i) Maize- Finger millet relay intercropping with NPK application(2012): Maize was sown in line. NPK was applied in maize at the rate of 60:30:30 Kg per hectare as basal dose. Nitrogen was applied to finger millet as a top dress before heading at the rate of 30 kg/ha. Urea was used as the source for nitrogen, di-ammonium phosphate as the source for nitrogen and phosphorus and muriate of potash as a source of potassium. Out of 15 trials seven trials failed. Result of the experiment showed that application of nitrogen as top dress in finger millet increased grain yield by about 204 kg/ha.

ii) Maize-Finger millet relay intercropping with Nitrogen fertilizer application (2012): In this intervention maize was sown in line and no NPK was applied to maize. Finger millet was sown in between maize rows. Nitrogen fertilizer was applied to finger millet only. It was applied in two spit doses. The first top dress was done after 35 days of sowing and second top dress was done after 60 days of sowing. Each top dressing was done at the rate 30 kg/ha. Out of the 15 trials 8 trials failed. The result showed yield advantage of about 419.1 kg/ha for nitrogen fertilizer application over the control conditions.

iii) Maize-Finger millet relay intercropping+ Legume intercropping (2012): In this intervention, maize was sown in lines and finger millet was then sown in between maize rows. Cowpea was intercropped in finger millet when maize was ready to harvest. Cowpea seeds were sown in the maize rows. Out of 15 trials, 10 trials failed. The yield of intercropped cowpea was 500 kg/ha. Economic analysis showed and advantage of about 44% by legume intercropping in finger millet over conventional practice.

iv) Maize-Finger millet relay intercropping with micronutrient application (2012): In this particular intervention, maize was sown in line and finger millet was sown in between the maize rows.

Complete micronutrient was applied in millet as foliar spray. Application was done during vegetative and heading stage. Out of 15 trials seven trials failed. The result showed that application of micronutrient in finger millet is not very effective in increasing yield of the crop.

v) Date of sowing trial (2012): Date of sowing trial for finger millet was conducted in Dhikurpokhari and Kaskikot VDCs to study the effect of date of sowing in direct seeded finger millet. The variety used for the trialing was Kavre Kodo 1. It was a single block trial with only plot for each date of sowing. Sowing was done four times at an interval of 15 days. The result clearly showed that delay in seeding affects the crop yield significantly. There is gradual decrease in the yield as the sowing is delayed indicating that seeding before first fortnight of May is appropriate for direct seeding method of finger millet cultivation.

Experiences from the experiments conducted in 2012 season showed that the problems associated with finger millet cultivation cannot be viewed in isolation. Since the finger millet is relayed with maize in most of the hilly regions, the agronomic experiments were designed taking into account of the maize-millet farming system. Twenty-farmers were involved in SAK trials in 2013 season. One of the hypotheses we tested was that direct seeding of the finger millet can reduce the labour required for nursery raising and transplanting. The experiments for direct seeding as a relay crop did not succeed in 2012 season in Kaski sites but the practice appeared to be promising in Dhading site. Hence, direct seeding experiments were given continuity in 2013 season to confirm if this practice appropriate for the farmers. Learning from the previous year's results compelled the project to design line transplanting experiment as an option to direct seeding. Finger-millet legume experiments were successful in 2012 season and these were further tested this year as well. The experimental plots were 30 m^2 and farmers' fields were taken as control plots.

vi) Line sowing of maize, line sowing of finger millet and application of nitrogen fertilizer (2013): Maize was sown in line. Finger millet seeds were sown in line in between maize rows. The spacing between two maize rows 75 cm and there were 5 finger millet rows between maize rows. Urea was applied as top dress after 45 days after sowing finger millet and just before heading at the rate 30 kg per ha at each application. Among the 15 trials conducted in three project sites, there was no germination of 6 trials in Kaskikot and Dhikurpokhari. There was continuous rainfall after seeding in these two sites which led to failure of these trials. In Jogimara, the trials were satisfactory, however compared to the control plots the yield in the experimental plots was much lower. Farmers responded that direct seeding was cumbersome as it was difficult to sow the seed in line maintaining uniform seed rate. Direct seeding has been rejected in relay cropping. However, direct seeding in diversity blocks was impressive as in the previous year. So, it has clearly indicated that direct seeding is successful only in mono-cropping system.

vii) Line sowing of maize and line transplanting of finger millet (2013 & 2014): In this intervention maize was sown in line and finger millet was transplanted in line. The spacing between two maize rows was maintained 75 cm and there were 5 finger millet rows between maize rows. The spacing in finger millet was maintained 15 cm x 10 cm as per the national recommendation. The result showed that the mean yield of finger millet in test plots was low compared to the farmers' practice. It was found the spacing recommended by NARC for finger millet is very inappropriate for farmers' situation. Mean yield of finger millet in test plots was 1344 kg/ha, 764 kg/ha, 1414 kg/ha in Kaskikot,

Dhikurpokhari and Jogimara sites respectively. Similarly, the mean yield in control plots was 1914 kg/ha, 1967 kg/ha, and 1968 kg/ha in Kaskikot, Dhikurpokhari and Jogimara respectively. Despite this, the farmers preferred line transplanting as they felt that weeding was very easy in line transplanting practice. They also added that line sowing of maize is a must to follow line transplanting in finger millet.

In 2014, out of the 47 farmers using auto seeder for line sowing of maize, 22 farmers have tried line transplanting of finger millet as relay intercropping. The spacing between two maize rows is maintained 75 cm and there are five finger millet rows between maize rows. The spacing between finger millet is maintained 10 cm x 5 cm. The crop is at the vegetative stage. One weeding using newly designed weeding machine has been done in the demonstration plots. Farmers indicated some uneasiness while maintaining the line in the trials at the beginning but they said that they found it easy as they continued transplanting in line. Further feedback on line transplanting is yet to be taken since the crop is still on the field.

viii) Line sowing of maize and line transplanting of finger millet, intercropping of legumes in finger millet (2013): In this experiment maize was sown in lines and finger millet was then transplanted in line in between the maize rows. Legumes (soybean and black gram) were planted as intercrop in finger millet. The spacing between two maize rows was maintained 75 cm and there were 5 finger millet rows between maize rows. The spacing in finger millet was maintained 15 cm x 10 cm as per the national recommendation. The plant population of finger millet in these experiments also low due to inappropriate spacing. Mean yield of finger millet in test plots was 1075 kg/ha, 660 kg/ha, 1138 kg/ha in Kaskikot, Dhikurpokhari and Jogimara sites respectively. Similarly, the mean yield in control plots was 1914 kg/ha, 1967 kg/ha, and 2240 kg/ha in Kaskikot, Dhikurpokhari and Jogimara respectively. The farmers responded that line transplanting can be adopted if they are provided with technology for sowing maize. They responded that intercrop yield in finger millet was bonus for the farmers.

Experiences from the experiments conducted in 2012 and 2013 season were used to design experiments for 2014 season. Basically, the trials conducted in 2014 are experiments cum demonstrations. Line sowing of maize for facilitating line transplanting of maize has been viewed as an important part for improving finger millet agronomy. In addition, line transplanting in finger millet has shown greater potential for drudgery reduction and crop management. Forty-seven farmers are involved in SAK agronomic trials in 2014 season.

ix) Line sowing of maize by auto seeder (2014): In 2013 farmers had given positive feedback on line sowing of maize using auto seeder. Hence, use of auto seeder was promoted through larger plot demonstrations. The spacing between two maize rows has been maintained 75 cm and the plant to plant distance has been maintained 25 cm. All together 47 farmers have tried line sowing of maize using auto seeder. Most of the farmers have harvested the maize by now. The feedback from the farmers on line sowing of maize auto seeder is as follows:

- Women and children can easily handle the auto seeder
- Germination is good since the depth of sowing is uniform
- Number of plants per unit area is more
- Easy for movement in the field

- Cob size appear to be larger

Many farmers expressed interest in using this machine in the following year. The only concern among the farmers is that the field has to be ploughed with bullocks before usage of auto seeder, which hence will not reduce the cost of sowing.

x) Blast resistant varieties: Neck blast, leaf blast and finger blast are very common diseases of finger millet in the project sites especially in Dhikurpokhari and Kaskikot VDCs. High rainfall and humidity could be the cause for the higher disease incidence in these two sites. Despite testing many new varieties under PVS, we were trying to introduce blast resistant varieties developed by ICRISAT. The seed samples were received late 2013 season and these are currently being tested in Dhikurpokhari. IE 7018 variety is more susceptible than others at early stage of growing.

2.3.8 Sri Lanka

i) Experiment to find the most suitable time period/s for weeding to obtain optimum yield for sustainability of groundnut cultivation in rainfed farming systems in Sri Lanka (2013): Field studies were conducted at farmer fields 2013/14 Maha season to find out the most suitable time period / periods to weed control in groundnut. The soil was sandy clay loam type, surface of the soil friable when moist and sticky and plastic when wet. Soil pH is slightly more than 7.0. Recommended variety "Tissa" was planted in the spacing 45cm by 15cm. The plot size was 20 m2. The natural weed populations were allowed to interfere with groundnut. Weed removal in different times from 3 weeks to 7 weeks from planting (WFP) were practiced to find out the most suitable time period or periods for weed removal. One plot maintained weed free from 3 to 7 WFP and the control treatment was maintained season long weedy. Hand-weeding was used to remove weeds. Practices recommended by Department of Agriculture were followed for fertilization, insect and pest management. Even though the crops were suppressed by the drought could able to collect data from four locations. Statistically analyzed data showed that the most suitable time periods for weed removal were 4 and 7 WFP for particular area. Groundnut yield decreased as weed interference intervals increased, demonstrating the need for weed control is important to get higher yield.

ii) Experiment to find out the cost effective method to prevent fungal diseases in sesame cultivation in rainfed farming systems in Sri Lanka (2013): The trials were designed to evaluate the effect of cattle manure solution (T1) and 5% commercial bleach solution (T2) to prevent fungal diseases of sesame. The trials were established in farmers' fields using Randomized Complete Block Design (RCBD) considering each farmer as a replicate.. The yields obtained from plots applied cattle manure and 5% commercial bleach solution were compared with yield of control plot (T3) of farmer practice. Random broadcasting was used for crop establishment. All the plots were partially destroyed by fungal diseases. Data obtained only from three locations. The result showed that there was no any significant difference between treatments and control.

iii) Development of sustainable agriculture kit (SAK) for the sustainability of small millets in rainfed farming systems (2013): Two sets of trials were established in two project villages; one under rainfed condition and the other in a land with minor irrigation facility in the other village. The set of trials established at kahakurullanpelessa has been was destroyed by wild elephants. The other

set of trials under minor irrigation is now at grain filling stage. Final result will be available only after mid-September.

iv) Experiment to find out the effects of inorganic fertilizers and micronutrients on yield of finger millet in Sri Lanka (2013): Eleven experiments were established with four different treatments as participatory demonstrations in the 2013/2014 Maha season. The trials were designed to evaluate the effect of NPK and micro nutrients on yield enhancement of finger millet. Demonstrations were established in farmers' fields using Randomized Complete Block Design (RCBD) with one replicate allocated per farmer. Application of one dose of micronutrients (T1), Application of recommended inorganic fertilizer mixture (T2) and Application of both NPK and micronutrients (T3) were tested as treatments in the demonstrations. The yields obtained from plots applied fertilizers were compared with yield of control plot (T4) which were under no fertilizer application (farmer practice). Random broadcasting was used for crop establishment. Weed control was taken place by using selective herbicides. T2 with recommended NPK dose showed better yield than T1 with only micro nutrients. T4 the farmer practice showed the lowest yield among treatments. Highest yield was shown by T3 indicating that application of both NPK and Micronutrients important for enhancing the yield of finger millet.

v) Experiment to test weed control methods for sustainability of finger millet cultivation in rain fed farming systems in Sri Lanka (2013): Twelve replications with eight different treatments were managed as participatory demonstrations in the 2013/2014 Maha season. The research trials were designed as comparisons of available weed control technologies. They were established in farmers' fields using Randomized Complete Block Design (RCBD) with one replicate allocated per farmer. Manual weeding, chemical weed control by using selective herbicides (MCPA 60) and mulching with organic materials were practiced for weed control. The yields obtained from plots under weed control methods were compared with the yield of no weed control plots. All the practices were tested under row sowing and random broadcasting. Highest yield was showed T1 the treatment under row sowing and manual weeding. With the random broadcasting manual weeding was difficult. Manual weed control and mulching were not efficient in broadcasted plots. Mulching was effective on weed control in line seeded finger millet and the yield obtained was high. Both broadcasted and row sowed plots under chemical weed control showed significantly higher yields.

vi) Experiment to find out the effect of different concentrations of commercial bleach solutions as seed treatments on germination of sesame for farmers in rainfed farming systems in Sri Lanka (2013): Calcium hypochlorite is being used for disinfecting the surfaces in tissue culture experiments. Commercially available bleach solution is a cheap source of Calcium hypochlorite. Possibility of using this available cheap disinfectant as seed treatment to prevent fungal diseases in sesame needed to be tested. As a start a table top observational experiment was carried out to find out the effect of different concentrations of bleach solutions on seed germination of sesame. Sesame seeds were treated with 5%, 10% and 20% commercial bleach solutions in the experiment. Seeds were soaked in commercial bleach solutions separately for three minutes and five minutes time periods. Then the seeds were rinsed in fresh water and kept on water soaked paper serviettes in plastic plates and allowed to germinate. After one week number of germinated seeds was counted and calculated the germination %. The experiment was repeated three times to confirm the results. According to the results highest germination showed in the treatment treated with 10% bleach solutions. Field trials

should be done in the future to find out the efficacy of bleach solutions as seed treatment to prevent fungal diseases.

vii) Trials for addressing storage pests in Cowpea*:* Arthacharya did some experiments to find out suitable storing methods for cowpea to prevent Bruchid weevil damage in 2013. Cowpea is short duration drought resistant crop cultivated widely by farmers in RESMISA project sites, especially when the monsoon get delayed and when they have no room for sowing other crops. Cowpea seeds are very much prone to Bruchid weevil during storage, and hence the farmers will sell the produce immediately after harvest, even though they know that storing and selling cowpea later can fetch them a good price. To enable farmers to find a suitable method to prevent Bruchid weevil attack during storage, experiments with different treatments were performed. The treatments were (i)storing seeds in three layer HDPE bag (ii) storing in poly-sack bags after mixing with wood ash (iii) storing in poly-sack bags along with dried neem and citrus leaves (iv) poly-sack bags mixed with dried Glyricidia flower petals and control treatment where seeds are stored in poly-sack bags

The treatments of three layer storage bag and farmer method of storing seeds mixed with wood ash performed better in preventing storage insect pests in stored cowpea. But the seed germination is slightly reduced when seeds were stored, mixed with wood ash.

2.4 Testing of small implements, machines and hand tools

To address some of the production constraints related to labour and drudgery in RESMISA project sites, attempt was made to introduce successful indigenous practices from other project sites for cross learning, new technologies available in the market and fabricated hand tools.

2.4.1 India

Among the Indian sites Anchetty farmers were far advanced and follow effective techniques and use indigenously designed tools for enhancing the efficiency and effectiveness of farming operations viz., land preparation, sowing, intercultural operations and harvesting.

Seed drill, spike toothed wooden harrow and thinner from this site was tried in Jawadhu Hills and the later two implements were found suitable by the farmers and adopted on a scale. Using spike toothed harrow improved the tillage and led to uniform germination. Thinner has helped addressing the problem of high plant population. In Jawadhu Hills, India, women do the ploughing operation, the practice so common particularly in women headed household and in households were men has migrated to other places in search of a better livelihood opportunity. The wooden plough used for this purpose, often get damaged due to stony nature of the soil and for repairing it women has to depend on men. As an alternative three models of iron ploughs ploughs were experimented viz., Tirupatthur plough, Uthangarai plough and Anchetty plough (going by the name of the place where they are popular). The Tirupatthur and Uthangarai plough were found suitable by both men and women farmers.

The introduction of iron plough has also reduced the women's dependency on men. Similarly Tirupathur iron plough and H 9 iron plough model were evaluated in three other sites and found

suitable. The H 9 plough was found highly suitable for the sticky soils of Semiliguda site. Grain pro bag were introduced in five sites to address the storage loss in associated pulse crops. Bhimji Kudal, a hand tool used for transplanting developed by a local innovative farmer in Bero was popularized in other villages in the site. Poor seed quality due to giving up of indigenous seed selection practices and using the grains as seeds, was an important issue in most of the seeds. Farmers hence cautiously resort to high seed rate, which in turn result in abnormally high plant density.

To address this issue, sieves were fabricated for each of the predominant varieties of each focus crop in each site for grading of the grains and use of bold grains as seeds. They were evaluated as a low cost measure for improving the seed quality in five sites and widely adopted by the farmers. Compost pit as a measure to improve the FYM was popularized in the sites. These technological options after testing in the project were disseminated in 2014.

Figure 2: Uthangarai plough

Figure 3: Tirupathur plough

Figure 4: Super grain bag

2.4.2 Nepal

In 2013 season, LI-BIRD tested two types of auto seeders of maize and only one auto seeder (Jab type) received good feedback from the farmers while the other was completely rejected. Thus in 2014 season, Jab type auto seeder of maize was tested widely. This auto seeder was used by all age groups and all the farmers expressed that the machine is user friendly and very effective.

In 2013, LI-BIRD tested corn shellers with 27 farmers with an aim to reduce little bit of drudgery faced by women farmers. There were mixed responses from the farmers on this tool. Three types of fork weeders were designed locally and tested in the farmers' field. The result showed that the weeders were useful for the trailing type of weeds and these were not effective to remove the weeds with upright growth habit. Four types of weeders have been designed locally in 2014 and these are tested in the farmer's field for one time. Among the four types of weeders, farmers have preferred the one with one wheel and forked type of part for weeding. Farmers gave the feedback that fork weeder tested in 2013 season was more efficient than these new weeders. A farmer group in Dhikurpokhari-9 has been provided with two mini-tillers to plow the field and sow the maize in line. Grain-pro bags are found effective in terms of insects and pest control during storage period for various crops and vegetable seeds.

Figure 5: Corn sheller

Figure 6: Zap Planter

Figure 7: Rotary drum maize seed planter

2.5 Location specific NRM Measures

2.5.1 India

Based on the constraints identified in the site potential NRM activities to address some of those constraints were identified base on the suggestions from the resourceful farmers and technical personnel. In Jawadhu Hills, Anchetty and Semiliguda the rolling topography, sloppy land, high soil erosion and declining soil fertility were identified as one of the important constraints. In these sites land leveling, earthen bunding, stone bunding, silt application for increasing soil fertility and improve soil structure were found suitable to improve the capacity of land to support crop development. In Peraiyur frequent infestation of fallow land by Prosophis (a thorny shrub) was identified as one of the important constraints and the farmers were supported for uprooting the same to increase their cultivable area. Similarly sheep penning was identified as the most suitable intervention to restore soil fertility. Damage of crop by wild animals was a major issue in Anchetty leading to partial to complete loss of crops in the villages adjacent to forest area. Solar fencing was found effective to address this important issue. Kitchen garden was found to be an effective intervention to increase the availability of safe vegetables and to revive the lost native vegetable varieties in the sites. During the project period 851 male and 912 female farmers tried and adopted these activities. These activities on the short term led to better rain water retention and increase in yield for the adopted farmers. Land leveling and Prosophis clearance had increased the value of asset and led to asset building.

2.5.2 Nepal

(i) Farm yard Manure Improvement

Farming in the hills of Nepal is rain-fed and farm yard manure (FYM) contributes greatly to increase the productivity of crops. However, most of the farmers adopt open heap method for collecting and storing FYM, which affects the quality in terms of nutrient availability and microbial load in long run. To address this training on storing FYM in shaded pits prepared exclusively for the purpose, was given to 49 farmers in 2012 by LI-BIRD. Among these farmers 16 were given financial assistance to do the same.

Sample of FYM was collected from shaded pits and the open heaps (check samples) from the 16 experimental farmers. The result clearly indicated that the proportion of major nutrients, namely nitrogen, phosphorus and potassium in the manure collected from shaded pits was significantly high compared to that from the check sample (Table-2).

Table 2 Result of nutrient analysis of FYM collected from open heaps and shaded pits

	Nitrogen (%)		Phosphorus (%)		Potassium (%)	
	Farmer practice	**Improved practice**	**Farmer practice**	**Improved practice**	**Farmer practice**	**Improved practice**
Average	0.761	1.425	0.257	0.437	1.093	1.729
Maximum	1.431	3.330	0.443	1.046	1.570	3.680
Minimum	0.260	0.618	0.152	0.260	0.650	1.110

In 2013, the result was shared with farmers in the project sites and 26 farmers were supported financially and technically to prepare pits beside shade for waste collection and FYM preparation. In 2014, 24 farmers (7 male and 17 female farmers) were supported partially to construct well structured shaded pits with a roof and water drainage system. Apart from the farmers who received support, 10 other farmers also resorted to this practice on their own, learning the technique from their neighbour. Feedbacks from the farmers indicate that farmers have understood the value of shaded pits, some of which are given below

- FYM does not get wet by rain water and it is easy/light to carry
- FYM prepared by this method has less moisture which makes it easy to work with and it is easy to carry to the field as well
- Easy to apply in the field
- FYM is soft and more friable
- Shaded pits make the homestead look clean
- It incurs cost to construct the shaded pits which is difficult for many smallholder farmers

(ii) Home gardening

Growing a number of possible seasonal vegetables, fruits, medicine and aromatic plants, fodders etc. utilizing the horizontal and vertical spaces within the homestead; rearing livestock, poultry and keeping small fish ponds constitute an integrated Home Garden. Home Garden maintains diversity of crop plants, which makes it more resilient in terms of climate change impacts. On the other hand since there is diversity of crops as well as animals and fishes, it directly helps in improving the nutrition of the family members. Surplus produce fetches additional income as well as they enter local markets. Considering the importance of Home Gardening from the view of food and nutrition security, LI-BIRD provided training on Home Garden to 49 farmers of three project sites in 2012. In 2013 altogether 21 very poor and marginalized household which mainly include the Dalits (so call untouchables) were supported through Home Garden intervention. These farmers increased the diversity of vegetables in 2013 by 2-5 species per household. They were provided with seeds of 17 vegetable species out of which four of them were new to most of them. They were also provided with two saplings each of guava, litchi, timmur and lime. Apart from this, 10 Dalit women farmers including seven home garden farmers from Dhikurpokhari VDC were provided training on mushroom cultivation. In 2014 the same 21 very poor and marginalized household were supported through Home Garden intervention. They have been provided with seed kits of six vegetables. The two saplings each of guava, litchi, timmur and lime are in good condition in all the households. Among the 10 Dalit women farmers trained on mushroom cultivation, one is continuing to do it on her own

(iii) Diversity Kits

In 2014, LI-BIRD provided diversity kits which included seeds of various vegetable crops to 841 (324 men and 570 female) farmers. These farmers are the members of the 27 groups supported by RESMISA project. The diversity kit was provided to the farmers to improve dietary diversity of the farmers. The farmers were provided with the seed of radish, broad leaf mustard, pea and four season beans.

(iv) Forage grasses

In 2012, signal grass was distributed as NRM measure in the project sites. Stolen were distributed to the farmers in June. Kote, a legume grass and Atriplex from Mustang, one of the mountain districts in Nepal, were introduced to the project sites. The seeds of these grasses did not germinate which could be mainly due to the higher temperature in the project sites compared to Mustang. In 2013 season signal grass was observed in some of the farmers' plot. It was also found that the grass did not grow in some of the farmers' fields. In 2014, some farmers have big patches of signal grasses growing at the margins of their field. The feedbacks of the farmers on the grass are:

- The grass is soft and liked by buffaloes and goats
- The grass multiplies very quickly
- At least two harvests are possible in season

2.5.3 Sri Lanka

(i) Identification of suitable method of composting

Arthacharya supported 25 demonstrations of composting in 2013 Yala season. Three methods of composting (heap method, pit method and cage method) were compared in the programme. A survey was carried out for the evaluation. Most of the farmers suggested that the heap method was the most suitable for the area under the project. Ten out of 25 told that the pit method was better but the problem was digging pits when the soil is very hard in the dry season. Eight out of 25 told that the cage method is good to compost kitchen garbage and residues of home garden.

2.6 Assembling of SAK from the trials and evaluation for dissemination

The synthesis of the results of SAK, and other agronomic trials and observations are shared site wise below.

Table 3 Results of SAK and on-farm trials conducted during 2011- 2013

Site	Focus crops	Site specific constraints	Sustainable agriculture practices identified
Jawadhu Hills	Little millet & finger millet	1. High plant population density, 2. Low soil fertility 3. Less attention to soil and weed management	1. Using improved iron ploughs, 2. Using spike toothed wooden harrow before and after sowing, 3. Improving quality of seed through seed selection in the farm and by grading with sieve, 4. Reducing plant population by reducing seed rate and using thinner,

Site	Focus crops	Site specific constraints	Sustainable agriculture practices identified
			5. Top dressing of Jeevamrutham & 6. Intercropping with redgram
Semiliguda	Finger millet & little millet	1. High plant population, 2. Weed menace & 3. Competition with paddy for labour	1. Using improved H.S. iron plough, 2. Improving quality of seed through seed selection in the farm and grading with sieve, 3. Transplanting of finger millet, 4. Intercropping with redgram, 5. Using modified weeder & 6. Composting using pit
Dumriguda	Finger millet & little millet	1) High plant population, 2) Competition with vegetables for labour	1) Transplanting finger millet, 2) Jeevamrutham and Panchakavya application & 3) Tirupathur model plough
Bero	Finger millet	1) High plant population, 2) Competition with paddy for labour & 3) Less attention for weed management	1) Improving quality of seed through seed selection in the farm and grading with sieve, 2) Line transplanting or *Guli* method, 3) using *Bhimji kudal*, 4) Ensuring weeding after 30-35 days of transplantation, 5) Top dressing with Urea & 6) Tirupathur model plough
Peraiyur	Barnyard millet & Kodo millet	1. Low soil fertility & 2. Inadequate rains	1. Improving quality of seed through seed selection in the farm and grading with sieve, 2. Basal application of Ganajeevamrutham, 3. Using optimum seed rate, 4. Reintroduction of intercropping, 5. Gap filling at right time & 6. Top dressing with Jeevamrutham / urea
Anchetty	Finger millet	1) Low soil fertility, 2) Crop damage by wild animals & 3) High pesticide use	1) Improving quality of seed through seed selection in the farm and grading with sieve, 2) Top dressing of Jeevamrutham, 3) Solar fencing & 4) Composting using pit
Nepal	Finger millet	1) High labour intensity, 2) Weed menace, 3) Blast incidence & 4) Low soil fertility	1) Line transplanting of finger millet, 2) Introduction of legumes in the finger millet cropping system, 3) Shaded pit method of compost preparation, 4) Jab type of auto seeder, 5) Different kind of weeders & 6) Blast resistant varieties
Sri Lanka	Finger	1) Primitive system	1) Row sowing and transplanting of finger millet for

Site	Focus crops	Site specific constraints	Sustainable agriculture practices identified
	millet	of cultivation, 2) weed menace, 3) wild animal damage & 4) Lack of appropriate machinery and tools	small holdings, 2) Selective herbicide use, 3) Application of inorganic fertilizers, 4) Storing cowpea with wood ash & 5) Heap method of composting

Grain pro bag was tested in all the three project countries with 1174 farmers. The sustainable agriculture practices identified were disseminated widely in the working villages through training and demonstration to 3768 men and 2390 women farmers. Picture book on the theme of SAK was designed and disseminated (Can be accessed in project webpage). Large plot demonstration of these practices was carried out in 2014 across the villages in the sites with the involvement of 140 farmers. In 2014 the following practices were widely adopted: seed grading with sieve (4915), using spike toothed harrow (388), transplantation of finger millet (234), furrow transplantation of finger millet (115), application of Jeevamrutham (888), Ganajeevamrutham (140), grain-pro bag (1174), improved composting methods (313) and iron plough (247). Some of the results of on-farm trials needs further testing.

2.7 Other developments

Dr Raizada and his students taken up research to understand physiological and biochemical properties of finger millet that make them capable to grow marginalized land with low soil fertility and less moisture or rain. Travis Goron, Vijay Bhosekar and Charles Shearer, students in Raizada Lab have initiated a study on root architecture of finger millet and revealed how the plants adjust its root architecture and root hairs to scavenge soil nutrition. The small cereal finger millet (Eleusine coracana) is well known in India and north-east Africa as a highly nutrient efficient, low-input crop. In these regions finger millet is valued in part due to an ability to adapt to a wide range of agronomic conditions. Previous studies have shown that in contrast to high-input crops such as maize, finger millet requires very little nitrogen fertilization; however, exact mechanisms of adaptation remain largely unknown. Here a detailed investigation of various physiological parameters in their response to zero nitrogen application as compared to a low nitrogen dose including biomass differences, chlorophyll content, and nitrogen allocation was done. Additionally, the use of sensitive imaging technology for the analysis of root characteristics in response to nitrogen removal was explored. Results indicate that finger millet is well suited to its native nutrient-poor environments and is extremely responsive to very low levels of nitrogen. Multiple areas in which finger millet may serve not only as a source of valuable traits for breeding highly nitrogen-use efficient lines, but also as a genetic repository for the improvement of other cereal crop species was discussed in the study. A manuscript on this research is under preparation for publication.

Walaa Mousa, a PhD student working in Raizada Lab at Guelph, has discovered that finger millet possesses a beneficial fungus which secretes a natural fungicide able to kill crop fungal pathogens including *Fusarium graminearum*. Finger millet is an ancient cereal, domesticated 7000 years ago in

East Africa, reaching India by3000 BC. The crop is resistant to many fungal pathogens including Fusarium, but the underlying reasons remain under-investigated. Finger millet has not apparently been explored for endophytes – microbes that inhabit plants without causing disease, some of which antagonize host pathogens. It was hypothesized finger millet harbors endophytes that combat Fusarium, perhaps due to co-evolutionary selection, as at least one species of Fusarium has been reported to have an ancient African origin. Here, an attempt was made to isolate fungal endophytes from finger millet and characterize the efficacy of their extracts to suppress Fusarium. Five distinct fungal strains were isolated from roots. Extracts from three endophytes inhibited growth of Fusarium graminearum and three other pathogenic Fusarium species. The endophyte extracts caused variable levels of toxicity in leaf and insect assays. In vitro interaction studies suggested that each extract had distinct fungicidal and/or fungistatic modes of action. From the most potent anti-Fusarium extract (from Phoma endophyte WF4), bioassay-guided fractionation identified the alkaloid viridicatol as the most active anti-fungal compound. Viridicatol caused dramatic cleavage of F.graminearum hyphae in vitro. Viridicatol has previously been associated with fungi that thrive in harsh environments. The results show that the ancient, disease-tolerant crop, finger millet, is a novel source of endophytes that have the potential to combat modern crop pathogens through the production of natural products. A research paper based on this work is submitted internal journal *PLoS One*. Walaa has also discovered that finger millet possesses a beneficial bacterium, which she has named strain M6. This strain can be sprayed on corn and wheat plants to partially suppress *Fusarium* diseases. Walla Mousa is preparing another manuscript for journal *PLoS Pathogens*. Dr Raizada has collaborated with scientists at the University of California at Davis to sequence the entire genome of strain M6 bacterium and this work will result in a future peer-reviewed publication. Further, research in Raizada Lab (Guelph) has also invented a new diagnostic technology called GlnLux which one day may help finger millet farmers better manage how much nitrogen fertilizer to apply, which would improve their profit margins and reduce environmental damage caused by excessive nitrogen fertilizer.

Vijay Bhosekar has done the study on “Current status of inorganic fertilizer management for finger millet and related millets in South Asia and Africa. This review is a meta-analysis of current fertilizer recommendations for finger millet and related millets grown in South Asia and Africa with a special focus on the importance of balanced soil nutrients.

3. Summary and conclusion

All the RESMISA project partners identified the production related constraints, designed location specific interventions to address these constraints and tested these interventions across all the eight project sites in the three countries. The interventions mainly comprised of agronomic interventions, seeds, implements (small machineries and hand tools) and location specific NRM measures. Many of these interventions have shown potential to address the location specific production related constraints identified at the initial phase of the project. Results from some of the agronomic experiments like population management by reduced seed rate in finger millet and little millet, application of organic formulations as fertilizer, application of bio-pesticides, Guli method of transplanting in finger millet and intercropping of red gram in finger millet show a high potential in Indian project sites. Similarly, line sowing of maize followed by line transplanting of finger millet has

been successfully tested in Nepal while line sowing of finger millet has been found useful in Sri Lankan project sites. Agronomic practices are the technologies for which adoption lag is significantly high. Thus, promotion using large plot demonstrations at a larger scale in terms of numbers will be very critical to promote the adoption of validated agronomic practices. The project partners tested different implements and hand tools associated with SMACs to address the constraints related to labour shortage and drudgery. Harvesters, threshers/dehullers, different types of ploughs were tested in India. In Nepal, maize auto seeders, weeders, finger millet threshers, corn shellers and grain-pro bags were tested while harvesters were tested in Sri Lanka. Many of these implements were accepted at larger terms while useful feedbacks were received to improve these implements for enhancing the adoption of these implements. The NRM measures promoted by the RESMISA project like silt application, Prosophis clearance, techniques of improving the quality of manure/compost, home gardening etc are the proven technologies and have the potential to be promoted with much more ease compared to other technologies. The potential for cross learning across the project sites was made visible in the project.

During the project period 1237 men and 1257 women farmers were involved in various kinds of on-farm trials related to tools/ implements, agronomic practices, NRM activities and storage practices. By pooling the learning from these activities and along with the results of PVS trials, location and cropping system specific sustainable agriculture kit with 3 to 6 potential practices was developed and disseminated to 3848 men and 2450 women farmers and eleven practices were widely adopted in the sites in 2014. Three years of participatory research also has resulted in a comprehensive approach with a set of tools and methods for understanding site specific production constraints and identifying suitable activities for addressing production constraints and opportunities in the site and SAK manual. The results clearly indicate the need of stretch of project duration to further scale up the validated technologies while to refine, fine tune and promote the technologies which were found useful but received considerable feedback for improvement.

Further efforts are needed for wider dissemination of the identified sustainable agricultural practices and for validating some of the other promising solutions. Scaling up of the approach and the individual promising technologies are very much feasible. The scaling up of the approach and the technologies will require a multi-stakeholder approach. The working relationship developed during the project period with other stakeholders particularly Department of Agriculture and research institutions and other NGOs and farmers organisations carry the potential for further scaling up.

ANNEXES

Annex-1 : Results of Soil Survey of Peraiyur Farmers, 2012

S. No.	Famers Name	Sample	Nutrient contents								Micro nutrients				
			PH	EC	Texture	Lime	Colour	N kg/ha	P kg/ha	K kg/ha	Cu (ppm)	Mn (ppm)	Fe (ppm)	Zn (ppm)	OC %
1	Indhurani	1	6.98	8.35	CL	NC	B	221	7	179	1.11	6.91	3.61	0.24	0.3
2	Rajeswari	2	8.35	0.11	SCL	NC	RB	185	11	159	1.32	5.92	6.38	0.37	0.37
3	T. Ganesan	3	7.83	0.04	CL	NC	B	185	8	317	0.99	6.29	4.59	0.28	0.4
4	K.S. Jeyalakshmi	4	8.16	0.11	CL	C	B	241	13	838	1.36	4.58	2.74	0.29	0.28
5	R. Vellammal	5	8.6	0.04	SCL	NC	B	218	8	156	1.23	3.79	4.51	0.22	0.31
6	Rajammal	6	7.67	0.1	SCL	NC	B	216	7	156	1.62	8.73	3.86	0.62	0.14
7	M. Kaveriselvi	7	8.15	0.04	CL	NC	RB	232	8	164	1.27	6.11	4.53	0.23	0.49
8	K.Bandhamuthu	8	8.23	1.42	CL	C	B	260	15	169	1.6	5.19	3.49	0.34	0.39
9	R. Vijayalakshmi	9	7.94	0.24	SL	NC	RB	361	14	235	0.92	5.77	3.97	0.39	0.34
10	M. Maheswari	10	8.7	0.1	SCL	NC	B	199	8	320	1.24	4.12	5.29	0.21	0.1
11	S. Muthammal	11	8.27	0.19	SL	NC	RB	221	23	168	1.84	8.75	2.43	0.41	0.12
12	R. Subburaj	12	8.24	0.25	SCL	C	B	202	25	160	2.14	4.68	4.34	0.43	0.42
13	R. Jeyamary	13	8.02	0.38	CL	C	B	283	14	162	1.85	5.94	5.37	0.42	0.31
14	S. Muthammal	14	7.66	0.36	SL	NC	RB	269	24	161	1.34	7.4	4.6	0.51	0.48
15	Shenbagalakshmi	15	8.4	0.16	SCL	C	B	249	10	781	1.55	4.66	6.4	0.44	0.22
16	T. Annakodi	16	8.09	0.13	CL	C	B	235	46	164	2.04	5.44	4.7	0.79	0.22
17	Shunmugam	17	8.16	0.04	CL	C	R	235	8	197	1.54	4.17	3.95	0.39	0.46
18	P. Murugan	18	8.52	0.06	CL	NC	B	162	7	167	1.11	3.97	5.38	0.14	0.1
19	Madasamy	19	8.22	0.14	SCL	C	RB	249	9	158	1.42	3.88	3.39	0.29	0.22
20	Pandeswari	20	8.28	0.15	CL	NC	B	140	8	163	1.1	4.79	5.02	0.19	0.15
21	E. Alagupandian	21	8.69	0.1	CL	C	RB	168	10	239	1.62	3.73	4.91	0.15	0.25
22	K. Kandharajammal	22	8.78	0.07	SCL	C	RB	134	7	232	1.03	4.05	4.09	0.15	0.34
23	Vellammal	23	9.03	0.02	SCL	NC	RB	126	8	157	1.3	6.18	5.52	0.28	0.42
24	Mani	24	8.22	0.04	CL	NC	RB	176	9	31	1.31	4.46	3.07	0.38	0.39

S. No.	Famers Name	Sample	Nutrient contents								Micro nutrients				
			PH	EC	Texture	Lime	Colour	N kg/ha	P kg/ha	K kg/ha	Cu (ppm)	Mn (ppm)	Fe (ppm)	Zn (ppm)	OC %
25	C. Gnana gurusamy	25	8.16	0.02	SCL	NC	RB	179	9	162	1.43	5.39	4.32	0.35	0.2
26	K.P. Ramachandran	26	8.09	0.14	CL	C	B	210	8	156	2.08	5.89	2.86	0.56	0.17
27	Sukilimani	27	8.4	0.04	CL	C	B	188	7	256	1.12	4.99	4.75	0.33	0.22
28	C. Pandiammal	28	8.26	0.04	CL	NC	B	165	8	151	1.21	4.2	7.54	0.28	0.17
29	Ramasamy	29	8.05	0.16	SCL	C	RB	210	18	158	1.46	5.25	2.83	0.38	0.31
30	S. Rajalatha	30	8.38	0.05	CL	C	RB	129	8	244	1.2	4.05	3.43	0.19	0.31
31	I. Thangamuniammal	31	9.38	0.06	CL	C	RB	188	10	234	1.36	4.35	5.74	0.19	0.42
32	P.Sivasangari	32	8.77	0.06	CL	NC	B	193	8	169	1.26	6.15	3.91	0.3	0.36
33	K. Perumal	33	8.08	0.06	CL	C	RB	204	52	255	1.33	0.58	4.74	0.2	0.18
34	P. Gurusamy	34	8.37	0.03	CL	C	B	196	56	162	1.15	3.4	3.97	0.15	0.36
35	T. Rajeswari	35	8.48	0.07	SCL	NC	B	190	32	179	1.26	4.51	3.79	0.24	0.31
36	Marimuthu	36	8.34	1.76	SCL	C	RB	286	16	156	1.11	3.56	3.77	0.24	0.28
37	B. Sundaravalli	37	8.29	0.23	CL	NC	RB	202	7	192	1.2	4.92	2.71	0.22	0.36
38	V. Velayi	38	8.08	0.03	SCL	NC	RB	179	7	156	1.48	6.56	2.72	0.33	0.17
39	M.Vellaisamy	39	8.54	0.06	SCL	NC	RB	210	9	175	1.24	4.04	3.4	0.3	0.31
40	P. Selvarani	40	8.37	0.02	CL	NC	RB	143	7	183	1.13	3.59	5.86	0.13	0.38
41	V. Pandiammal	41	8.33	0.03	CL	C	B	202	7	373	1.06	4.3	5.86	0.15	0.31
42	Karuppayi	42	8.95	0.7	CL	C	RB	171	17	215	1.44	7.49	3.6	0.36	0.22
43	Annalakshmi	43	8.7	0.04	CL	NC	B	148	10	287	1.07	4.18	3.75	0.13	0.45
44	M. Palaniammal	44	8.07	0.03	SCL	NC	B	185	11	161	1.2	4.14	3.63	0.35	0.48
45	T. Vijayalakshmi	45	9.16	0.05	SCL	C	B	280	30	159	1.6	5.04	4.88	0.5	0.31
46	P. Rameshwari	46	8.4	0.04	SCL	C	B	221	14	244	1.9	5.84	3.32	1.02	0.22
47	K. Eswari	47	8.31	0.04	SCL	C	RB	160	9	238	1.3	4.18	2.83	0.41	0.46

Annex -2: Results of Soil Survey of Anchetty Farmers, 2012

S.No.	Famers Name	Sample	Nutrient contents									Micro nutrients			
			PH	EC	Texture	Lime	Colour	N kg/ha	P kg/ha	K kg/ha	Org. Carbon %)	Cu (ppm)	Mn (ppm)	Fe (ppm)	Zn (ppm)
1	Mathappan	1	8.02	0.06	SCL	NC	R	157	20	103	0.15	0.72	9.91	5.04	1.92
2	Basappa	2	6.25	0.24	SCL	NC	RB	252	88	723	0.49	1.72	19.23	13.55	2.76
3	Ruthirappa	3	6.28	0.14	SCL	NC	BR	291	45	614	0.4	2.68	31.8	19.11	1.85
4	Nagaraj	4	6.42	0.1	SCL	NC	BR	266	70	583	0.41	1.64	17.5	17.3	23.43
5	Singappa	5	7.69	0.38	CL	NC	BR	224	20	544	0.41	1.72	7.2	23.43	1.27
6	Bimanna	6	7.1	0.15	SCL	NC	RB	227	14	389	0.49	1.1	9.12	3.26	0.77
7	Attiyappan	7	5.56	0.03	SL	NC	R	162	55	261	0.24	1.28	37.62	15.63	1.08
8	Murukash	8	5.52	0.08	SCL	NC	RB	171	45	292	0.3	0.91	16.67	3.76	1.44
9	Mathappan	9	6.46	0.09	SCL	NC	BR	174	40	414	0.46	1.11	9.2	5.84	0.87
10	Elangovan	10	6.4	0.09	SL	NC	RB	199	40	300	0.47	0.82	18.69	9.68	1.56
11	Jampiramma	11	5.37	0.04	SL	NC	R	188	40	119	0.34	0.62	15.78	11.78	1.31
12	Ponnagkatti	12	7.46	0.08	SCL	NC	BR	168	16	100	0.24	0.65	5.4	2.44	0.45
13	Perumal	13	5.87	0.2	SCL	NC	R	224	35	252	0.35	1.33	10.51	4.12	0.57
14	Marigowdu	14	6.93	0.15	SCL	NC	BR	168	18	378	0.43	0.76	6.78	2.84	0.56
15	Sombulingam	15	5.68	0.04	SCL	NC	BR	179	40	106	0.3	0.73	12.82	18.03	0.41
16	Thottekauda	16	6.14	0.09	SCL	NC	RB	207	45	183	0.32	1.19	18.72	2.94	0.88
17	Munigowda	17	5.91	0.04	SCL	NC	BR	204	30	115	0.39	1.08	14.87	15.14	1.16
18	Nagaraj	18	5.98	0.12	SCL	NC	BR	244	30	835	0.32	1.04	18.72	15.86	0.9
19	Mathappa	19	5.82	0.1	SCL	NC	BR	221	25	107	0.46	1.03	18.46	9.98	0.94
20	Munigowda	20	5.06	0.03	SCL	NC	RB	199	45	230	0.14	1.05	22.82	34.61	1.1
21	Sandra	21	5.64	0.06	SCL	NC	RB	196	30	101	0.17	2.43	28.72	12.98	0.97
22	Mathappa	22	5.3	0.06	SCL	NC	R	188	30	100	0.38	1.3	27.43	14..42	0.98
23	Sannappa	23	5.63	0.06	SCL	NC	R	179	40	100	0.22	1.05	16.92	8.78	0.73

S.No.	Famers Name	Sample	Nutrient contents									Micro nutrients			
			PH	EC	Texture	Lime	Colour	N kg/ha	P kg/ha	K kg/ha	Org. Carbon %)	Cu (ppm)	Mn (ppm)	Fe (ppm)	Zn (ppm)
24	Basappa	24	5.7	0.09	SCL	NC	BR	190	45	141	0.38	1.39	19.99	11.54	1.31
25	Sivaruthrappa	25	5.15	0.06	SCL	NC	BR	202	40	194	0.43	1.25	19.49	20.19	0.94
26	Muniraj	26	5.55	0.03	SL	NC	R	216	45	125	0.41	1.1	37.9	17.18	1.53
27	Mathevaiya	27	6.09	0.07	SCL	NC	BR	258	25	480	0.4	2.33	19.97	16.58	2.3
28	Ruthraiya	28	6.18	0.11	SCL	NC	BR	204	30	471	0.4	2.81	22.81	11.54	1.81
29	Rasettapa	29	6.21	0.22	SCL	NC	BR	227	30	580	0.4	1.76	2.04	9.97	2.13
30	Nangiunnappa	30	6.15	0.1	SL	NC	RB	190	80	327	0.36	1.09	38.3	11.6	1.98

Annex-3: Results of Soil Survey of Jawadhu Hills Farmers, 2012

S.No.	Famers Name	Sample	Nutrient contents									Micro nutrients			
			PH	EC	Texture	Lime	Colour	N kg/ha	P kg/ha	K kg/ha	Org. Carbon (%)	Cu (ppm)	Mn (ppm)	Fe (ppm)	Zn (ppm)
1	Unnamalai	1	3.9	0.09	SCL	NC	RB	199	60	165	0.31	0.88	24.06	40.96	1.04
2	Unnamalai	2	6.24	0.15	SCL	NC	RB	213	60	297	0.49	1.26	9.62	16.28	0.86
3	Gopal	3	5.82	0.07	SCL	NC	RB	185	75	295	0.4	0.32	5.01	11.9	0.48
4	Santha	4	6.21	0.14	SCL	NC	RB	244	40	908	0.4	1.22	6.68	11.9	0.32
5	Papathi	5	5.43	0.1	SCL	NC	R	241	45	591	0.4	1.26	10.42	5.04	0.32
6	Ruku	6	5.97	0.08	SCL	NC	BR	182	35	417	0.49	0.74	5.46	11.27	0.78
7	Ramamoorthy	7	6.1	0.15	SCL	NC	BR	193	30	106	0.43	0.88	8.52	10.65	0.6
8	Manikkam	8	5.49	0.07	CL	NC	BR	204	65	269	0.1	0.7	15.63	12.53	12
9	Rukku	9	4.64	0.08	SL	NC	RB	171	40	186	0.33	0.56	15.65	17.05	1.11
10	Malliga	10	5.36	0.07	SCL	NC	BR	188	75	369	0.46	1.06	2.34	10.02	0.82
11	Kasi	11	5.72	0.06	SCL	NC	BR	199	55	246	0.26	0.98	5.925	12.53	1.2
12	Kuppu	12	5.81	0.07	SCL	NC	BR	182	50	154	0.11	0.54	4.98	11.27	0.66
13	Govindha	13	6.29	0.08	SCL	NC	BR	157	55	154	0.31	1.04	16.64	10.65	1.68
14	Papathi	14	5.36	0.08	SCL	NC	BR	190	65	242	0.14	0.86	11.94	15.66	1.18
15	Chinnapabu	15	5.21	0.06	SCL	NC	BR	185	55	199	0.31	0.48	19.33	11.9	0.58
16	Manikam	16	4.47	0.09	SCL	NC	R	216	55	205	0.42	0.78	21.74	31.21	1.17
17	Maliga	17	6.17	0.09	SCL	NC	RB	196	85	625	0.43	1.02	10.09	10.02	0.92
18	Sivagami	18	5.68	0.12	SCL	NC	RB	196	60	230	0.4	0.64	8.58	11.9	1.76
19	Vijaya	19	5.68	0.06	SCL	NC	RB	224	60	403	0.37	1.3	9.58	20.04	0.66
20	Kasi	20	5.55	0.14	SL	NC	R	174	65	225	0.34	0.68	13.69	15.36	1.02
21	Priya	21	5.51	0.09	SCL	NC	BR	235	75	471	0.17	1.32	10.76	8.77	0.5
22	Govindhammal	22	5.83	0.05	SCL	NC	BR	190	90	236	0.38	0.26	7.28	8.77	0.52
23	Annamalai	23	5.97	0.21	SCL	NC	R	176	90	204	0.31	1.59	37.3	27.14	2.12

Annex-4 : Results of Soil Survey of Semiliguda Farmers, 2013

SL. No.	Name of the farmer	Name of the village	PH	EC	Soil texture	OC	P2O5 (ppm)	K2O) (ppm)	N (ppm)	S (ppm)	Zn (ppm)	Fe (ppm)	Mn (ppm)	Cu (ppm)
1	Hari Khila	Ramnaikput	8.2	0.08	SCL	L	42.88	369	81	73.87	0.928	11.41	3.994	1.242
2	Madhaba Nandbali	Kutugaon	7.6	0.08	SCL	L	29.86	463	81	56.96	1.208	22.66	1.097	1.56
3	Bijaya Sadapali	Kankadambo	6.7	0.04	SCL	L	29	414	59	51.62	0.296	1.42	2.934	0.398
4	Padu Majhi	Kumbhariput	6.1	0.03	SCL	L	23.9	115	91	125.5	1.014	19.54	2.257	1.712
5	Rabi Chapadi	Gelhaguda	6.2	0.05	SCL	L	21.37	113	97	35.6	0.674	14.73	3.231	0.772
6	Somanatha Sagri	Sana Tema	6.2	0.04	SCL	L	19.09	207	86	37.38	0.912	15.55	4.024	0.848
7	Madhaba Burudi	Pujariput	6	0.07	SCL	L	17.54	201	86	34.71	1.31	20.37	2.904	1.054
8	Padma Majhi	Phuldhaba	6.2	0.08	SCL	L	10.28	110	86	65.86	0.872	19.36	1.494	0.886
9	Padu Bhoi	Lunguri	6.6	0.14	SCL	L	9.38	234	91	37.38	1.224	8.31	2.91	2.198
10	Selia Jani	Parja Sirimunda	6.8	0.07	SCL	L	7.67	411	71	33.82	0.796	12.2	3.277	1.224
11	Sima Hantal	Dekapar	5.5	0.05	SCL	L	7.46	437	75	39.16	0.922	14.36	4.07	1.43
12	Ramesh Hantal	Jagamput	5.7	0.05	SCL	L	6.65	452	70	27.59	0.434	15.08	2.554	0.772
13	Laxman Guntha	K. Sirimunda	6	0.06	SCL	L	6.55	320	3.5	1.38	0.0217	0.754	0.128	0.039
14	Sukra Dora	Bileiguda	6.1	0.05	SCL	L	6	552	61	67.64	0.918	19.04	4.094	1.594
15	Jairam Moyullu	B. Marla	6.1	0.07	SCL	L	5.57	380	74	46.28	0.81	5.212	1.138	1.204
16	Damburu Disari	Gadi Khamra	5.9	0.08	SCL	L	5	391	63	52.51	0.826	20.73	1.552	2.086
17	Padu Kirshani	Bodchori	6	0.05	SCL	L	3.18	281	81	37.3	0.53	14.38	3.686	1.748
18	Ballhaba Guntha	Durkaguda	6.1	0.05	SCL	L	3.1	300	75	40.05	0.362	16.61	3.872	0.698
19	Ramo Khila	Gelhaguda	5.8	0.07	SCL	L	2.92	292	75	38.27	0.77	20.45	1.045	0.96
20	Manglu Gellhanaik	Gelhaguda	5.3	0.05	SCL	L	2.856	469	65	56.96	0.984	3.13	4.204	0.866

Annex-5: Result of the soil analysis in Nepal site, 2012

Name of VDC	Sample details	pH (1:2.5)	%OM	% N	Available		Boron (ppm)	Soil texture		
					P mg/kg	K mg/kg		Sand %	Silt %	Clay %
Dhikurpokhari	Soil sample no.- 1	4.45	6.22	0.31	6.95	134.3	0.25	70	26	4
Dhikurpokhari	Soil sample no.- 2	4.8	5.23	0.26	5.95	53.2	0.41	65	31	4
Dhikurpokhari	Soil sample no.- 3	5.17	6.19	0.31	15.9	129	0.29	70	26	4
Dhikurpokhari	Soil sample no.- 4	5.54	6.41	0.32	2.8	166.2	0.40	75	21	4
Dhikurpokhari	Soil sample no.- 5	4.92	5.78	0.29	30.3	62.9	0.38	70	26	4
Dhikurpokhari	Soil sample no.- 6	4.5	7.01	0.35	50.5	145.7	0.18	70	26	4
Dhikurpokhari	Soil sample no.- 7	4.79	7.41	0.36	4.85	115.5	0.11	65	31	4
Dhikurpokhari	Soil sample no.- 8	4.58	5.74	0.29	9.2	46.3	0.09	65	26	9
Dhikurpokhari	Soil sample no.- 9	5.54	7.44	0.37	45.5	342	0.45	70	27.5	2.5
Dhikurpokhari	Soil sample no.- 10	4.95	5.16	0.26	19.35	107.8	0.19	70	27.5	2.5
Dhikurpokhari	Soil sample no.- 11	4.91	4.10	0.21	69	59	0.30	70	27.5	2.5
Dhikurpokhari	Soil sample no.- 12	4.67	6.65	0.33	247.5	196.3	0.51	65	32.5	2.5
Dhikurpokhari	Soil sample no.- 13	5.15	6.35	0.31	100.5	112.1	0.40	75	22.5	2.5
Dhikurpokhari	Soil sample no.- 14	5.01	5.16	0.26	394	110.9	0.37	75	22.5	2.5
Dhikurpokhari	Soil sample no.- 15	4.85	4.99	0.25	44.5	93.5	0.14	65	32.5	2.5
Kaskikot	Soil sample no.- 16	5.86	5.99	0.30	383	128.6	0.11	65	32.5	2.5
Kaskikot	Soil sample no.- 17	5.02	6.92	0.34	447	318	0.49	52	39	9
Kaskikot	Soil sample no.- 18	8.35	3.34	0.17	158	84.4	0.60	77	19	4
Kaskikot	Soil sample no.- 19	4.91	5.41	0.27	68.5	268.8	0.08	52	39	9
Kaskikot	Soil sample no.- 20	4.86	4.15	0.21	42	90.3	0.35	62	29	9
Kaskikot	Soil sample no.- 21	5.44	6.50	0.32	87	68.3	0.40	62	34	4
Kaskikot	Soil sample no.- 22	4.44	5.49	0.27	269	230.1	0.59	62	34	4
Kaskikot	Soil sample no.- 23	7.26	3.89	0.20	5.15	40.2	0.40	62	34	4
Kaskikot	Soil sample no.- 24	5.39	6.86	0.34	290	810	0.92	67	29	4
Kaskikot	Soil sample no.- 25	4.38	5.52	0.28	162.5	160.8	0.71	67	30.5	2.5
Kaskikot	Soil sample no.- 26	5.71	5.05	0.25	250.5	31	0.49	68.5	29	2.5
Kaskikot	Soil sample no.- 27	4.84	4.03	0.21	50	261.6	0.65	68.5	29	2.5
Kaskikot	Soil sample no.- 28	4.83	5.22	0.26	10.15	164.1	0.37	63.5	29	7.5
Kaskikot	Soil sample no.- 29	4.84	4.95	0.25	89.5	171.1	0.46	68.5	29	2.5
Kaskikot	Soil sample no.- 30	4.66	7.20	0.35	24.3	109.5	0.21	58.5	39	2.5
Kaskikot	Soil sample no.- 31	5.02	6.64	0.33	22.5	88.3	0.20	48.5	44	7.5
Kaskikot	Soil sample no.- 32	7.01	5.51	0.28	51	163.8	0.21	58.5	34	7.5
Jogimara	Soil sample no.- 33	6.69	1.91	0.11	18.6	75.7	0.15	68.5	29	2.5
Jogimara	Soil sample no.- 34	5.82	2.78	0.15	90.5	170.5	0.41	73	24.5	2.5
Jogimara	Soil sample no.- 35	7.07	2.04	0.11	33.75	163.2	0.21	73	24.5	2.5
Jogimara	Soil sample no.- 36	6.32	4.12	0.21	11.35	225.5	0.25	78	19.5	2.5
Jogimara	Soil sample no.- 37	6.21	4.40	0.22	122	165.5	0.56	68	24.5	7.5
Jogimara	Soil sample no.- 38	6.26	3.06	0.16	93.5	83.5	0.22	78	19.5	2.5
Jogimara	Soil sample no.- 39	6.43	3.57	0.18	94.5	302	0.16	83	14.5	2.5
Jogimara	Soil sample no.- 40	4.46	4.23	0.22	154	179.8	0.85	58	34.5	7.5

Name of VDC	Sample details	pH (1:2.5)	%OM	% N	Available		Boron (ppm)	Soil texture		
					P mg/kg	K mg/kg		Sand %	Silt %	Clay %
Jogimara	Soil sample no.- 41	7.1	3.48	0.18	88.5	300	0.24	83	14.5	2.5
Jogimara	Soil sample no.- 42	6.5	3.15	0.17	130	162.7	0.17	73.5	22.5	4
Jogimara	Soil sample no.- 43	6.46	3.06	0.16	83.5	172.8	0.31	93.5	2.5	4
Jogimara	Soil sample no.- 44	6.58	2.37	0.13	24.25	268.9	0.19	73.5	22.5	4
Jogimara	Soil sample no.- 45	6.83	3.39	0.18	225.5	217.3	0.62	68.5	27.5	4

Annex 6 : Results of soil sample analysis in KahaKurullanpelessa, 2013

Index No:	Farmer Name	Soil character					
		pH	Electric conductivity (Desi seimans /m)	Soil texture	Available phosphorus (ppm)	Exchangeable Potassium (ppm)	Organic matter %
01	W.Leela	6.4	0.03	Sandy loam	13.2	115.86	2.9
02	J.A.Anusha	7.07	0.07	Sandy loam	40.81	171.52	2.7
03	M.D.Jayaweera	7.0	0.05	Loam	42.70	244.02	3.8
04	J. A .Sriyani Kumudu	7.11	0.04	Clay loam	25.3	172.25	2.96
05	W .D. M. Bandara	7.01	0.03	Sandy loam	16.47	275.5	2.97
06	V.P. Kusumawathie	6.54	0.04	Clay loam	23.16	177.38	2.44
07	R. P. Pushpalatha	6.7	0.04	Clay loam	19.12	249.87	2.44
08	E. K. Sriyani	7.35	0.01	Clay loam	29.08	192.03	1.87
09	A. W. Dayawathie	7.59	0.12	Clay loam	20.26	233.03	3.67
10	T. Leelawathie	6.88	0.04	Clay loam	16.858	180.31	2.90
11	D. Gaminie	6.83	0.04	Sandy Clay loam	16.60	238.89	2.25
12	G.R.Chaminda Kumara	6.78	0.04	Sandy loam	34.38	194.95	2.50
13	H.A. Somawathi	7.09	0.07	Clay loam	22.65	101.22	2.31
14	R.P.G.L.N.Rajapaksha	6.87	0.04	Clay loam	24.16	317.97	2.57
15	W.M. Menike Weerasuriya	7.14	0.05	Sandy loam	41.81	458.57	3.67

Annex-7: Crops recommended for such lands, in KahaKurullanpelessa, 2013

Index No:	Farmer Name	Recommended crops Small Millet SMAK	Recommended Fertilizers				
			Tons/ha	Basal(kg/ha)			TDM(kg/ha)
			compost	Urea	TSP	MOP	Urea
01	W.Leela	Finger millet Cowpea	4 4	20 14	20 40	20 30	30 (3-4 weeks after planting) 12(at flowering)
02	J.A.Anusha	Finger millet Cowpea Groundnut	4 4 4	20 14 14	20 40 40	20 30 30	30 (3-4 weeks after planting) 12(at flowering)
03	M.D. Jayaweera	Finger millet Cowpea	4 4	20 14	20 40	20 30	30 (3-4 weeks after planting) 12(at flowering)
04	J. A . Sriyani Kumudu	Finger millet Cowpea	4 4	20 14	20 40	20 30	30 (3-4 weeks after planting) 12(at flowering)
05	W .D. M. Bandara	Finger millet Cowpea	4 4	20 14	20 40	20 30	30 (3-4 weeks after planting) 12(at flowering)
06	V.P. Kusumawathie	Finger millet Cowpea	4 4	20 14	20 40	20 30	30 (3-4 weeks after planting) 12(at flowering)
07	R. P. Pushpalatha	Finger millet Cowpea Groundnut	4 4 4	20 14 14	20 40 40	20 30 30	30 (3-4 weeks after planting) 12(at flowering) 12(at flowering)
08	E. K. Sriyani	Finger millet Cowpea	4 4	20 14	20 40	20 30	30 (3-4 weeks after planting) 12(at flowering)
09	A. W. Dayawathie	Finger millet Cowpea Groundnut	4 4 4	20 14 14	20 40 40	20 30 30	30 (3-4 weeks after planting) 12(at flowering) 12(at flowering)
10	T. Leelawathie	Cowpea Peanut Groundnut	4 4	14 14	40 40	30 30	12(at flowering) 12(at flowering)
11	D. Gaminie	Finger millet Cowpea	4 4	20 14	20 40	20 30	30 (3-4 weeks after planting) 12(at flowering)
12	G.R.Chaminda Kumara	Finger millet Cowpea	4 4	20 14	20 40	20 30	30 (3-4 weeks after planting) 12(at flowering)
13	H.A. Somawathi	Cowpea	4	14	40	30	12(at flowering)
14	R.P.G.L.N.Rajapaksha	Cowpea/ Mung bean	4	14	40	30	12(at flowering)
15	W.M. Menike Weerasuriya	Finger millet Cowpea	4 4	20 14	20 40	20 30	30 (3-4 weeks after planting) 12(at flowering)

Annex-8: Results of soil sample analysis in Mahawewa, 2013

Index No:	Farmer Name	soil character					
		pH	Electric conductivity (Desi seimans /m)	Soil texture	Available phosphorus (ppm)	Exchangeable Potassium (ppm)	Organic matter %
01	K.A. Dayarathne	6.28	0.08	Clay loam	10.58	527.4	2.89
02	W.A.Chandrasena	6.36	0.06	Clay loam	13.2	217.65	2.96
03	M.L.A.Gunarathne	6.37	0.06	Sandy loam	9.99	331.89	2.57
04	R.P.Ariyadasa	6.49	0.05	Sandy loam	23.29	320.17	2.32
05	G.L.Ariyasena	6.46	0.05	Sandy loam	11.53	158.34	2.57
06	E.K.Sugathadasa	5.38	0.03	Loam	6.79	92.44	2.50
07	R.P.Chitra Rohini	5.56	0.05	Loam	19.49	85.11	2.57
08	W.A. Jayasena	6.02	0.06	Silt loam	12.48	265.99	4.12
09	L.A. Babanona	6.04	0.06	Loam	15.33	253.53	3.15
10	P.G . Abeypala	6.11	0.05	Sandy loam	13.91	98.30	3.22
11	L. Disanayaka	5.83	0.03	Loam	18.18	126.85	2.57
12	K.P. Nikulas Appuhamy	6.32	0.03	Clay loam	19.61	255.73	2.77
13	R.P.Karunarathne	6.02	0.04	Sandy loam	14.86	108.08	2.90

Annex-9: Crops recommended in Mahawewa, 2013

Index No:	Farmer Name	Recommended crops Small Millet SMAK	Recommended Fertilizers				
			Tons/ha	Basal(kg/ha)			TDM(kg/ha)
			Compost	Urea	TSP	MOP	Urea
01	K.A. Dayarathne	Finger millet Cowpea Maize	4 4 4	20 14 30	20 40 40	20 30 20	30 (3-4 weeks after planting) 12(at flowering) 56(3-4 weeks after planting)
02	W.A.Chandrasena	Finger millet Cowpea Groundnut	4 4 4	20 14 14	20 40 40	20 30 30	30 (3-4 weeks after planting) 12(at flowering) 12(at flowering)
03	M.L.A.Gunarathne	Finger millet Cowpea Groundnut Maize	4 4 4 4	20 14 14 30	20 40 40 40	20 30 30 20	30 (3-4 weeks after planting) 12(at flowering) 12(at flowering) 56(3-4 weeks after planting)
04	R.P.Ariyadasa	Finger millet Cowpea	4 4	20 14	20 40	20 30	30 (3-4 weeks after planting) 12(at flowering)
05	G.L.Ariyasena	Finger millet Cowpea Maize	4 4 4	20 14 30	20 40 40	20 30 20	30 (3-4 weeks after planting) 12(at flowering) 56(3-4 weeks after planting)
06	E.K.Sugathadasa	Finger millet Cowpea/mung bean Maize	4 4 4	20 14 30	20 40 40	20 30 20	30 (3-4 weeks after planting) 12(at flowering) 56(3-4 weeks after planting)
07	R.P.Chitra Rohini	Finger millet	4	20	20	20	30 (3-4 weeks after planting)
08	W.A. Jayasena	Finger millet Maize	4 4	20 30	20 40	20 20	30 (3-4 weeks after planting) 56(3-4 weeks after planting)
09	L.A. Babanona	Finger millet Cowpea Maize	4 4 4	20 14 30	20 40 40	20 30 20	30 (3-4 weeks after planting) 12(at flowering) 56(3-4 weeks after planting)
10	P.G . Abeypala	Finger millet Cowpea Groundnut	4 4 4	20 14 14	20 40 40	20 30 30	30 (3-4 weeks after planting) 12(at flowering) 12(at flowering)
11	L. Disanayaka	Finger millet Cowpea Maize	4 4 4	20 14 30	20 40 40	20 30 20	30 (3-4 weeks after planting) 12(at flowering) 56(3-4 weeks after planting)
12	K.P. Nikulas Appuhamy	Finger millet Mung bean	4 4	20 14	20 40	20 30	30 (3-4 weeks after planting) 12(at flowering)
13	R.P.Karunarathne	Finger millet Cowpea	4 4	20 14	20 40	20 30	30 (3-4 weeks after planting) 12(at flowering)

Annex-10: Results of soil sample analysis in Sooriyaara, 2013

Index No:	Farmer Name	Soil character					
		pH	Electric conductivity (Desi seimans /m)	Soil texture	Available phosphorus (ppm)	Exchangeable Potassium (ppm)	Organic matter %
01	K.A.Dayawathie	6.4	0.03	Clay loam	19.49	233.03	2.25
02	A.G.Abeywikrama	6.36	0.02	Clay loam	08.92	87.31	2.44
03	R.M. Seelawathi	6.49	0.03	Clay loam	11.96	266.71	2.77
04	S.M.A.Chandrika	6.57	0.04	Clay loam	09.40	433.67	2.64
05	W.A.Mangalika	6.42	0.02	Clay loam	10.70	123.19	1.93
06	B. Indrani Chandralatha	6.65	0.04	Sandy loam	15.93	394.13	2.89
07	K.H.A.Padma	6.38	0.03	Sandy Clay loam	10.94	223.51	3.54
08	A.G.Chandanie	6.13	0.06	Clay loam	15.93	273.31	2.70
09	M. Seelawathie	6.51	0.04	Clay loam	11.53	216.19	3.09
10	S.K.Dimuthuni	6.46	0.03	Sandy loam	13.91	194.22	2.77
11	M. Dayawathi	6.27	0.04	Clay loam	11.43	332.10	2.83
12	M. Premawathi	6.38	0.05	Sandy clay loam	7.62	214.73	2.19
13	A.Padmini	6.25	0.03	Clay loam	11.89	349.46	2.83
14	M.B.Priyanganie	6.43	0.04	Clay loam	14.38	232.3	2.44

Annex -11: Crops recommended for Sooriyaara, 2013

Index No:	Farmer Name	Recommended crops Small Millet SMAK	Recommended Fertilizers				
			Tons/ha	Basal(kg/ha)			TDM(kg/ha)
			compost	Urea	TSP	MOP	Urea
01	K.A.Dayawathie	Finger millet	4	20	20	20	30 (3-4 weeks after planting)
		Cowpea/Mung bean	4	14	40	30	12(at flowering)
		Maize	4	30	40	20	56(3-4 weeks after planting)
02	A.G.Abeywikrama	Finger millet	4	20	20	20	30 (3-4 weeks after planting)
		Cowpea	4	14	40	30	12(at flowering)
		Maize	4	30	40	20	56(3-4 weeks after planting)
03	R.M. Seelawathi	Finger millet	4	20	20	20	30 (3-4 weeks after planting)
		Cowpea	4	14	40	30	12(at flowering)
		Maize	4	30	40	20	56(3-4 weeks after planting)
04	S.M.A.Chandrika	Finger millet	4	20	20	20	30 (3-4 weeks after planting)
		Cowpea	4	14	40	30	12(at flowering)
		Groundnut	4	14	40	30	12(at flowering)
		Maize	4	30	40	20	56(3-4 weeks after planting)
05	W.A.Mangalika	Finger millet	4	20	20	20	30 (3-4 weeks after planting)
		Cowpea/Mung bean	4	14	40	30	12(at flowering)
		Maize	4	30	40	20	56(3-4 weeks after planting)
06	B. Indrani Chandralatha	Finger millet	4	20	20	20	30 (3-4 weeks after planting)
		Cowpea	4	14	40	30	12(at flowering)
		Maize	4	30	40	20	56(3-4 weeks after planting)
07	K.H.A.Padma	Finger millet	4	20	20	20	30 (3-4 weeks after planting)
		Cowpea	4	14	40	30	12(at flowering)
		Maize	4	30	40	20	56(3-4 weeks after planting)
08	A.G. Chandanie	Finger millet	4	20	20	20	30 (3-4 weeks after planting)
		Cowpea/mung bean	4	14	40	30	12(at flowering)
09	M. Seelawathie	Finger millet	4	20	20	20	30 (3-4 weeks after planting)
		Cowpea	4	14	40	30	12(at flowering)
		Maize	4	30	40	20	56(3-4 weeks after planting)
10	S.K. Dimuthuni	Finger millet	4	20	20	20	30 (3-4 weeks after planting)
		Cowpea	4	14	40	30	12(at flowering)
		Maize	4	30	40	20	56(3-4 weeks after planting)
11	M. Dayawathi	Finger millet	4	20	20	20	30 (3-4 weeks after planting)
		Maize	4	30	40	20	56(3-4 weeks after planting)
12	M. Premawathi	Finger millet	4	20	20	20	30 (3-4 weeks after planting)
		Cowpea	4	14	40	30	12(at flowering)
		Maize	4	30	40	20	56(3-4 weeks after planting)
13	A.Padmini	Finger millet	4	20	20	20	30 (3-4 weeks after planting)
		Cowpea	4	14	40	30	12(at flowering)
		Maize	4	30	40	20	56(3-4 weeks after planting)
14	M.B. Priyanganie	Finger millet	4	20	20	20	30 (3-4 weeks after planting)
		Cowpea	4	14	40	30	12(at flowering)
		Maize	4	30	40	20	56(3-4 weeks after planting)

Annex- 12: Sustainable Agriculture Kit (SAK) Survey Schedule

(Surveyor: Complete one per family)

Surveyor Name: _____ **Date:** (Day/Month/Year):_____
Hamlet/Village/Site: _____ / _____ / _____
District/State (Province)/
Country of Farmer: _____ / _____ / _____

A. **Biographical/Socio-Economic Data of Farmer Interviewed** *(Interview only one family member who plays important role in farming)*

1. Name: _____
2. Sex: ☐ Male ☐ Female
3. Age: _____ Years *(Write the completed years)*
4. Position in family: ☐ Husband ☐ Wife ☐ Son/Daughter ☐ Elderly parent
   ☐ Other specify: _____
5. Contact Info (Door No, cell phone, if available): _____
6. Language(s) spoken: 1) _____ 2) _____
7. Highest education achieved: _____
8. Writing literacy?: ☐ Yes ☐ No ☐ Moderate
   Which written language(s): 1) _____ 2) _____
9. Number of children living at home (upto age 14): # Boys: _____ # Girls _____
10. Total number of dependents (who do not contribute to family income): _____
11. Own farmland?: ☐ Yes ☐ No (Leased in) ☐ Both
12. Access to land: Give the following details as on the date of survey *[Do not leave any cell empty; use 0 where necessary]*:

1	2	3	4	5	6	7
Sl. No.	**Type of land**	**In acres or any other unit**				
		Owned	**'Leased in' in the last 365 days**	**'Leased out' in the last 365 days**	**Forest land/ others without *patta****	**Total land (=3+4+6)**
1	Land cultivated with annual rainfed crops					
2	Land cultivated with annual irrigated crops					
3	Orchards					
4	Fallow land					
5	Uncultivable land					
6	Others, specify:					
7	Total land area accessed by the family					

13. Who officially owns the land? ☐ Not applicable ☐ Husband ☐ Wife ☐ Father
    ☐ Mother ☐ Others, specify: _____

14. Livestock details**:** Do you have large animals for ploughing and/or manuring? ☐ No ☐ Yes If 'Yes' give details:

Animal	**Native cows/calves**	**Cross-bred cows/calves**	**Buffaloes**	**Goats/ Sheep**	**Ploughing animals**	**Others**
Number						

15. Who decides which crops to plant, animals to rise? _____

16. House type: ☐ Pucca ☐ Semi pucca ☐ Kutcha ☐ Other.

If 'Other', specify: _____
Roof details:_____

Wall details:_____

House type: The Government of India definition of house category is followed with slight modification to the definition of semi-pucca house.
(See website: http://www.mospi.gov.in/ecs_Ins_Manual_part_I_two.htm)
Pucca house: *A pucca house is one, which has walls and roof made of the following material.*
Wall material: Burnt bricks, stones (packed with lime or cement), cement concrete, timber, ekra, etc. Roof material: Tiles, GCI (Galvanized Corrugated Iron) sheets, asbestos cement sheet, RBC (Reinforced Brick Concrete), RCC (Reinforced Cement Concrete) and timber, etc.
Kutcha house: *The house with walls and/or roof, which are made of material other than those mentioned above, such as un-burnt bricks, bamboos, mud, grass, reeds, thatch, loosely packed stones, etc. are treated as kutcha house.*
Semi-Pucca house: *A house that has fixed walls made up of pucca material but roof is made up of the material other than those used for pucca house. If the roof is made of pucca materials and the walls are made of mud, then also that house falls in semi-pucca category.*
Others: *The houses, which are not covered by the types mentioned above, are to be treated as 'others' type.*

17. Are you native of this village? *(If the family interviewed have moved to the current village in the life time of any of the family members, then tick 'No'; otherwise tick 'Yes'.)*

☐ Yes ☐ No

If 'No', year of arrival to this village: _____ and Origin: _____

B. Farm System Overview (please note abbreviation, SMAC: Small Millet and Associated Crops)

1. Diagram of farm lay out with plot numbers, directions and landmarks like house, pump set, well, etc. *(If land is spread out in two or three parts of the village, show them separately; Layout not to scale)*

2

Answer the following questions only for the SMAC plots

3. Features of each plot of the farm: *(Different plots in the farm are to be identified by the farmer. Unit land with same topography and soil features is generally considered as a plot; follow the criteria followed by the farmer)*

Plot No.	***Slope of farm***	***Soil drainage***	***Soil colour***	***Soil texture***	***Soil problem***	***Flooding/ Waterlogging***
	Slope of farm: *Highly sloppy..... HS* *Sloppy.....SL* *Moderately flat....MF* *Very flat.....VF*	**Drainage:** *Give grade 1 to 5; 5 = good drainage, . . . , 1 = high waterlogging potential*	**Soil colour:** *Black.....BL* *Dark brown.....DB* *Moderate brown.....MB* *Light brown.....LB* *Red.....RE* *Sandy.....SA* *Other (specify).....OT*	**Soil texure:** *Loam.....LO* *Sand.....SA* *Heavy clay.....HC* *Clay mix....CM* *Rocky.....RO* *Other (specify).....OT*	**Soil problem:** *Alkalinity....AL* *Salinity.....SA* *Other (specify).....OT* *No problem.NP*	*Flooding.....FL* *Waterlogging..WL* *No problem.....NP*

4. What are the practices followed for rectifying the above mentioned soil problems?

5. a) Give details of the flooding / waterlogging problems mentioned above

(b) What solutions are you using to prevent flooding/waterlogging on SMAC fields?

(c) Are there any ancient/indigenous solutions to prevent flooding/waterlogging (for any crop), and if so, why is it not used today?

C. Water – SMAC fields only

1. Do you have irrigation facilities? ☐ No ☐ Yes If 'Yes', give the following details:

a) Source of irrigation *(Tick all that apply. Indicate based on individual or collective ownership for the first two options; if irrigation water is purchased for a fee, then indicate in 'Others')*.

☐ Open well ☐ Bore well ☐ River/stream/water bodies ☐ Others

If 'Others', give details:_____

b) Water drawing by: _____

2. If you irrigate, describe irrigation system in detail (type of irrigation, pumping method, water available months, for which crops, frequency of irrigation, etc.).
   ☐ Flow irrigation (☐Flood irrigation/ ☐Ridges and furrows), ☐Drip irrigation, ☐ Sprinkler

   _____
   _____
   _____

3. Do you harvest/trap water ☐ No ☐ Yes If 'Yes', give details:

   _____
   _____
   _____

4. Are there any ancient/indigenous solutions to harvest water? (e.g. use of porous rocks around trees, sloped hills with irrigation channels). If yes, describe; *Draw diagram if easier*

5. In the last 10 years, what has been the change in rainfall (check all that apply):
   ☐ Drier ☐ Wetter ☐ More or less same
   ☐ Less frequent ☐ More intense storms
   ☐ Other changes, Specify:_____

6. Have the cultivation period/ '*pattam*' changed? ☐ No ☐ Yes If 'Yes', give details:

   _____
   _____
   _____

7. Which crops do you plant after an extended period of several years of drought?

   _____
   _____

8. Did you change the crop / variety due to late onset of monsoon? ☐ No ☐ Yes. If yes, give details:

   _____
   _____
   _____
   _____
   _____

9. What are the other coping mechanisms you follow to managing rainfall related problems?

   _____
   _____
   _____
   _____
   _____

D. Choice of crops

1. **Cropping pattern:** *(Surveyor, please include all the cereals/root crops/ legumes/ spices/ fruits/ vegetables/ fibre/ medicinal/ tree crops grown by farmer (not only SMAC) in 2012 in the cropping pattern, even if it is cultivated in a small area. Standard way of writing cropping pattern is Main crop + inter/mixed crops/border crops- next season main crop. Begin with summer or Kharif crop(s). Sowing month has to be considered for identifying the season. Area to be mentioned like this, if there is difference in area of first crop and the second crop in the cropping pattern of first crop- 1- 0.5)*

a)

Sl. No.	Cropping Pattern in 2012	Rainfed	Irrigated	Area (in acre)	Month											
					Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
1																
2																
3																
4																
5																
6																
7																
8																
9																
10																

(b) What are the benefits of intercropping the above crops with small millets? (refer to Sl. No. of 1 (a)).

2. Crop rotation related to SMAC *(Give details of crops grown for all the plots where SMAC was grown even for any one year. If there is more than one crop in one plot, use the same plot no. in the concerned rows; if the crop rotation is the same in more than one plot, give the concerned plot numbers in one row.)*

a)

Plot No.	**2012crops**		**2011 crops**		**2010**	
	Season 1	**Season 2**	**Season 1**	**Season 2**	**Season 1**	**Season 2**

(b) Please explain the benefits of the above crop rotation system(s) involving small millets (refer to Plot No. of 2 (a)):

c) Additional Details: *(If there is any SMAC related crop rotation practices that were followed earlier but not in the last three years, mention it here. Also write any other relevant information.)*

3. More details on the Small Millet and Associated Crops (SMAC) designated as focus crops in each site grown by the respondent in 2012 *(Use separate rows for each variety).*

SMAC	**Variety, local landrace name or breeding name**	**Original Seed Source (Govt, NGO, ancient) + YEAR**	**Seed rate (Kg / acre)**	**Seed obtained through purchase/ reuse/ exchange in 2012**	**Details (Where purchased? If re-use, seed selection criteria)**	**Major Problems with the variety and practical solutions/suggestions they have (this is very important even if it seems simple)**	**Like to grow more?**	
							Yes	**No**

Which NEW/OLD crops would you like to grow that you are currently NOT growing, including ancient/old/indigenous crops *(this question is about all crops)*? NEW crops here mean crops so far not cultivated in the village.

New crop like to grow	What is preventing you from growing these crops?
Old crop like to grow	

E. Sowing and preparing land in 2012 *(Surveyor it is recommended that you take a picture of field)*

Question 1 pertains to land preparation before sowing; Question 2 pertains to soil tillage during planting (STDP) and intercultural operations. STDP refers to land preparation taken up during sowing or planting like harrowing. Intercultural operations include soil disturbing operations taken up after sowing until harvesting.

1. (a) How did/do you prepare the land? ☐ By hand ☐ Machinery ☐ With animals
   Details (How many ploughings, types of ploughing, time interval between ploughings, etc.):

_____

_____

_____

_____

_____

(b) List the tools/implements used for preparing the land. *(Surveyor, please take picture during sowing or field preparation tools if unusual)*

_____

_____

_____

_____

_____

_____

(c) Do you practice summer ploughing? ☐ No ☐ Yes If 'Yes', provide reason(s):

(d) Surveyor, document any additional unusual land preparation practices.

2. Details of soil tillage during sowing / planting (STDP) and intercultural operations of major SMAC in 2012:

Sl. No.	**Main Crop**	**Major intercrops/ mixed crops**	**STDP (Yes/ No)**	**If YES, give details (Whether ridges, tied ridges, furrows done, tillage before and/or after sowing/ planting done, equipment for each activities, etc.)**	**Details of intercultural operations done like earthing up, thinning & gap filling, leaving out weeding**
1					
2					
3					
4					
5					

3. Sowing practice of major SMAC in 2012 *(Surveyor, take pictures of any interesting implements)*:

SMAC	**Dry sowing or wet sowing***	**Seed priming (soaking)/ seed treatment?**	**Sowing method (broadcasting, row sowing or other)**	**Sowing implements (e.g. seed drill details)**

* Dry sowing is sowing without soil moisture in anticipation of rains & wet sowing is sowing after adequate rains with soil moisture.

4. Effects of early/late sowing / planting and early/late harvesting of focus SMAC:

SMAC	**How does early or late sowing / planting affect yield? Be specific (e.g. pods with no seeds) (give reasons)**	**How does early / late harvesting affect yield? (explain, e.g. too wet so grain gets fungus)**

F. Fertilization/Soil Erosion Prevention (SMAC only)

1. Do you have the practice of soil testing? ☐ No ☐Yes If 'Yes',
   a) How often you do soil testing?
   ☐ Once in a year ☐ Once in 2 years ☐ Once in 5 years ☐ No specific frequency
   b) Soil testing has been done with the advice of

☐ Government Dept. ☐ NGO ☐ Self ☐ Others (Specify) _____

c) Available NPK status (write the status as in the soil test report available with the farmer)

Date of the Report	N	P	K	Organic Carbon	Other details

2. Did you apply chemical fertilizers in 2012? ☐ No ☐ Yes If 'Yes', give details for the cultivated area: *(For area cultivated for each SMAC refer to Q C 1)*

SMAC	Area (Acre)	NPK formulation (e.g. 20-20-10) or Fertilizer NAME/Description	Application Method Details (Timing, before/after sowing? Top dressing? Broadcast/rows?)	Quantity (kg/cultivated area)	Total Fertilizer cost	Application		Total cost (Rs.)
						No. of labourers	Cost	

3. a) Did you apply any of the following items in 2012? (applicable for more than one)
☐Micro Nutrients ☐ Bio Fertilizers ☐ Plant Growth Promoters
☐ Others, specify: _____
b) If yes, give details (Which crop, Chemical Name, Company name, Quantity, Cost, time and method of application)

_____

_____

_____

4. Do you have the practice of mulching/use of green manures/ green leaf manures on SMAC fields? ☐ No ☐ Yes If 'Yes', give the following details:
(a) Use of green manures grown on SMAC fields

SMAC	Green manure	Details (include seed rate, when incorporated in terms of DAS, irrigation given, etc.)

(b) More details on green leaf manuring / mulching:

Helps which SMAC crop?	Green leaf manure/ Mulch Source	When applied? (Dry season, before planting, side dress*, etc)	Benefit (stops weeds, kills insects, adds nutrients to soil, arrest leakages of water and fertilizer through evaporation and volatilisation, moisture conservation, prevents soil erosion, etc.)

* Similar to top dressing during the crop growth period

(c) Details of indigenous practices on mulching/ green leaf manuring/ green manure that is not followed now?

_____

_____

_____

(d) What are the trees on your farm (agroforestry) and do they provide any benefits to you?

Tree	Origin		Benefit (kills insects, adds nutrients to soil, food for humans, food for animals, medicines, shade, etc.)
	Natural	Planted	

5. (a) Did you use organic manures in 2012? ☐ No ☐ Yes If 'Yes', give details

(Applicable for more than one)

Kind of organic manure	Used or not	Quantity applied					Total Cost	Timing of application(s) (Basal, Top dressing, etc.)	Want to use more? Yes or no	Barriers for using more
		Area	Unit	No. of units	Own	Purchase				
Farmyard Manure										
Neem Cake										
Vermicompost										

(b) If you use Farmyard Manure (FYM), provide **Animal Source of Manure (e.g. cow)** details:

_____

(c) Is the FYM applied to a plot every year? Describe application pattern?

_____

_____

(d) Is there a compost pit in the farm? ☐ No ☐ Yes If 'Yes', give the dimension:

Length_____m; Breadth_____m; Depth_____m; If circular, radius_____m

6. Is cattle, goat, sheep penning practiced? ☐ No ☐ Yes If 'Yes', provide details:

Animal Type(s)	Numbers of animals	Total duration of penning

Frequency of penning to a plot:

_____

7. Do you ever burn residues or forests to clear land? ☐ No ☐ Yes If 'Yes', provide details:

_____

_____

8. Is there any difference in manure application across SMAC? ☐Yes ☐ No. If 'Yes', give details.

_____

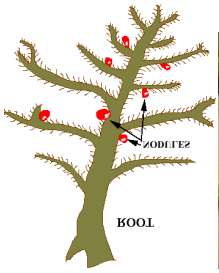
_____

9. **(OPTIONAL)** Do any of your crops have specific signs of having poor nutrition? *(Information for surveyor: Look for yellowing, pale colour, shorter plants and/or red colour and take picture.)*

List crop and symptoms

SMAC	Symptoms

10. OPTIONAL: *(Surveyor, dig 2-3 legume plants (daal, horsegram, etc) and count nodule number, and record if nodule is pink when cut open (see pictures below))*:



Legume crop	No. of leaves	Approx. nodule number	Pink colour?

11. (a) If the land is sloped, do you try to cover the ground with plants, branches, or leaves to prevent soil erosion? ☐ No ☐ Yes If 'Yes', provide type of plant(s) and details:

_____

_____

(b) If the land is sloped, do you undertake any other soil and water conservation measures?
☐ No ☐ Yes If 'Yes', what are the measures?
☐ Terracing ☐Tied ridges ☐ Contour Ridges ☐ Bunding
☐ Others, Give details: _____

(c) If you are NOT practicing any conservation solutions, explain why not or what help you need?

12. (a) Are there any ancient/indigenous soil fertility/soil nutrient/erosion strategies that were practiced that you remember that are no longer practiced today? (e.g. silting) Describe:

(b) If no longer practiced, explain why?

G. Weed control (SMAC only)

1. Which weeds are a major problem and for which crop? *(Surveyor take pictures)*

SMAC	Weeding practiced?- Yes or No	Name of the weeds *(Mention the major weeds that cause significant loss)*	Method of Weed Control	% of yield Lost due to	Weeding done for the cultivated area* in 2012			
					No.	When as DAS*	No. of male & female labourers	Cost (Rs)

* DAS- Days after sowing; ** For area cultivated under each SMAC refer to Q C 1

2. Describe tools/machinery used to remove weeds? *(Surveyor take pictures)*

3. Details of herbicides used: (if relevant)

SMAC	Chemical & Manufacturer	DAS @	Weeds	Weeding in 2012 for cultivated area**				
				Herbicide Quantity	Herbicide Cost	Application cost	Total Cost	Effectiveness 1 to 5*

@DAS- Days after sowing; * **1=poor, . . ., 5= very good ; ** ** For area cultivated under each SMAC refer to Q C 1

4. Do you minimize tilling/soil disturbances in order to prevent weeds? ☐ No ☐ Yes
If 'Yes' give details:

5. Describe any other ancient/indigenous practices to prevent weeds. If not practiced, explain why not:

H. Pests control (Insects/ Diseases/ Rodents/ Wild animals like wild boar/ others) (For SMAC only)

1. Which are the most damaging insects/pests/worms, and for which crops? *(Surveyor, take pictures)*

Affects which SMAC crop(s)?	Pest/Disease (Local name)	Affects which stage(s) ? (check all that apply)@	Plant Symptoms	% of yield lost	Prevention or

@Affects which stage(s)and which part?: SR- Seedling root; **SS**- Seedling shoot; **AR**- Adult root; **AS**- Adult shoot; **PHG-** Pre-Harvest grain, fruit or tuber; **PHS**- Post-Harvest grain, fruit or tuber (storage); **OT**- Others

Other details of pests/diseases:

_____
_____
_____
_____
_____

2. Details of any chemical fungicides/pesticides/insecticides used in 2012?

SMAC	Pests/ diseases	Chemical & Manufacturer	When DAS	Quantity	Cost	Application cost	Cost for cultivated area*	Effectiveness **

*** For area cultivated under each SMAC refer to Q C 1; ** 1=poor, . . ., 5= very good**

3. Do you have any plants that scare away insects or disease or attract pests away from crops? (e.g. Push/Pull strategies - Niger border crops for pathogen control and Refugee crops?) Give details:

4. Were there any ancient/indigenous practices to reduce pests/diseases that are no longer practiced today? Why they are not practiced?

I. Harvest (SMAC)

1. How did/do you harvest the plant?

SMAC focus crop	Method of harvest (describe tool) *Surveyor: take picture of tool if interesting*	Problems in the present method of harvesting?	Quantity of wastage of grain?	If there are some problems, how could this process or tool be improved?
	__By hand ___tool. Describe:			
	__By hand ___tool. Describe:			
	__By hand ___tool. Describe:			
	__By hand ___tool. Describe:			

2. At harvest time, describe what other treatments you do for grain/kernel separation and how you do it?

SMAC focus crop	Purpose (e.g. Separating grains from earhead/ Fingers)	How? (describe tool) *Surveyor: take picture if interesting*	How could this be improved?

J. SMAC Yield Data and Crop Failures

1. What was the yield of your SMAC focus crops?

SMAC Crop	Area cultivated (Acre)*	2012 Yield (Kg) #	Yield per acre (Kg)	Grade Productivity @	Reasons	Best yield (Kg)	Breakeven yield (Kg)

***** For area cultivated under each SMAC refer to Q C 1; **@Grade Productivity: GA-** Good and above; BE- Break even; L- Loss; TL- Total loss (75 % and above loss)

If the farmers express in the volume measure give details of conversion here:

2. (a) Describe the trend in yield and number of crop failures in last 10 years and reasons:

SMAC Crop	Trend in yield in the last 10 years	Reasons	Number of crop failures in last 10 years (defined as >75% loss)							Reason(s) for crop failures for each of the years
			0	1	2	3	4	5	>5	

@ **Trend in yield in the last 10 years when compared to the period before**: IN- Increasing; DE- Decreasing; SA- More or less the same; NA- Not applicable

(b) Are crop failures becoming more frequent in the last 10 years when compared the 10 years before, and if so, what are the reason(s)?

_____
_____
_____
_____
_____

(c) How do your family cope up with crop failure?

_____
_____
_____
_____

K. Family income -- Marketing, sales, trade, cash crops

1. Do you sell any of your SMAC crops? ☐ No ☐ Yes If 'Yes' give details:

SMAC Crop Product	Selling Quantity (kg)	Amount per unit weight (Rs)	Total amount/ yr (Rs)	Who sells? (e.g. wife)	Where/to whom do you sell? (local market, government, cooperative)	Distance to market (km)	When do you sell? (immediately after harvest?)

2. Do you wish you could sell your produce later to obtain a better price, and if so, what is preventing you from selling at a later date?

   _____

   _____

3. If you sell crops, where do you learn the price from?

   _____

   _____

4. Do you process any SMAC products before you sell them? Describe. (e.g. sell ground roasted spices, etc.).

   _____

   _____

5. Do you want to process your SMAC products? ☐ No ☐ Yes
   If yes, what kind of support you require?

   _____

   _____

   _____

6. Where is the market where you BUY goods? Location:_____
   Distance_____km

L. Cost of production in 2012 (*Surveyor, complete the following 2 tables to describe the cost of production of the top 1-2 SMAC crops; Include value of own material and labour along with actual expenses):*

(One day wages for Male labour is Rs. _____ and for Female labour is Rs._____)

1. (a) Cost of production for 1st most important SMAC crop:_____ for_____ acre

Purpose of expense	Material			Labour			Per Season Total Cost (Rs.)
	Quantity	Unit cost	Amount	Male (No.)	Femal e (No.)	Wage cost	
Seed purchase- Main crop							
Seed purchase- Mixed/ inter crop							
Preparing land and							
Soil tillage during planting							
Intercultural operations							
Sowing- Main crop							
Sowing- Inter crop							
Nursery preparation, transplanting							
Chemical fertilizers							
Manure application							
Irrigation							
Manual Weeding							
Weedicide application							
Spraying pesticide							
Harvesting, Staking, and Bundling							
Post harvest: Threshing, Winnowing, grain drying, transport to threshing yard							
Storing grain							
Transport cost							
Other costs							
Total cost							
Yield details	Quantity					Price/Kg	Total Value (Rs.)
Main crop							
Other crops							
Gross returns							

(b) Cost of production for 2nd most important SMAC crop:_____ for_____ acre

Purpose of expense	Material			Labour			Per Season Total Cost (Rs.)
	Quantity	Unit cost	Amount	Male (No.)	Femal e (No.)	Wage cost	
Seed purchase- Main crop							
Seed purchase- Mixed/ inter crop							

Preparing land and							
Soil tillage during planting							
Intercultural operations							
Sowing- Main crop							
Sowing- Inter crop							
Nursery preparation, transplanting							
Chemical fertilizers							
Manure application							
Irrigation							
Manual Weeding							
Weedicide application							
Spraying pesticide							
Harvesting, Staking, and Bundling							
Post harvest: Threshing, Winnowing, grain drying, transport to threshing yard							
Storing grain							
Transport cost							
Other costs							
Total cost							
Yield details	Quantity					Price/Kg	Total Value (Rs.)
Main crop							
Other crops							
Gross returns							

M. Allocation of labour and access to financial institutions

1. Are you part of a group/cooperative? (e.g. 10 women working together) Describe:

_____

_____

2. Are micro-finance loans available and have you used it? ☐ Yes ☐ No
3. What are the jobs done by adult men (M), adult females (F) or children (C) (indicate all that apply).

Task	M	F	C	Task	M	F	C
Selecting seeds				Staking			
Selecting varieties				Threshing			
Preparing land				Grain drying			
Manure application				Storage			
Planting seeds				Transportation and selling crops at market			
Thinning and gap filling				Collecting wild plants			
Weeding				Feeding, milking animals, collecting eggs			
Irrigation				Selling animal products			
Fertilizer application				Choosing medicinal plants			
Spraying pesticide chemicals							
Harvesting							

N. What are the recommendations/ suggestion to increase the yield/ Productivity of the SMAC in your locality?

a) General suggestions (Like NRM, soil health, etc.)

_____

_____

_____

_____

b) Crop specific suggestions:

SMAC	Suggestions

O. Cooking and cooking fuel (Surveyor: this impacts labour and crop residues to build soil)

1. What type of stove is used for cooking food?
   ☐ Earthen stove ☐ Open pit (wood/charcoal) ☐ Gas ☐ Other:
   If 'Other', give details:_____

2. (a) Are you using dung for cooking fuel? ☐ Yes ☐ No
   (b) Wood for cooking? ☐ Yes ☐ No
   If 'Yes', ☐ Collect ☐ Purchase ☐ Not applicable
   (c) Other plant/tree materials for cooking? Describe: _____
   _____

3. If you collect wood for cooking, provide details OR ☐ Not applicable:
   Location: _____ (e.g. hillsides?)
   Person who collects: _____ (e.g. daughter?)
   Distance to wood source: _____ km

4. When you cut trees, how do you cut them? (check all that apply)
   (a) ☐ Cut branches alone, so that tree survives ☐ Cut main stem/trunk (tree dies)
   (b) ☐ Cut mostly old trees ☐ Cut mostly young trees
   ☐ Both young and old

5. Describe local plants that can be used as a source of cooking fuel, for cooking oil or for night light? (including wood, other plant material for charcoal, etc.):

Plant/Tree Local Name	Source			Purpose		
	Cultivate	Purchase	Collect from Wild	Cooking fuel	Cooking oil	Night Light

6. Do you ever burn crops/ trees to making cooking charcoal? Yes ☐ No

P. External expertise

1. (a) Has a government expert (agricultural extension officer) given you advice to related to SMAC crops, and if so, when?
   ☐ Never ☐ Last 5-10 years ☐ Last <2-5 years ☐ Last 24 months
   (b) Name/organization of agricultural expert? _____
2. Which are the other organizations and individuals who have advised you related to SMAC crop production?

_____

3. (a) Describe the recommendations/advice received related to SMAC:

_____

_____

_____

_____

_____

(b) Which advice did you follow? Why?

_____

_____

_____

_____

(c) Which advice did you NOT follow? Why?

_____

_____

_____

_____

4. Do you receive help from the State? ☐ No ☐ Yes
   If 'Yes' for what? ☐ Fertilizer ☐ Pesticides ☐ Seeds
   ☐ Work equipment ☐ Other (specify) _____
5. Do you receive help from Other Organisation ? ☐ No ☐ Yes
   If 'Yes', Name of the Organisation : _____
   And for what? ☐ Fertilizer ☐ Pesticides ☐ Seeds
   ☐ Work equipment ☐ Other (specify) _____

Q. Additional Information about Indigenous Knowledge/Innovations

1. Recommendation of name & location of older farmer with good indigenous knowledge of SMAC:
   Name: _____ Contact/Location: _____

2. What was eaten in your childhood? ☐ Same ☐ Different
   If different, describe AND explain why it is no longer eaten:

_____

_____

_____

3. Do you have any farm innovations/inventions/seeds or indigenous practices that would like to share or sell with other SMAC farmers? (*Cover aspects he only can do*) Describe:

_____

_____

_____

R. Help with identifying other entrepreneurial/innovative farmers

1. Do you know of any local people studying at an agriculture university or who is an agricultural expert?
   Name: _____ Contact info: _____
   Name: _____ Contact info: _____
2. Do you know of any young entrepreneurs in your area? (good at buying/selling/business)
   Name:_____ Contact info: _____
   Name: _____ Contact info: _____
3. Who are the influential or very good farmers?
   Name:_____ Contact info: _____
   Name: _____ Contact info: _____

S. Does participant agree to allow this data to be published? ☐ Yes ☐ No
(Provide thumbprint or initial of farmer here if "yes"):

T. Additional observations by surveyor (problems/solutions, etc.) (USE BELOW OR REVERSE)

_____

_____

_____

_____

Annex-12: Agronomic practices documented in Nepal site

In 2011, LI-BIRD conducted two focus group discussions in Dhikur Pokhari and Jogimara to document the agronomic practices of finger millet. It was observed that farmers in both the project sites adopt common agronomic practices are given below.

Result of the FGD conducted to document agronomic practices of finger millet

Check list	Agronomic practices in Dhikurpokhari	Agronomic practices in Jogimara
Area under cultivation	Finger millets are grown in sloppy and marginal land. The area under finger millet has reduced considerably during the recent years. Instead farmers have started growing some rice varieties requiring less water in *bari* land itself.	Finger millets are grown on sloppy land without any irrigation facilities. In general half of the farmers land is under finger millet while the rest is under vegetables.
When is the nursery raised? When are the seedlings transplanted When is the crop harvested? Is there any change in cropping season in past few years?	For early crop nursery is raised during April/May and seedlings are transplanted in June. The crop is ready for harvest during October. For late planting nursery bed is raised during June and seedlings are transplanted in mid July to 1st week of August. The crop is ready for harvest in November. In low lying irrigated land, some farmers grow Asare cultivar of finger millet. They broadcast the seed in March/April and crop is ready for harvest during late June to early July. No change in the cropping season but timing may fluctuate based on rainfall.	Generally, nursery is raised in June and seedlings are transplanted in mid July to August. Crop is ready for harvest during Mid October to November. No change in the cropping season but timing may fluctuate based on rainfall.
What is the method of nursery bed preparation? What is the Seed Rate? Do you practice seed priming,	Soil is made loose, friable and free from weeds and the beds are raised for nursery raising. They apply around 250 Kg of FYM and 30 Kg of Goat pellets for raising 150 m2 NB. About 800 gm of finger millet seed is raised in 150 m2 nursery bed which is sufficient for	Soil is made loose, friable and free of weeds. About 120 Kg FYM and 1.5 Kg Mustard oil cake is used in nursery bed. Beds are not raised. Seeds are broadcasted and mixed in soil with the help of twigs. About 800 gm of finger millet seed

Check list	Agronomic practices in Dhikurpokhari	Agronomic practices in Jogimara
seed treatment, and raised bed? What farmers feel about labor requirement?	transplanting 1 ropani of land. Raised beds, seed priming and seed treatments are not practiced. Normally, it requires labour cost around NRs. 1500 for raising nursery bed.	is raised in 150 m2 nursery bed which is sufficient for transplanting of seedling in 1 ropani of land. Raised beds are not practiced. There is no practice of seed priming and seed treatment against seed borne disease. Normally, it costs around NRs. 400 for raising nursery for 1 ropani of land.
Transplanting and labor requirement.	30 to 45 days old seedlings are transplanted. In June planting, millets are relayed with maize. It costs around NRs. 2000 per ropani for transplanting millets. In July planting, millets are transplanted after maize harvest. The field is ploughed, weeds removed, leveled and seedlings are transplanted. It costs around NRs.2000 per ropani for transplanting operation.	Finger millet seedlings are transplanted in the month of July/ August. 30 to 45 days old seedlings are transplanted. Millets are relayed with maize by majority farmers and in few low lying areas they are transplanted after maize harvest. It takes around NRs. 1000 for transplanting finger millet in 1 ropani of land. In relay condition land are tilled using spades and in sole cropping tilling is done using oxen plough.
Do farmers practice inter-culture operations? What are common weeds? What are the common methods of weed control? What farmers say about requirement for weeding?	The most prevalent weeds are Gandhe(Ageratum sps.) , Banso, Ratnaulo, Avijalo and Dubo (Cynodon dactylon). Only single weeding is done in both nursery and crop field. Hand weeding is done both in nursery bed and crop field. It costs around NRs. 500 for weeding nursery bed (150 m2) prepared for 1 ropani of land while it costs around NRs. 1000 per ropani for weeding 1 ropani of crop field. No irrigation and mulching is practiced.	The most prevalent weeds in millet field are Gandhe (Ageratum sps.), Avijalo, Chitlange and Mothe. Single weeding is done 45 days after transplanting. About NRs. 500 is needed for weeding 1 ropani of land.
Do farmers apply FYM, Chemical fertilizers?	Farmers apply FYM in their field while chemical fertilizer is not common. Manure is usually applied only once in a year. Very few farmers apply manure in their field two	There is no practice of applying manure in finger millet. Generally, 600 to 800 Kg of FYM per ropani is used before maize planting. Some

Check list	Agronomic practices in Dhikurpokhari	Agronomic practices in Jogimara
What is the rate and timing of application?	times in a year. There is no practice of applying chemical fertilizers in bari land. Generally, they apply 5000 Kg FYM per ropani of land before planting maize during March. It requires about NRs. 4000 to apply manures in field	farmers use Mustard oil cake @ 25 Kg per Ropani.
Do farmers adopt intercropping, relay cropping and mixed cropping? Are farmers aware of benefits of these practices?	Cowpea, bush-typed beans, horse-gram and soybean are mixed cropped with millet field. Planting pigeon pea in the margins, fodder grass, sorghum, colocasia and pumpkin on the margins of land is practiced. Farmers aware that intercrop is beneficial in terms of income generation and family nutrition. Farmers also believe that shading effect is seen among some of the inter/mixed crops.	There is no practice of intercropping in millet. There is practice of planting Ricebean in the margins of field plots not in the main field with finger millet.
What are the methods of harvesting? How much farmers need to invest in harvesting the crop?	Fingers are picked first and then straw are cut at its base. Farmers use sickle for harvesting of finger millet. About NRs 1000 per ropani is required for harvesting.	Fingers are picked with the help of sickles and the plants are cut thereafter. It requires about NRs. 500 for harvesting crop from one ropani of land.
What are the common cultivars?	Kalo Dalle, Seto Dalle, Bhachuwa, Jhyape, Pumdeli, Okhle are the common cultivars.	Kartike and Mangsire are common cultivars. Kartike has high productivity with open head and large grain size. Mangsire has close head and small sized seeds.
What are the major disease and pests?	The major insects are white grub and stem feeding caterpillars while blast is the major disease.	The major insects are white grub and stem feeding caterpillars while blast is the major disease.
What is the most tedious part among the different agronomic practices?	Weeding and threshing are the most tedious operations in millet farming.	Weeding and threshing are the most tedious operations in millet farming.
What are the areas you feel	The areas for improvement as indicated by the farmers are as:	The areas for improvement as indicated by the farmers are as:

Check list	Agronomic practices in Dhikurpokhari	Agronomic practices in Jogimara
that need to be improved for sustainable finger millet farming?	• Improved variety • Threshing and harvesting machines • Weeding facilities • Value addition and marketing	• Improved varieties • Mechanization in farming
What is the productivity of finger millet?	Farmers indicated that on an average productivity is about 125 Kg/ropani. They shared that price of finger millet increased this year from NRs. 30 to NRs. 38 per Kg.	The yield of crop is about 125 Kg/ropani on an average in Dhading. The price of finger millet is NRs. 32 per Kg.

Annex-13: Effect of line sowing method on growth and yield of little millet crop, (J. Hills, 2013)

Method	PP/sq.m	Weeds at 30 DAS		PL HT (cm)	TILL / Pl	Pro TILL/ Pl	Weeds at Fl stage		PL (cm)	Grain yield (Kg/ac)	Straw yield (Kg/ac)
		PP /m^2	BM (Kg)				PP /m^2	BM (Kg)			
Anchetty	933	146	1.17	92.4	3.1	2.8	69	0.24	38.0	427.3	2339
Kayatharu	756	210	1.52	94.8	4.0	3.1	72	0.30	41.7	443.1	2297
Control	1800	84	0.52	87.3	2.2	2.1	33	0.23	38.6	503.6	2568
MEAN	**1159**	**147**	**1.07**	**91.5**	**3.1**	**2.7**	**58**	**0.26**	**39.4**	**458.0**	**2401**
Sem	4.69	23.49	0.18	3.51	0.35	0.13	6.66	0.06	0.91	30.62	150.78
CD at 5%	156.3	70.43	0.55	NS	1.03	0.40	19.96	NS	2.74	NS	NS
CV%	13.49	48.07	51.40	11.52	33.45	14.91	34.41	73.26	6.96	20.06	18.84

PP- Plant population; BM- Body mass; PL HT- Plant height; ***TILL / Pl****- Tillers per plant;* ***Pro TILL/ Pl-*** *Productive tillers per plant;* ***PL-*** *Panicle length*

Annex-14: Effect of seed rate on growth and yield in little millet (Jawadhu Hills, 2013)

Treatments (seed rate Kg/ac)	Plant populn. /sq.m	Weeds at 30 days after sow		Plant height (cm)	Pro Till/ Plant	Weeds at flo-wering stage		Panicle Length (cm)	Grain yield (Kg/ac)	Straw yield (Kg/ac)
		Popn /m^2	Bmas (Kg)			Popn /m^2	Bmas (Kg)			
Control - (34.6)	1663	41.2	0.41	80.1	1.95	23.2	0.08	36.9	520.5	2692.9
75% - (24.7)	1118	59.7	0.42	90.3	2.62	24.8	0.14	38.4	560.9	2754.2
50% - (17.5)	711	83.8	0.45	92.9	3.91	32.3	0.10	38.8	585.5	2529.6
25% - (8.0)	276	99.3	0.83	93.7	5.98	34.6	0.12	38.4	612.8	3367.2
Mean	**942**	**71.0**	**0.52**	**89.2**	**3.62**	**28.7**	**0.11**	**38.1**	**569.9**	**2836.0**
SEm±	4.05	7.22	0.07	2.6	0.36	2.09	0.02	0.73	17.8	110.3
CD(0.05P)	129	20.7	0.19	7.4	1.04	6.0	NS	NS	51.0	424.3
CV (%)	17.2	36.7	44.3	10.5	36.3	26.2	69.1	6.9	11.3	14.0

Annex-15: Effect of thinning on growth and yield in little millet (J. Hills, 2013)

Treatment	Plant population Per sq.m	Weed population per sq.m	Plant height (cm)	Tillers /plant	Prod Tillers	Panicle length	Grain yield (Kg/ac)	Straw yield (Kg/ac)
Thinning	411	27	88.7	2.6	2.7	39.0	575.4	2637
Control	478	45	86.3	2.2	2.3	38.1	528.4	2801

Annex-16: Effect of topdressing on growth and yield parameters in little millet (J. Hills, 2013)

Treatments	Days to 50% flowering	Plant population /sq.m	Plant height (cm)	Total tillers/plant	Prod tiller	Panicle length (cm)	Grain yield (kg/ac)	Straw yield (kg/ac)
Jeevamrutham	54	311	89.5	3.37	3.16	38.9	581.0	2889
Urea	54	306	86.6	2.85	2.76	38.5	553.3	2597
Control	60	342	82.2	2.37	2.35	37.7	531.6	2498
Mean	**56.2**	**320**	**86.1**	**2.76**	**2.86**	**38.35**	**555.28**	**2661.3**
SEm±	0.37	1.35	1.40	0.12	0.16	0.58	19.55	88.39
CD(0.05P)	1.06	NS	4.00	0.35	0.45	NS	NS	253.02
CV%	2.94	20.97	7.25	19.65	24.35	6.74	15.75	14.85

Annex-17: Effect of seed rate on growth and yield of little millet (Semiliguda 2013)

Treatments	Plant population /sq.m	Weed population per sq.m		Plant height (cm)	Tillers/plant	Panicle length (cm)	Grain yield (Kg/ac)	Straw yield* (Kg/ac)
		30 DAS	FL stage					
Line sowing	868	369.6	160.4	85.2	2.11	29.6	486.4	2484
50% of normal	739	276.3	125.5	83.6	1.60	29.3	361.9	2660
75% of normal	912	233.2	105.4	86.1	1.65	30.2	388.8	2661
Normal	1,137	183.3	99.5	87.4	1.61	29.3	478.6	3368

**Straw yield data collected only from 8 trials out of 14 trial*

Annex-18 : Effect of seed rate on growth and yield of finger millet (Semiliguda 2013)

Treatments	Plant population /sq.m	Weed population per sq.m		Plant height (cm)	Tillers/ plant	Fingers/ panicle	Finger length (cm)	Grain yield (Kg/ac)	Straw yield (Kg/ac)
		30 DAS	FL stage						
Line sowing	123.2	508.2	186.1	74.0	1.39	4.96	5.72	692.8	3253.3
50% of normal	137.3	309.8	174.4	75.7	1.36	4.92	5.61	618.9	3162.7
75% of normal	153.4	254.6	131.4	74.9	1.44	5.10	5.57	786.8	3649.0
Normal	164.2	141.5	81.7	74.9	1.39	5.09	5.54	924.3	3859.5

Annex-19:Effect of *Guli* method of planting in finger millet (Semiliguda, 2013)

Methods	Plant population /sq.m	Weed population per sq.m		Plant height (cm)	Tillers/plant	Fingers/ panicle	Finger length (cm)	Grain yield (Kg/ac)	Straw yield (Kg/ac)
		30 DAS	FL stage						
Guli method	15.6	711.3	194.5	58.9	9.3	4.9	5.3	619.3	3787
Farmers' practice	38.4	274.5	121.8	54.7	1.7	3.9	4.8	629.8	3463

Annex-20: Effect of *Guli* method of planting in finger millet (Bero, 2013)

Methods	Plant population Per sq.m	Weed population per sq.m	Plant height (cm)	Tillers /plant	Fingers/ Panicle	Finger length (cm)	Grain yield (Kg/ac)	Straw yield (Kg/ac)
Guli method	14.13 (7- 20)	83.4 (15-360)	104.3 (33-131)	7.37 (2-25)	7.28 (4-11)	7.85 (5-14)	810.7 (400-1720)	2037.3 (680-3840)
Farmers' practice	27.22 (16-44)	72.5 (12-256)	102.9 (73-138)	3.04 (1-9)	6.57 (2-10)	7.51 (4-14)	629.3 (320-1080)	1869.3 (720-3360)
Increase in yield (%)							28.81	8.98

Note – Figures in parentheses are range of values

Annex-21: Yield performance of finger millet in upland paddy fields(Bero, 2013)

	Paddy in Upland	Finger Millet in Upland
Grain yield (Kg/ac)	931.43 (240-1720)	620 (240-1280)
Straw weight (Kg/ac)	1648.57 (720-3200)	1482.86 (360-3320)

Note - Figures in parentheses are range of mean values

Annex-22: Effect of topdressing on growth and yield parameters in finger millet (Anchetty, 2013)

Treatments	Plant population /sq.m	Plant height (cm)	Total tillers/plant	Prod tillers	Fingers/ panicle	Finger length (cm)	Grain yield (Kg/ac)	Increase in yield (%)
Jeevamrutham	62.3	83.3	2.25	1.91	6.0	6.8	1008	27.3
Urea	61.1	87.4	2.21	1.83	6.1	6.9	950	19.9
Control	57.0	79.5	1.76	1.60	5.6	6.1	792	--
Over all mean	**60.1**	**83.4**	**2.07**	**1.78**	**5.9**	**6.6**	**916.7**	**--**

Annex-23: Effect of micronutrient application on growth and yield of finger millet (Anchetty, 2013)

Treatments	Days to 50% flowering	Plant height (cm)	Total tillers/plant	Prod tillers	Fingers/ panicle	Finger length (cm)	Grain yield (Kg/ac)
MN application	70.6	87.5	2.19	2.10	6.67	7.97	883.3
Control	70.5	85.9	2.14	2.14	6.76	7.85	876.7
Over all mean	**70.6**	**86.7**	**2.17**	**2.12**	**6.72**	**7.91**	**880.0**

Annex-24: Efficacy of bio-pesticides and insecticides in pod borer control (Anchetty, 2013)

Treatments	Number of larva/5m crop row		Reduction in larval population (%)	Extent of damaged pods (%)	Grain yield/ 100 pods (g)	Increase in yield over control (%)
	After 1st spray	After 2nd spray				
FIELD BEAN (Data from 9 trials)						
Chemical	5.25	2.93	64.5	17.58	413.36	19.29
Bio-pesticide	6.18	3.43	58.4	23.41	393.17	13.46
Control	9.08	8.25	--	27.23	346.51	--
REDGRAM (Data from 16 trials)						
Chemical	3.23	1.34	78.1	26.93	173.14	3.34
Bio-pesticide	5.00	1.45	76.3	29.53	184.55	10.15
Control	7.23	6.12	--	32.82	167.54	--

Annex-25: Effect of micronutrient application on barnyard millet (Peraiyur, 2013)

Treatments	Plant population /sq.m	Plant height (cm)	Total tillers/plant	Prod tillers	Panicle length (cm)	Grain yield (Kg/ac)	Increase in yield (%)
MN application	5.13	114	10.87	7.66	15.53	423.1	6.15
Control	4.46	111	10.86	7.20	14.06	398.6	--
Over all mean	**4.80**	**113**	**10.87**	**7.43**	**14.80**	**410.9**	

Annex-26: Effect of date of sowing on finger millet yield (Dumriguda, 2013)

Name of the variety	No. of farmers	Category	Nursery started	Transplanted	Average yield (g/3 sq.m)
Srichaitanya - 847	7	Early sown farmers	23rd to 27th May	4th June to 10th June	977
VR 900		Early sown farmers	23rd to 27th May	4th June to 10th June	810
Srichaitanya -847	7	On time	5th to 10th June	25th to 27th July	1000
VR 900		-do-	-do-	-do-	900
Pedda chodi		-do-	-do-	-do-	928

Annex-27: Effect of SCI method on growth and yield in three small millet crops (Dumriguda, 2013)

S.No.	Crop Name	Date of Nursery	Date of transplanting	Plant height cm	No. of productive tillers	Date of harvesting	Grain yield (kg/40 sq.m)
1	Pedda Sama	22/6/13	8/7/13 (17 days)	111	8-10	1/10/13 (90 days)	6
2	Chodi (Bharati)	29/6/13	15/7/13 (17 days)	63	4-5	31/10/13 (115 days)	12
3	Korra (ISE 1575)	22/6/13	8/7/13 (17 days)	73	5-6	05/08/13 (44 days)	1

Annex-28: Yield of maize and finger millet in direct seeded finger millet trials, 2013

S.No.	Research site	Maize yield test plot (kg/ha)	Maize yield control plot (kg/ha)	Finger millet yield test plot (kg/ha)	Finger millet yield control plot (kg/ha)
1	Kaskikot	3074.5	3294.1	0.0	1778.8
2	Kaskikot	5600.0	4941.2	0.0	2058.8
3	Kaskikot	5380.4	3952.9	0.0	1910.6
4	Kaskikot	4831.4	3952.9	0.0	1844.7
5	Kaskikot	3074.5	3294.1	219.6	1976.5
	Mean	**4392.2**	**3887.1**	**43.9**	**1913.9**
6	Dhikurpokhari	5622.0	5270.6	0.0	1910.6
7	Dhikurpokhari	4611.8	5600.0	65.9	1976.5
8	Dhikurpokhari	5600.0	4941.2	0.0	2042.4
9	Dhikurpokhari	3294.1	4611.8	43.9	1844.7
10	Dhikurpokhari	1537.3	4941.2	1098.0	2058.8
	Mean	**4133.0**	**5072.9**	**241.6**	**1966.6**
11	Jogimara	2735.2	3805.8	1599.8	2218.0
12	Jogimara	5780.1	2846.1	1866.7	2679.2
13	Jogimara	2686.0	3513.7	1317.6	2745.1
14	Jogimara	3424.1	2905.4	1581.2	2020.4
15	Jogimara	2686.0	2813.2	1317.6	2305.9
	Mean	**3462.3**	**3176.8**	**1536.6**	**2393.7**

Annex-29: Yield of maize and finger millet in line sown maize and finger millet, 2013

S.No.	Research site	Maize yield test plot (kg/ha)	Maize yield control plot (kg/ha)	Finger millet yield test plot (kg/ha)	Finger millet yield control plot (kg/ha)
1	Kaskikot	3952.9	3294.1	834.5	1976.5
2	Kaskikot	4172.5	3952.9	1273.7	1778.8
3	Kaskikot	5270.6	5270.6	2305.9	2058.8
4	Kaskikot	3074.5	3952.9	1317.6	1910.6
5	Kaskikot	4392.2	3952.9	988.2	1844.7
	Mean	**4172.5**	**4084.7**	**1344.0**	**1913.9**
6	Dhikurpokhari	5709.8	4941.2	741.2	1910.6
7	Dhikurpokhari	5380.4	5600.0	823.5	1976.5
8	Dhikurpokhari	5380.4	4611.8	829.0	2042.4
9	Dhikurpokhari	2196.1	4282.4	768.6	1844.7
10	Dhikurpokhari	4502.0	4282.4	658.8	2058.8
	Mean	**4633.7**	**4743.5**	**764.2**	**1966.6**
11	Jogimara	3117.6	2846.1	1976.5	2196.1
12	Jogimara	4928.0	3074.5	2218.0	1866.7
13	Jogimara	1716.7	3428.7	988.2	1581.2
14	Jogimara	2330.0	2822.0	966.3	2218.0
15	Jogimara	3782.7	3033.2	922.4	1976.5
	Mean	**3175.0**	**3040.9**	**1414.3**	**1967.7**

Annex-30: Yield of maize and finger millet in intercropped legume crop, 2013

S.No.	Research site	Maize yield test plot (kg/ha)	Maize yield control plot (kg/ha)	Finger millet yield test plot (kg/ha)	Finger millet yield control plot (kg/ha)	Legume yield (kg/ha)
1	Kaskikot	1756.9	3952.9	461.2	1778.8	1372.5
2	Kaskikot	4172.5	3294.1	988.2	1976.5	549.0
3	Kaskikot	5709.8	3952.9	713.7	1844.7	576.5
4	Kaskikot	5051.0	4875.3	1647.1	2058.8	274.5
5	Kaskikot	5380.4	3952.9	1564.7	1910.6	960.8
	Mean	**4414.1**	**4005.6**	**1075.0**	**1913.9**	**746.7**
6	Dhikurpokhari	6039.2	3623.5	658.8	1910.6	137.3
7	Dhikurpokhari	5051.0	4480.0	713.7	1976.5	549.0
8	Dhikurpokhari	4721.6	4611.8	719.2	2042.4	549.0
9	Dhikurpokhari	3733.3	4941.2	658.8	1844.7	411.8
10	Dhikurpokhari	4523.9	3821.2	549.0	2058.8	274.5
	Mean	**4813.8**	**4295.5**	**659.9**	**1966.6**	**384.3**
11	Jogimara	2013.6	2622.8	768.6	1976.5	411.8
12	Jogimara	2805.3	2913.8	658.8	2196.1	631.4
13	Jogimara	3199.7	2320.6	1559.2	2437.6	1372.5
14	Jogimara	2735.2	3012.4	1778.8	2305.9	411.8
15	Jogimara	4113.7	2806.6	922.4	2283.9	343.1
	Mean	**2973.5**	**2735.2**	**1137.6**	**2240.0**	**634.1**

Annex: SAP picture book

Annex: SAP Manual