Integrating Conservation, Varietal Improvement and Seed Systems in Small Millets

An experience of enhancing resilience of farmers in India

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DHAN Foundation, India

As 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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Preface and Acknowledgements

DHAN Foundation started its learning journey on small millets and community biodiversity management with the inception of Revalorising Small Millets in Rainfed Regions of South Asia (RESMISA) project in three countries across South Asia in 2011. This book reflects the learning process of the team of researchers and development professionals who have went through this journey in the four years period of the project dealing, among other aspects, with on-farm conservation, varietal improvement and local seed production. What started as the application of general understanding of these aspects to small millets was enriched by contextualizing them to vastly different socio economic and agro-ecological systems in place in various sites. The team gained a lot from the intrinsic understanding of the farmers in the project sites on the agro-ecology of their area and from their niche experiential knowledge on cultivation and use of focus small millet crops. Similarly the team learnt a good deal from veteran small millet scientist and plant breeder Dr. A. Seetharam, who with his vast experience was able to offer a unifying perspective and necessary guidance throughout the project. He facilitated collaboration of All India Coordinated Small Millets Improvement Project, a unit of Indian Council of Agricultural Research, as a partner in the project. The virtuous cycle of learning from doing was followed where in by the end of each year the learning from practice was synthesized and used as the base for design of experiments and activities in the next year. This book reflects this interactive and progressive experiential learning gained by the team members.

This book shares the unique experience of the RESMISA project where in '*in situ* conservation on-farm', 'varietal improvement' and 'local seed production' were taken up in an integrated way, through the results of large number of trials carried out in the farms of the large number of participating farmers. The project experience made the team members realise that *in situ* conservation on-farm, participatory varietal improvement and local seed production in a decentralized manner with the direct involvement of local community is a necessity and not an option, given the drastic erosion of varietal diversity, inadequate options for suitable varieties and lack of access to quality seeds faced by the farmers and organic links of these activities to local food systems, food sovereignty and climate change adaptation. This is more so in the case of poorly researched and invested marginalized crops grown mostly in remote areas like small millets. But the current reality is that almost no effort is taken on these aspects at the decentralized level, though the know-how has been established by many agencies many years ago. These interventions have lost their sheen and attraction among the development and scientific circles even before they were institutionalized. It is time that large scale efforts are taken for bringing back on-farm conservation, varietal improvement and local seed system to the domain of local community by large number of enlightened actors with the necessary support structures. We feel sharing of our limited experience will help the interested actors to navigate their path in this crucial effort. We believe the integrated perspective adopted by the project and the specific methods and tools involved will be of use to them.

This book is a result of collective efforts by large number of men and women farmers, field workers, scientists, development professionals and many others. It is through their dedicated involvement and contribution for on-farm experiments and through their willingness to share their insights and experience to all the fellow people that we have been able to complete this book. It is a privilege to work with them and facilitate the collective learning process and also to share the learning so gained

with a large number of practitioners and other interested and concerned people. We appreciate and recognize their vital contribution to this book.

I thank LI-BIRD, a pioneer in Community Biodiversity Management and a partner in the RESMISA project, to share their practitioner knowledge with us in the beginning of the project, which helped as a reference framework for our iterative learning efforts during the project period. I also thank All India Coordinated Small Millets Improvement Project and Tamil Nadu Agricultural University, Indian partners in RESMISA project, for their valuable contributions to the various research activities shared in the book. We profusely thank DFATD and IDRC for their generous financial support for the RESMISA project, which resulted in this book.

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9th June, 2015
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1. Introduction

Food and nutritional insecurity remains a significant challenge in many regions of the World. The need to improve food security is particularly urgent in Sub-Saharan Africa and Asia, as well as in some countries in Latin America and the Caribbean, which account for almost 90% of the undernourished people in the world, most of them in rural settings. International Development Research Centre, Canada, an organisation promoting and supporting research on food and nutrition security, stated that while access to food is increasing for a large number of people around the world, new challenges are emerging. One is the overlap in different forms of malnutrition now common in most countries (including under-nutrition, micronutrient deficiencies, and obesity). This is being accompanied by a sharp rise in non-communicable disease burdens (e.g. diabetes, hypertension and heart disease), imposing high human, social, and economic costs at all income levels. Low- and middle-income countries are disproportionally affected with more rapidly rising rates of non-communicable diseases in younger populations that further deteriorate health and strain economic resources for all. This pattern of development issues is very much visible in India. Among the children under the age of five years, 38.8% have stunted growth and 15% are wasted (IFPRI 2014). The prevalence of Type-II diabetes mellitus and impaired glucose tolerance were affecting, at an alarming rate, both rural (2.4%) and urban (11.6%) populations of India (Mohan et al. 2009). Obesity is on the rise in various sections of the Indian society (Kalra and Unnikrishnan 2012). A common element in these problems is an unhealthy diet, defined by the quantity, quality, and diversity of foods consumed (Khoury et al. 2014). Diets based on a diversity of fresh and minimally processed foods have numerous health benefits to individuals, communities, and countries, including disease prevention, lower health care costs, and more productive societies. Fresh thinking is needed to promote public and private efforts for tackling malnutrition in all its forms and reduce the economic and disease burdens that it brings. This will need practical solutions that take into account the policy, social, cultural, and economic environments that shape food systems and affect both the quality of food supplies and demand for healthy foods. Small millets are one of the important traditional food groups that have been moved out of the food basket in recent time (Ramachandran 2007). They can contribute to an answer.

Small millets and their importance

A group of coarse-grained cereal grasses are collectively described as 'Millets'. Millets are one of the oldest cultivated foods known to humans. Based on grain size the group is characterized as major and minor or small millets. Both major and small millets have traditionally been the main components of the food basket of the poor people in India. The group of small millets is represented by six species, namely finger millet (*Eleusine coracana* (L.)), little millet (*Panicum sumatrance*), kodo millet (*Paspalum scrobiculatum* (L.)), foxtail millet (*Setaria italica* (L.)), barnyard millet (*Echinochloa frumentacea* (L.)) and proso millet (*Panicum miliaceum* (L.)).1 These crops have traditionally been the indispensable component of dry farming system in India and in various other South Asian and African countries. In India, among small millets, finger millet is the most important crop grown in many states of Southern,

[1] In some literature finger millet is put under major millets.

Central, Eastern, Western and Northern regions, from sea level in coastal Andhra Pradesh to 8000 feet altitude in Himalayas. About 60% of the area under small millets is occupied by finger millet, with the rest of the area (40 %) occupied by other five small millets. Though small millets are grown in almost every region, the distribution of individual millet is not uniform among the growing areas (Hariprasanna).

Nutritional profile

Small millets are known for their nutritive value and are found more nutritious compared to fine cereals like rice and wheat. Finger millet is the richest source of calcium (300-350 mg/100 g) and other small millets are good source of phosphorous and iron. The protein content ranges from 7 to 12% and fat content from 1 to 5.0% (Table 1). The millet protein has well balanced amino acid profile and good source of methionine, cystine and lycine. These essential amino acids are of special benefit to those who depend on plant food for their protein nourishment. The millet grain contains about 65% carbohydrate, a high proportion of which is in the form of non-starchy polysaccharides and dietary fibre, which help in prevention of constipation, lowering of blood cholesterol and slow release of glucose to the blood stream during digestion. Lower incidence of cardiovascular diseases, duodenal ulcer and hyperglycemia (diabetes) are reported among regular millet consumers. Millet grains vary largely in composition of carbohydrates as proportion of amylose and amylopectin content vary from 16-28% and 72-84%, respectively. Millet grains are also rich in important vitamins *viz.*, thiamine, riboflavin, folic acid and niacin.

Table 1.1: Nutrient composition of millets compared to fine cereals (per 100 g)

Food gain	Carbo-hydrates (g)	Protein (g)	Fat (g)	Energy (KCal)	Crude fibre (g)	Mineral matter (g)	Ca (mg)	P (mg)	Fe (mg)
Finger millet	72.0	7.3	1.3	328	3.6	2.7	344	283	3.9
Kodo millet	65.9	8.3	1.4	309	9.0	2.6	27	188	0.5
Proso millet	70.4	12.5	1.1	341	2.2	1.9	14	206	0.8
Foxtail millet	60.9	12.3	4.3	331	8.0	3.3	31	290	2.8
Little millet	67.0	7.7	4.7	341	7.6	1.5	17	220	9.3
Barnyard millet	65.5	6.2	2.2	307	9.8	4.4	20	280	5.0
Sorghum	72.6	10.4	1.9	349	1.6	1.6	25	222	4.1
Pearl millet	67.5	11.6	5.0	361	1.2	2.3	42	296	8.0
Wheat (whole)	71.2	11.8	1.5	346	1.2	1.5	41	306	5.3
Rice (raw, milled)	78.2	6.8	0.5	345	0.2	0.6	10	160	0.7

Source: Nutritive value of Indian foods, NIN, 2007

Other important benefits of small millets

Small millets share certain common characteristics which make them socially important crops (DHAN Foundation and WASSAN 2012):

- Small millets are **drought resistant** and require **few external inputs**. They can be grown under harsh circumstances in arid and semi-arid environments requiring less water than many

other cereals and are often able to cope with poor soils. For this they are sometimes called 'miracle grains', 'climate smart crops' or 'crops of the future'.

- Small millets provide **food and livelihood security** to millions of households, in particular, to small and marginal farmers and inhabitants of rainfed areas, especially in remote tribal areas. Millets are usually cultivated as **dual-purpose crops** providing both food grain for human consumption and straw for animals, contributing to economic efficiency in mixed farming systems. Small millets are the staple crops in some rainfed regions.
- Numerous varieties of small millets exist with differentiated cultivation and taste characteristics, including released varieties, and local ones. This especially applies to local varieties, which are predominantly conserved on-farm. Small millets are frequently cultivated with pulses, beans, oilseeds, etc. as part of the mixed farming system. The rich crop and varietal diversity of small millet based cropping systems foster and enrich **agro-biodiversity** of their ecosystems.
- Some of the small millets (foxtail and finger millets) are C4 carbon sequestrating crops contributing to the reduction of CO2 in the atmosphere, besides being water efficient (Osborne & Beerling 2006). For this they deserve to be cherished. They may also become entitled for benefits under (international) climate change mitigation mechanisms like Payment for Environmental Services (PES) schemes. Rice, on the contrary, is one of the major contributors to climate change through methane emissions and wheat, a thermally sensitive crop, is vulnerable for reduction in its cultivation range if average temperatures increase as part of climate change (IPCC).
- Small millets have been cultivated for around 3,000 years making them an integral part of the **culture and history** of India. References to millets can be found in mythology, poetry, religious practices, *ayurvedic* recipes, and in numerous dishes. Small millets are not only food grains; they are still intricately interwoven in the socio-cultural fabric of numerous regions.

Need for reviving small millets

Despite their superior nutrition qualities and climate change resilience, small millets cultivation and consumption have declined across the world. In India, the area under small millets declined after inception of green revolution. The area under small millets other than finger millet declined by 82 %, while that of finger millet reduced by 56% from 1965-66 to 2011-12. While the productivity of finger millet significantly increased in the same period (from 492 kg/Ha to 1641 kg/Ha), productivity of other small millets have increased only to a limited extent (from 341 kg/Ha to 565 kg/Ha) (Govt. of India, 2014). This decline in area has a direct bearing on overall decline in the consumption of all millets. Finger millet consumption, declined by 47%, while other small millets declined by 83%. Given the high prevalence of malnutrition and non-communicable diseases, these production and consumption trends can have significant negative effect on the wellbeing of the people. In this context, scaling up of the production and consumption of small millets can make a significant impact on the nutrition and health of the general population, especially women and children.

RESMISA project

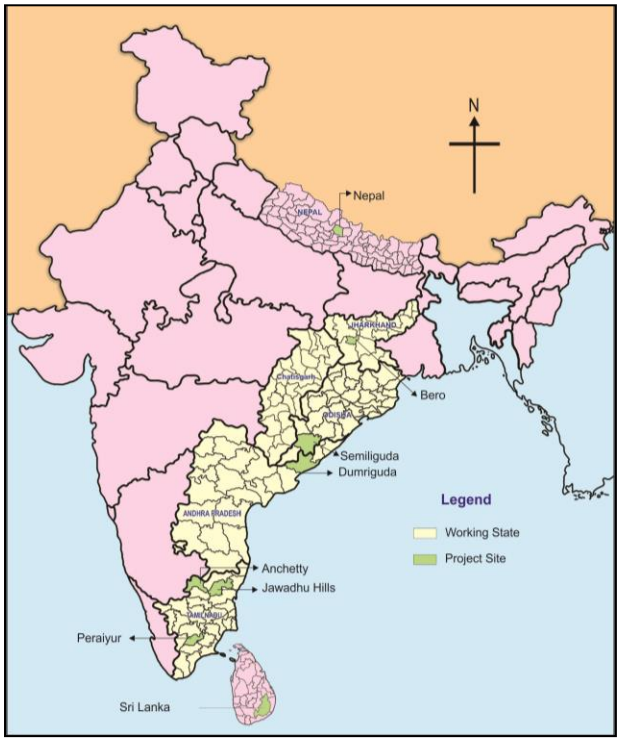


Figure 1.1: Geographic locations of RESMISA project sites

The action research project **'Revalorising of Small Millets in Rainfed Regions of South Asia' (RESMISA)**, which was in operation during 2011-2014, aimed to address this challenge of increasing production and consumption of nutritious small millets and associated pulse and oil seed crops in rainfed regions of India, Nepal and Sri Lanka. It focused on overcoming existing constraints related to production, distribution and consumption of small millets and associated crops. It pursued a multi-pronged research strategy related to conservation, productivity enhancement, value addition, post-harvest processing, promotion and policy action to raise the profile of small millets. The project had selected six research sites in the backward and tribal dominated pockets of Tamil Nadu (Jawadhu Hills, Anchetty & Peraiyur), Andhra Pradesh (Dumriguda), Odissa (Semiliguda) and Jharkhand (Bero) states of India and one site each in Sri Lanka and Nepal (Figure 1). This project was anchored by DHAN Foundation, India and Canadian Mennonite University, Canada. The project was implemented in South Asia by DHAN Foundation in India, LI-BIRD in Nepal and Arthacharya Foundation in Sri Lanka. There were other six collaborating organisations, namely, Tamil Nadu Agricultural University (TNAU), All India Coordinated Small Millets Improvement Project (AICSMIP) of Indian Council of Agriculture Research, WASSAN, University of Guelph, University of Manitoba, and McGill University. This project was supported by Canadian International Food Security Research Fund (CIFSRF) promoted by Foreign Affairs, Trade and Development (DFATD) and International Development Research Centre (IDRC), Canada.

The major objective of the action research project was to increase production and daily consumption of small millets in rainfed regions of the project countries, by using gender sensitive participatory approaches to address constraints related to the production, distribution, and consumption. The RESMISA project was unique in many aspects. It was a multi-disciplinary project with well defined objectives, followed participatory approach and worked in the intersection of indigenous knowledge and modern science. All the themes of main objectives namely, 1) Promoting on-farm conservation and varietal diversity, 2) Addressing site specific production constraints, 3) Addressing post harvest constraints and value addition research, 4) Revitalising indigenous knowledge and practices, 5) Promoting consumption of small millets and 6) Undertaking policy analysis and policy advocacy, were well integrated to accomplish a common goal of increasing production and consumption of small millets. The successful completion of the project encourages us to share the rich experience with other interested individuals as well as groups through bringing out various informative and quality publications. This book is one of such efforts and restricts its scope, for convenience, only to promoting

on-farm conservation and varietal diversity in small millets that have been accomplished in five Indian sites of RESMISA project.

Under the first objective, the project attempted to promote sustainable *use* and *on-farm conservation* of crop and varietal diversity of small millets that are important for minimizing climate change related risks in agriculture and improving human and animal health in rainfed ecosystems. This involved addressing some of the important reasons for poor productivity of small millets namely decline in inter and intra-species diversity among small millets, inadequate presence and penetration of site specific released varieties from national agricultural research systems and lack of timely supply of quality seeds. These interrelated issues led to decline in area under cultivation on the one hand and increased the vulnerability of small millet farmers to changes in local climate on the other hand. The project adopted a community based approach integrating on-farm conservation, varietal improvement and local seed systems of small millets to address these challenges in the project sites and the following chapters share the experience of the project. Never the less, what is going to be said about small millets in this regard based on the experience of RESMISA project might find relevance in case of other field crops too. The learning is highly relevant particularly for crops facing similar conditions of neglect and under investment.

The second chapter describes the approach and methods followed. Third, fourth and fifth chapters share about documentation and characterisation of crop and varietal diversity, varietal improvement and facilitating access to crop and varietal diversity , respectively, with a focus on findings. The last chapter shares the emerging outcomes, important lessons learnt, conclusion and the way forward.

2. Approach and Methods

The guiding methodology adopted by the RESMISA project was farmer-led research that builds on indigenous knowledge systems and it was complemented by gender sensitive scientific and participatory methods. The participant communities including women, indigenous peoples, and marginal farmers in resource poor areas remained central and essential to this project, and strategies were planned accordingly. This overall approach was reflected in the specific research methods and approaches followed in the project related to conservation, varietal improvement and seed systems.

Why participatory methodology?

Research and development activities related to agriculture and nutrition are supply driven and rarely implemented with participation of the end users. This is very much so in the case of research on various dimensions of agricultural biodiversity management. The contribution of farming community and other stakeholders for conservation of varieties, varietal improvement and seed supply is rarely recognized and given their due credit. This is mainly because they operate outside the formal research and delivery systems. Lack of recognition leads to existence of dual systems namely formal and informal systems and lack of public support to informal systems. Wherever there is interaction between these two systems, the power equations are such that there is less space for effective partnership, complementary functioning and equity in benefit sharing. In addition social relations as they exist in the project areas are conservative in tradition and usually distances women, tribals (indigenous people) and marginal communities from the mainstream development activities and related research results uptake (Chambers 1983; 2006). Women farmers face the additional constraint of invisibility of their significant role in conservation of varieties, varietal improvement and seed supply, given the patriarchal social relations. On the other hand, it is increasingly recognized that users' participation in technology development may increase the probability of success for the technology (Rhoades and Booth 1982). Similarly the need for systematic involvement of farmers and other stakeholders like extension staff, seed producers, traders and NGOs, etc. for varietal improvement is also recognized (Ceccarelli and Grando 2007). So the project adopted a participatory methodology. The project benefited from the long years of experience and guidance of the project partner LI-BIRD, Nepal, on community biodiversity management. The project has created a platform where in farmers and their organisations like federation/ association of self help groups (SHGs) from the sites, scientists and field staff of DHAN Foundation, and scientists from Tamil Nadu Agricultural University and All India Coordinated Small Millets Improvement Project of ICAR continually interacted throughout the course of study. The approach of new professionalism in plant genetic resources management was followed in the project in defining the relationship between professionals and farming communities (Pimbert and Pretty 1997; De Boef 2000).

Why on-farm conservation?

Crop varietal diversity is often perceived as antithetical to agriculture development or as a vestige of underdeveloped farming systems. The reasons for this perception are linked to contemporary advanced agricultural production systems. These systems, supported by intensive research and an enabling policy environment, have eroded agro-biodiversity at both farm and agro-ecosystem levels. There is,

however, a growing realization that crop varietal diversity, conserved and cultivated by small and marginal farmers in the global South, has enormous public value for ensuring global food security, poverty alleviation, and environmental sustainability (Boyce 2006). Presence of varietal diversity in crops in general is expected to aid the farmers to cope with the unexpected risks faced due to change in climate. But in the last two decades decline in inter and intra-species diversity among small millets is being observed in various degrees in India. So there is need for on-farm conservation of small millet varieties/crops in the project areas. The project considered the on-farm conservation approach as 'conservation through cultivation' (Asfaw 2000). It is considered a direct outcome of farmers' continued efforts to make use of genetic diversity to meet their diverse needs (Jarvis et al. 2000). The project perceived various advantages of '*in situ* conservation on-farm' over 'ex-situ conservation', as the traditional/ local varieties are products of evolutionary process operating at specific ecological niche. In other words, they possess heritable adaptability traits, which are more relevant to the local situations than to other areas. Further with certain amount of within population variation they could evolve further to suit ever changing local situations. Hence the project adopted the approach of '*in situ* conservation on-farm' of local varieties of small millets.

Why PVS?

Public research institutes and universities are primarily responsible for plant breeding. The role of conventional plant breeding (CPB) has been well acclaimed in increasing productivity and production of major food crops as well as commercial crops, heralding 'green revolution'. However, it failed to make significant impact in vast areas of farming situations characterised by diversity in site factors, crops, local farmers' needs, and farming practices. Much of the progress made in varietal improvement through conventional approach is limited to a few major crops and most of the modern varieties are being bred under controlled conditions (on research farms) to suit highly favorable growing situations. Further the improved varieties developed through conventional plant breeding are designed mostly based on breeder's perspective and not much attention is given about the specific needs of the farmers in the target production areas, especially during initial phases of selection process. The varieties so developed, however, are tested only at final stages before their release on the farmers' fields for their suitability. Once an improved variety is released with recommendation for a specific production area (at zone or state or national level), easy access to quality seeds of such varieties is also ensured through formal seed chain. As the farmers of such target production areas are left with no option than to accept it, go for its cultivation covering vast area. Such a move replaces gradually the existing traditional as well as popular varieties of that region, making the situation more vulnerable in future due to reduction in varietal diversity. In addition, there is little scope for effecting changes in genetic makeup of such varieties to suit local situations because of high genetic purity and also due to chances of being replaced by fresh seeds regularly. So, in the absence of inbuilt mechanisms to adjust with the changing surroundings, most of these varieties lose their existence after some years. Similar views on the limitations of CPB have been expressed by others also (Arunachalam, 2007; Ceccarelli and Grando, 2007; SEARICE, 2007). Still the conventional approach remains as the main domain of public and private research organisations at national, regional and global levels.

On the other hand, the traditional practice was in contrast with the modern plant breeding strategy. Local farmers, through their domestication, introduction and selection skills, were responsible for creating rich crop and varietal diversity in the past. It could be mainly because their selection process

was unique in the sense it involved both farmers' perspective as well as natural forces, which operated over a long period in the same habitat where they lived. The varieties so evolved adapted to the specific sites resulting in increased varietal diversity. The traditional knowledge and skill of the local inhabitants in maintaining crop and varietal diversity also got enriched over the years. One can assume that the genetic makeup of such varieties never fixed at a given point of time and space, but remained ever changing through evolutionary forces. In that sense plant breeding by farmers was a part of co-evolution of different biological systems that formed important component of a particular ecosystem.

It is but natural that the above mentioned two situations gave impetus to think about participatory approach of crop improvement (PCI). The term 'participatory plant breeding' (PPB) became established in the 1990s, as several projects were undertaken under this banner (Vernooy, 2003). At the same time it became clear that quite different approaches were captured under this term and participatory varietal selection (PVS) was one among them. The concept of PCI emerged especially as a response to alarming loss of traditional varieties in farmers fields and as well as in response to growing marginalisation of farmers in crop improvement and agriculture development (SEARICE 2007). By involving the farmers in the various stages of selection process and taking up on-farm trials in the target production areas, the participatory approach aims to strengthen the dynamic farmer system of co-evolving and co-adapting varieties to the changing environment. Participatory approach helps in integrating farmers' expertise, their indigenous technical knowledge, and ecology and growing environment of the local varieties synergistically with appropriate scientific skill and knowledge (Arunachalam, 2007). It is also considered as a more rapid and cost-effective approach in identifying farmer-preferred cultivars than conventional approach, provided a suitable choice of cultivars exists (Yadavendra and Witcombe, 2007; Ceccarelli and Grando 2007; Abay and Bjernstad, 2008; De Boef et al., 2010). PVS can be organically linked to community based seed production (Ceccarelli et al., 2009). This ensures the access to good quality seeds of most preferred varieties by large number of farmers within a short time. Considering these advantages of participatory method of crop improvement and given the fact that small millets are grown in heterogenous and remote target environments mainly under rainfed regions, PVS was thought to be more appropriate approach in the project.

It is to be noted that PCI need not be considered as the alternate method to the conventional approach of crop improvement; but both could complement each other in order to reach the benefits of scientific and indigenous knowledge to the farmers of diverse farming situations in shortest possible period. It has been expressed that there is risk of replacing the existing popular local varieties by the end products of either CPB or PPB after introduction in the target production area. In order to overcome this issue, the strategy considered in RESMISA project was that the newly identified farmers' preferred varieties were not intended to replace the existing popular local varieties; but were considered as the additional options to the local farmers so as to enhance local varietal diversity.

Why local seed systems?

Access to quality seeds of better adapted varieties by the local farmers is of utmost importance for increasing productivity (Bishaw et al. 2008). Difficulty in accessing quality seeds in time is a major issue faced by large number of farmers and this is the case in small millets also. Seed replacement ratio is very low for the focus small millet crops in the project sites. Conventional seed policies and the

regulatory frameworks have unilaterally focused on a linear model of seed sector development restricted to multiplication and marketing of varieties bred and released by the formal crop improvement establishments. The linear model has been dominant in agricultural development for the past four decades and it foresaw the rapid and complete substitution of the informal system by a commercial system, and the replacement of local varieties by modern varieties. But, despite the limitations that informal seed systems exhibit, their advantages are significant both in developing and industrialized countries. An estimated 60 to 80% of all seed used in Africa and Asia is produced in the informal systems, and for many crops the estimate is closer to 100%, which means that informal seed supply is the main source of seed for most crops and farmers in developing countries, and is likely to remain so for the foreseeable future (Louwaars and de Boef, 2012; Louwaars et al., 2013). As the sole source of the majority of seed in smallholder communities, these informal systems have an essential role in promoting food security, and in the face of rapidly dwindling global genetic diversity, they are central to the conservation of biodiversity (Gill et al, 2013). This is very much true in case of small millets also. The formal seed chain does not produce seeds of farmers' preferred traditional small millet varieties. Even in the case of released small millet varieties, only few successful or recently released varieties are produced by the development oriented public seed chain in a centralized manner for meeting the requirements of farmers from large area, thereby creating a situation of vulnerability arising from narrowing of genetic base (Louwaars and de Boef, 2012). Private formal seed chain does not take up production of seeds of small millet varieties as they are not commercially attractive. Neate and Guei (2011) suggested production and marketing of quality seeds of wide range of adapted varieties by groups of small scale farmers locally as an option to address these issues. So to meet the small millets seed requirements of local farmers, in terms of their preferred varieties, quality and timeliness, and to build on the on-farm conservation and varietal improvement initiatives, the project attempted community based local seed production.

Why integrated approach?

On-farm conservation, participatory crop improvement and local seed production are three interconnected core components of a community agricultural biodiversity management and local seed systems. All three components supplement and complement each other. But in reality these interconnections are rarely taken into account by the entities involved in these components and they work in isolation. National agricultural research system (NARS), a prominent actor, focuses only on research station based varietal improvement, following the 'develop and deploy' approach. Limited number of non-governmental organisations (NGO) working on on-farm conservation of local varieties, focus only on that aspect. The actors in formal and informal seed chains are not connected to on-farm conservation or varietal improvement. Recognising the need for integration of these complementary roles, an integrated model was designed and attempted at the community level under 'Revalorising Small millets in Rainfed Regions of South Asia' (RESMISA) project, in order to accomplish the objective 'On-farm conservation and improvement of crop varietal diversity of small millets' more effectively and efficiently.

Integrated model attempted in RESMISA project

As shown in the flow chart (Figure 2), understanding the present status of varietal diversity and seed dissemination system in the sites was attempted in the beginning. Different tools such as field survey,

transect walk, biodiversity fair, preparation of community biodiversity register and interaction with the local farmers were used for scouting the varieties of focused crops that are under cultivation in each of the study sites. This was followed by establishing biodiversity blocks and morphological characterisation of local varieties. The varieties collected were classified into popular and rare varieties. While special attention was given for on-farm conservation of the rare varieties through nodal farmers, the popular varieties entered the PVS trials as local checks. In PVS, experimentation on acceptability of suitable materials in farmers' fields included mother trials, baby trials and informal research and development. Mass multiplication and promotion of preferred varieties emerging from PVS and on-farm conservation of rare local varieties were taken up as follow up steps and were housed in community seed systems. Though the project followed the above mentioned sequence, it is also conceptualised that this interaction across the three components - on-farm conservation, varietal improvement and local seed systems- will be a continuous process and will continue beyond the project period. The local community organisations will carry on these aspects based on their need beyond the project period and necessary capacities (both knowledge and financial) for the same were created during the project period.

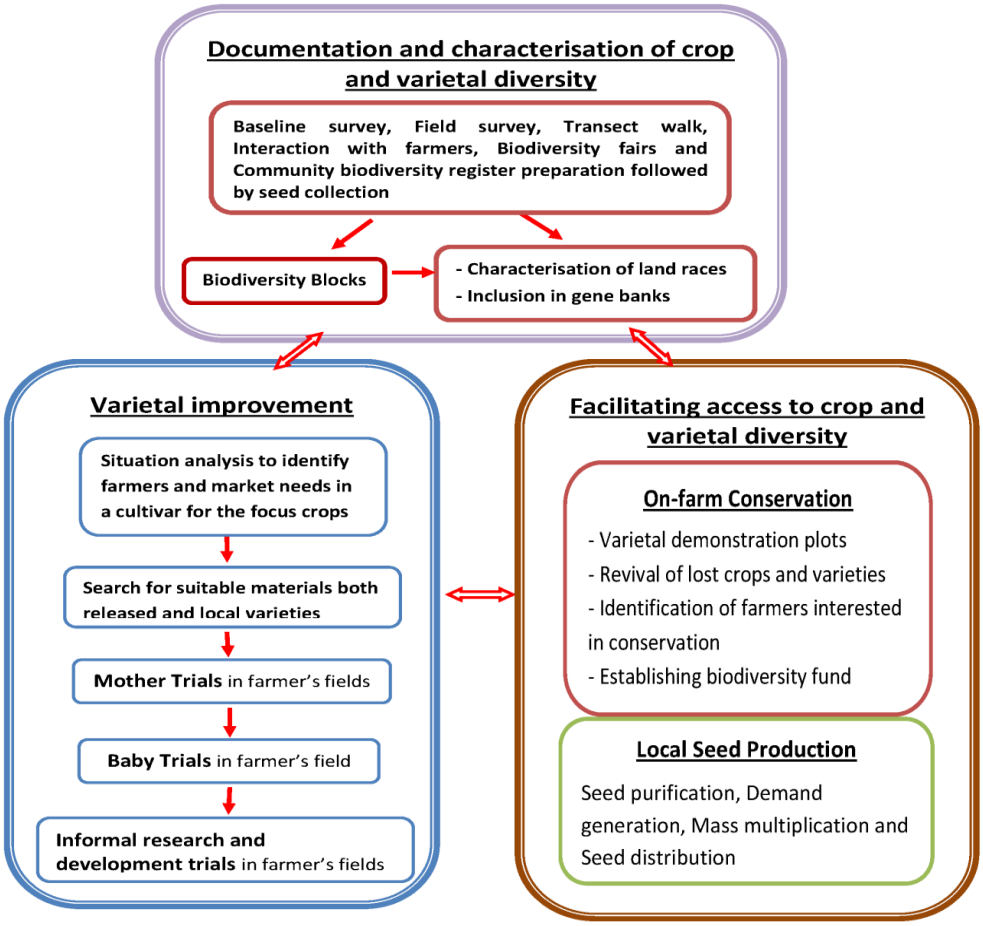


Figure 2.1: Integrated Model of Community Biodiversity Management

Materials and methods

In this section, the main features of project sites, including focus crops, and experimental methods, designs and tools used in implementing various activities mentioned above are described.

Site features

In India, the project has been implemented in six sites located in four different states and the information covered in this book is confined to only five sites. The selected sites fall in the backward rainfed areas, which have high incidence of poverty and, food and nutritional insecurity. The sites for the project were chosen based on: (i) presence of small millets based cropping systems and their local use as food, (ii) predominance of rainfed agriculture, (iii) high incidence of poverty, and (iv) poor performance in human development indicators, including female literacy and malnutrition. The selected sites are remote, underdeveloped and some of them have significant tribal (indigenous) populations. The sites in Odisha and Jharkhand fall in the country's eastern plateau, while the three sites in Tamil Nadu (Jawadhu hills, Anchetty and Peraiyur) fall in the southern plateau. According to the recent Food Insecurity Atlas of Rural India (2008), the food security status in the selected locations ranges from poorly secure to severely insecure. Koraput in Odisha, for example, is one of the 10 poorest districts in Odisha, where the problem of food insecurity has raised international concern (Government of India, 2007). Although Tamil Nadu is considered as an economically advanced state, the sites selected for the project are in rainfed and poverty stricken parts, and they are similar to tribal areas pertaining to many of the development indicators.

Jawadhu Hills, Tamil Nadu: This is a remote hilly site with tribal population located in the Eastern Ghats of Tiruvannamalai district. It is the least developed block in the district. It is characterised by red loamy soil, high rainfall, small land holding size and limited adoption of technologies. Little and finger millets are the important small millets crops in this site and were taken as focus crops for the study. High plant population, low soil fertility and less attention to cultivation practices were identified as the main production constraints.

Semiliguda, Odisha: It falls in tribal Dandakaranya region of eastern plateau and hills agro-climatic zone. This is a backward site with mix of tribal and non-tribal farmers. It is characterised by undulated land with red sticky soil, high rainfall, small land holding size and limited adoption of technologies. Finger and little millets were the focus small millet crops here. High plant population, weed menace and competition with paddy for labour were identified as the main production constraints.

Bero, Jharkhand: Bero, another tribal site in Central India, is located in the naxalite-prone pocket of Jharkhand. This is a backward site with mix of tribal and non-tribal farmers. It is characterised by plain lands with red soil, high rainfall, small land holding size and limited adoption of technologies. Finger millet was the focus small millet crop here. High plant population and competition with paddy for labour were identified as the main production constraints.

Peraiyur, Tamil Nadu: Peraiyur site is located in the Madurai district of Tamil Nadu. This is a well connected site with non-tribal farmers. It is characterised by plain land with black soil, low rainfall, moderate land holding size and limited adoption of technologies. Barnyard and kodo millets were the focus small millet crops here. Low soil fertility and inadequate rains are the main constrains here.

Anchetty, Tamil Nadu: Anchetty is located in the Melagiri Hill range of Krishnagiri district in the remote Tamil Nadu and Karnataka border with non-tribal farmers. It is characterised by undulating land with red loamy soil, low rainfall, moderate land holding size and higher level of adoption of

modern technologies. Finger millet was the focus small millet crop here. Low soil fertility and high pesticide use were identified as main issues.

Methods followed

On-farm conservation

Collection of existing local germplasm of small millets and their characterization, documentation and conservation formed the key aspects of the project, for which the following scientific as well as participatory methods were followed.

Transect walk for identifying the varietal diversity

A transect walk is a tool for describing and showing the location and distribution of resources, features, landscape, and main land uses along a given transect. This tool was used mainly to enlist the present and past varieties of small millet crops, cultivation practices and production issues in the project site. Systematic effort was undertaken covering the working villages in the sites for observing the small millets varietal diversity during the crop season.

Biodiversity fair

Biodiversity fair is a participatory tool for documenting the local varietal diversity and raising public awareness on the value of conserving local landraces. It involves bringing the farmers from different communities together to exhibit the range of landraces and encourage them to share the associated knowledge. The exhibits in the form of live plants, seeds and fruits were documented and classified into different categories. Prizes were given to contestants on the basis of the total number of entries and uniqueness of genetic diversity displayed in the fair. Discussions were held after the biodiversity fair on the use value of different varieties of various small millet crops and the reasons for the decline in the diversity.

Community biodiversity register

Community Biodiversity Register (CBR) refers to a record kept in a register by community members of the genetic resources in a community, including information on their custodians, passport data, agro-ecology, cultural and use values. It is also defined as an effort by a community to document and conserve both the biodiversity that is used within a given area, and relevant knowledge about it. The formats accepted by the National Biodiversity Authority were followed.

Biodiversity blocks

Biodiversity blocks are established in the fields by raising together crops of all the available varieties of a particular crop in a block so that each variety occupies a small plot within the block. So, biodiversity blocks provide an opportunity to the participating farmers, field staff and also to the scientists in knowing the identity of the varieties included, by observing them during different stages of crop growth. The other important uses of such blocks could be creating awareness about the existing varietal diversity within a crop among the farmers, assessment of relative performance in respect of

growth and yield components and preserving the identity of each variety through purification by seed selection.

The seeds of local collections were sown during cropping season at each site. The plot size for each entry in the blocks varied across the sites (6-15 m2) depending on the number of varieties and availability of space in the farmers' fields. Observations on growth and yield parameters were recorded; field days and exposure visits were arranged for the local farmers; and purification work was also attended wherever possible. The fresh seeds were collected after maturity from each variety for future use.

Morphological characterization

Morphological characterization of a variety is a method of recording varietal features using a set of widely accepted morphological descriptors to describe the phenotype of that particular variety. Morphological characterization helps in knowing the identity of a particular variety and helps in better utilization. In the present project, standard set of descriptors suitable for small millets were used for morphological characterization of different varieties of small millets.

Compiling information on released varieties

The AICSMIP and TNAU scientists compiled information on improved varieties of small millets released in India. They included information on pedigree, breeding method, important yield, and agronomic-related attributes.

Varietal improvement of small millet crops

PVS is a system of selection amongst fixed lines by farmers under target environment. It is both research and extension method (Witcombe). It is a simple way for breeders and agronomists to learn which varieties perform well on-farm and are preferred by farmers.

A successful participatory varietal selection programme has four phases:

- Participatory evaluation to identify farmers' needs in a cultivar
- A search for suitable material to test with farmers
- Experimentation on its acceptability in farmers' fields and
- Wider dissemination of farmer-preferred cultivars.

1. Participatory evaluation to identify farmers' needs in a cultivar

It is important to understand the requirements of farmers in a particular location for initiating varietal selection for that particular area. This was done through Focus group discussion (FGD), which was held in all the project sites, separately for men and women farmers, to elicit information on preferred varieties and varietal traits along with the reasons for specific preference. A set of preferred traits like duration, tolerance to moisture stress, grain colour and taste, plant height, high yielding ability etc, were identified and then prioritized (Joshi and Witcombe).

2. A search for suitable material to test with farmers

Once the requirements of farmers in the particular location were understood, then search for suitable varieties from various sources were taken up. The suitable varieties were sourced from,

- National list of released varieties
- District/ agro-climatic zone level recommended varieties
- Local collections as a result of transect walks, field visits and biodiversity fairs conducted in the sites
- Popular local varieties of nearby areas with similar agro-climatic situations
- Seeds of known varieties available at local markets
- Promising pre-release stage varieties suggested by the breeders

3. Experimentation on its acceptability in farmers' fields

Once potential cultivars that meet the requirements of farmers in a particular location are short listed from various sources, they need to be tested in the farmers' fields for on-farm evaluation to understand their relative performance and acceptance by the local farmers. For this purpose various kinds of PVS trials were designed and implemented with full cooperation of participating farmers. The three kinds of PVS trials are:

a. Mother trials
b. Baby trials
c. Informal research and development (IRD)

a. Mother trials

A common set of varieties of small millet crops comprising potential traditional as well as improved varieties, usually 8 to 10 in number were chosen in each crop for evaluating in mother trials. The number of mother trials and the varieties tested during 2011-2014 is given in Annexure-1. As per the procedure, the field experimental design for these mother trials was un-replicated, wherein each variety is raised in one plot of 1 cent area (40 sq.m) and all the plots of different varieties formed one block in the field of each farmer. The same set of varieties, arranged randomly in different order, was distributed to the selected farmers of identified hamlets across village Panchayats in each site. Care was taken to distribute the farmers across the villages in the site and selection of experimental fields with least influence of external factors on the crop growth. Since each trial in the famers' fields form one replication, the number of trials is considered equal to the number of replications, in the experimental design (Sieglinde, 2002). In addition to such mother trials , replicated trials (RCBD) consisting the same set of varieties, one in the farmer's field in each site and another in research centres (TNAU, AICSMIP centres), were also taken during 2012, with recommended package of practices. The pooled experimental data of all the mother trials were then analyzed according to the procedure followed for trials with RCBD. The opinion of individual farmers, who involved in conducting mother trials, on the performance of varieties was recorded. In addition, a group of local farmers, male and female groups separately, also participated in farmers' preference analysis (FPA) activities, which were arranged at each site in one of the mother trials, when the crop attained

maturity stage. FPA is a technique used to assess the relative performance of varieties in the field by the farmers themselves. The farmers were asked to indicate 3 best varieties of their choice by placing the corresponding indicators (different coloured/shaped cards) in the boxes placed in each plot. The score of indicators for each of the varieties in the trial was recorded. The actual score values were converted as weighted scores in order to arrive at a single overall preference value for each variety. Efforts were taken to elicit and analyze the preferences of men and women separately.

b. Baby trials

The varieties identified in mother trials were tested in baby trials during the following cropping season. For each identified variety a minimum of 25 baby trials were planned in each site. The selected farmer was given 2 kg of seeds of a particular variety for testing along with his/her own variety in a plot of 200 sq. m size and above. The crops of both test and check varieties were raised side by side in the same field following same cultural practices. The number of varieties and baby trials taken up in each project site during the project period are also furnished in Annexure-1. Estimated yield data based on two sample plots was recorded for each variety. The opinion of participating farmers with respect to the comparative performance of varieties was also recorded using a pre-tested questionnaire.

c. Informal research and development (IRD)

Once the suitability of varieties were tested through baby trials, the farmers identified varieties need to be further validated and disseminated to large number of farmers in the selected location. Seed kits containing about 1 kg of seeds of farmers' preferred varieties were distributed as IRD to disseminate the preferred varieties further. In order to understand the perception of the farmers regarding the new varieties introduced on their farms, individual farmer's feedback was collected from a sample of randomly selected fields having the new variety.

Organoleptic tests for food crops

The identified varieties in each site through PVS comprised both improved and traditional varieties of small millets. Acceptance of a particular variety by the local farmers does not depend only on its field performance but also on its desirable attributes related to consumption such as taste, colour, dough consistency, keeping quality etc. Hence in order to collect systematic and reliable information on consumption aspects a standard procedure called organoleptic test was carried out in three project sites. A group of farmers, both men and women, evaluated the varieties of finger millet, little millet and barnyard millet based on the local recipes prepared using the grains of selected varieties. Paired ranking participatory tool was used for recording the data in each test.

Capacity building of the farmers and location researchers

Realising the fact that the field staff drawn for handling field activities in close association with the participating local farmers are mainly coming from non-agricultural back ground and the need for certain amount of practical skills in executing large number of field trials, systematic capacity building efforts were taken before and during the cropping season. The field staff was trained and provided required orientation before the start of cropping season. In addition, a field manual, both in English and one in regional language (Tamil), was prepared for the benefit of the field staff. Handholding

during at every stage of trials and regular monitoring was done by the technical personnel. Field data sheet was provided to the field staff for recording cultivation aspects and observation made by the technical personnel, and to collect morphological and yield data of varieties included in the trials.

Facilitating sustainable access to seed

The methods adopted for conservation and dissemination of varieties identified in documentation of varietal diversity and PVS trials are shared below.

Documentation of seed source: Sources of seed was documented through sample baseline survey and sustainable agriculture kit survey, besides the focus group discussions.

Varietal diversity demonstration and on-site conservation: It involves establishing plots of all the local varieties and few suitable released varieties of a crop, in the pattern of biodiversity blocks in all the main villages for conserving them and to demonstrate available varietal diversity to the local community.

Identification and encouraging farmers growing rare varieties: Cultivation of some of the varieties is restricted to one or two hamlets and if not protected, they will also vanish soon. So a method of promoting on-farm conservation of rare varieties through interested farmers by encouraging through recognition and sharing to other farmers was adopted.

Reintroduction and popularising vanished small millet crops and varieties: Various studies on small millet crops and varietal diversity indicated that many of the sites had many small millet crops earlier and now have only one or two of them. Some of the varieties and crops vanished mainly because there was a break in the seed chain. A method of promoting on-farm conservation of lost varieties and crops through seed provision and encouragement of cultivation was adopted.

Biodiversity fund: Biodiversity fund was created in each location to systematically involve the local community organisations in conservation and to generate income. The design is to use the allocated funds as credit by the local community organisations to meet the requirements of the community and in the process to generate interest income, which will meet the conservation related expenditures in a sustained manner.

Local seed production: Local farmers interested in seed production were trained to create a pool of qualified farmers in each site for seed production. The design is to procure seeds from these farmers and supply on cost basis to the needy farmers by raising demand among the members in the farmers' groups and among the general public.

3. Documentation and Characterization of Varietal Diversity of Small Millet Crops

Realizing that crop and varietal diversity of small millets eroded alarmingly during recent decades, it was essential to understand the existing status of them before initiating any efforts of their conservation and utilization. Various activities comprising collection, purification and characterization for understanding the crop and varietal diversity of small millets were undertaken in the project sites in the first two years. The progress and achievements of each activity in five Indian project sites is presented in the following sections.

Transect walk (scouting for traditional varieties of small millets)

The activity comprised collecting information by interacting directly with individual farmer or group of farmers and specific field surveys. It was carried out intensely in the first two years in two phases. The first phase was taken up before the cultivation season. Based on the information and seeds collected during the period, several biodiversity blocks and mother trials were conducted in the sites. In the second phase exclusive efforts were made during the cultivation season to understand the varieties under cultivation in and around the site by visiting the farms in various parts of the site and interacting with the farmers. In addition to small millets, details of local varieties of horsegram and niger were also collected in Anchetty, Jawadhu Hills and Semiliguda sites.

Biodiversity Fair

In the project biodiversity fair was conducted with the following objectives: 1) to understand the status of agro-biodiversity with a focus on crop and varietal diversity of small millets and associated crops in the project site and 2) to create awareness about the importance of agro-biodiversity among the local community for their sustainable livelihood. During the project biodiversity fair was held in two project sites with the active participation of local people. The outcome of these fairs is presented here.

Project site: Anchetty, Tamil Nadu

At Anchetty the biodiversity fair was held on January 19, 2012 and more than 40 farmers participated in the fair. Before the event the local farming community was informed about the event and was invited to participate. They were informed to bring as many varieties of cultivated crops as possible with a focus on small millets and associated crops. The seeds and live specimens of different crops locally available were exhibited by groups of farmers from six clusters (Kottaiyur, Anchetty-1 and 2, Attinattam, Madakkal and Byadrahalli). One farmer from neighboring state also participated and displayed many traditional varieties of finger millet. Prizes were distributed to the exhibitors as recognition of their effort to maintain agro-biodiversity in their farm and their willingness to share the information with others. One farmer from Byadrahalli had displayed maximum number of crops and varieties in the event. The details of crops and varieties exhibited are given in Table 3.1. The fair revealed that Anchetty site possessed vast crop diversity and as many as five small millets find their presence in the site. Presence of significant number of varieties of finger millet, cowpea and castor also came to light. Hitherto not documented two local varieties of finger millet, *Siddu gidda* and *Karun gatti,* were identified in the fair.

Dr. Nirmalakumari, TNAU viewing varieties displayed in Anchetty

Dr. Patil, delivering a speech in Anchetty Biodiversity Fair

Table 3.1: Crops and varieties displayed in the Anchetty biodiversity fair

I. Cereals and millets	II. Pulses	III. Oil seeds	IV. Fruits and vegetables
Rice (3)	Field bean (4)	Ground nut (3)	Tomato (2)
Maize (1)	Horse gram (3)	Sesame (1)	Ladies finger (1)
Sorghum (3)	Cowpea (7)	Niger (1)	Pumpkin (2)
Finger millet (13)	Red gram (4)	Mustard (1)	Mesta (1)
Little millet (4)	Beans (6)	Castor (5)	Tamarind (1)
Kodo millet (2)	Pea (1)		Goose berry (1)
Foxtail millet (3)			
Pearl millet (3)			
Proso millet (2)			

Note: Figures in brackets indicate number of varieties

Project site: Peraiyur, Tamil Nadu

The event was arranged in one of the working village at Peraiyur on 31.1.2012. Invitation cards were prepared about the diversity fair and distributed to the local farmers. In all 212 specimens of different crops, such as barnyard millet, kodo millet, finger millet, pearl millet, field bean, sorghum, maize, rice, cotton, etc. were exhibited by 46 farmers in the fair. The details of crops and the number of varieties in each crop displayed in the diversity fair are given in Table 3.2. About 83 farmers participated in the fair. The discussion after the fair centered on the purpose of the fair, quality seed selection, *kari pootai* infection in kodo millet and subsidy for SMAC crops. The fair helped in recognizing three varieties of kodo millet namely, *Karuvaragu, Siru (podi) varagu* and *Sentharai (Senthazh*) and also one white finger millet variety from Sengapadai village. Peraiyur village farmers exhibited different varieties in Barnyard millet including *Sadai kuthiraivali* and CO2.

Display of varieties in Peraiyur, Madurai

Display of varieties in Peraiyur, Madurai

Table 3.2: Crops and varieties displayed in the Peraiyur Bio-Diversity fair

I. Cereals and millets	II. Pulses	III. Oil seeds	IV. Fruits, vegetables & others
Barnyard millet (3)	Field bean (3)	Groundnut (2)	Ladies finger (1)
Maize (3)	Cowpea (1)	Sesame (1)	Tamarind (1)
Sorghum (3)	Red gram (1)	Castor (1)	Gooseberry (1)
Finger millet (1)	Blackgram (3)	Sunflower (1)	Cotton (3)
Kodo millet (3)	Greengram (1)		Neem (1)
Foxtail millet (2)	Bengalgram (1)		Papaya (1)
Pearl millet (2)			Coriander (1)
Paddy (4)			Curry leaf (1)
			Chillies (1)
			Avuri (1)
			Teak (1)

These events also provided platforms for interaction among farmers, project scientists and field staff. Important issues like the need for conservation, importance of local crop and varietal diversity, and maintaining seed purity through seed selection practice were discussed. The biodiversity fairs revealed presence of rich crop diversity in all three sites. Interestingly, good number of varieties (as many as 13) of finger millet and little millet were exhibited at Anchetty. Varietal diversity was found to be very low at Peraiyur site. Three local varieties of kodo millet and 2 varieties of finger millet were recognized at Peraiyur and Anchetty fairs, respectively.

Community biodiversity register (CBR)

In four project sites, namely, Anchetty, Peraiyur, Jawadhu Hills and Semiliguda, the CBRs have been prepared for the working *panchayats* and the reports from Tamil Nadu sites were submitted to state biodiversity board. A brief summary regarding the status of varietal diversity extracted from these reports is mentioned below.

Among the four sites, varietal diversity was richer in Semiliguda; they had about 77 traditional varieties under 12 crops. In finger millet itself 24 traditional varieties were available. Varietal diversity was less in Anchetty site with only 35 traditional varieties in 13 different crops. As many as 41 traditional varieties are available in Peraiyur site in 20 different crops, while 38 traditional varieties in 15 crops are found in Jawadhu hill site. This site also had more varietal diversity in little millet.

From CBR reports, it was found that many crops, especially the ones which were under rainfed conditions, vanished from cultivation in the last two decades and a few more were in vanishing condition. Anchetty and Peraiyur have lost 7 and 8 local varieties in different crops, respectively. Some of the important reasons elicited from the farmers were change in rainfall pattern and low yielding ability of certain varieties. The information from these CBR was useful to workout suitable strategy for conservation and utilisation of local crops, especially small millets and associated crops.

Biodiversity block

Biodiversity blocks of focused small millet crops were laid during Kharif 2011 and 2012 in all the Indian project sites to ascertain the identity of the varieties collected in transect walk and biodiversity fair. As most of the collected varieties were included in mother trials in 2011, the selected trials were used to meet the purpose of biodiversity blocks (Table 3.3). However, separate biodiversity blocks were established at Semiliguda during 2012 as there was large number of local varieties which were not part of mother trials. Exposure visits for the local farmers, including members of Rainfed Research Coordination Committee (RRCC)[2], were arranged to create awareness regarding the local varietal diversity in small millets.

Figure 3.1: Farmers visiting biodiversity block at Bero

Table 3.3: Number of varieties included in biodiversity blocks in each project site, 2011

Project Site	Finger millet	Little millet	Kodo millet	Barnyard millet	Foxtail millet
Semiliguda	21	8			3
Bero	6				
Anchetty	15				
Jawadhu hills	7	8			
Peraiyur			4	19	

Data on growth and yield traits were also recorded by the field research staff under the guidance of technical personnel. Variation for growth and yield traits were noticed among different varieties of each small millet crop included in the biodiversity blocks. With the help of local farmers, purification was also taken up to maintain the identity of each variety.

[2] This committee was promoted in each location for systematic involvement of local community, comprising men and women, in identifying the research needs, in implementing on-farm research activities and in dissemination of research results of RESMISA project.

Too many admixtures in a local field of finger millet (left picture) makes it necessary to follow purification operation as shown in the picture at right (purification of *Demba* variety of finger millet at Bero).

Morphological characterization

Morphological characterization and purification of local varieties of four focused small millet crops collected in three sites, Anchetty , Jawadhu Hills and Peraiyur, were carried out by TNAU, while AICSMIP conducted DUS characterisation of selected varieties of finger millet (39), little millet (15), barnyard millet (11) and kodo millet (7) from across the 6 Indian sites. These studies revealed that local varietal diversity did exist in finger millet, little millet, barnyard millet, and kodo millet crops for growth, inflorescence and yield traits. However, the number of collections were too less, especially for barnyard millet. Nutrient analysis of the local varieties was taken up and here again considerable variation was noticed. Since most of these local varieties contain mixtures at varying levels, it needs to be purified to assess their identity based on systematic characterization. Efforts in this direction are already in progress involving the local varieties collected in all the project sites in India with the technical support from AICSMIP. Morphological characterisation of local small millet varieties was useful for identifying the unique and potential varieties, which can be used for further crop improvement programs.

Compiling information on released varieties

The AICSMIP and TNAU scientists compiled information on improved varieties of small millets released in India. They included information on pedigree, breeding method, important yield, and agronomic-related attributes. In India, 233 varieties of small millets, which comprise finger millet (109), foxtail millet (30), kodo millet (32), little millet (19), barnyard millet and proso millet (24), were released. The compilation serves the purpose of tracing back some of the varieties, which are still in cultivation. Most importantly, the information on pedigree of released varieties would be helpful in planning future breeding programs, especially participatory plant breeding.

Status of small millets varietal diversity in project sites

Through the above mentioned activities it was possible to document the crop and varietal diversity of small millets in all the five sites (Table 3.4 & 3.5) and collect the seeds of available local varieties in each site. Seeds of most of these varieties were shared for morphological characterisation and further studies.

Table 3.4: Status of varietal diversity in small millets at the study sites

Focus crop & Project sites	No. of varieties present		Popular varieties	
	Local#	Released	Number	Name
FINGER MILLET				
Anchetty	10	3	2	GPU 28 (R), INDAF 5 (R)
Bero	5	-	2	Demba (L), Lohardagiya (L)
Jawadhu Hills	3	-	1	Muttan kelvaragu (L)
Semiliguda	31	2	4	Bati (L), Mati (L), Kalakarenga (L), Sunamani (L)
LITTLE MILLET				
Jawadhu Hills	15	-	3	Sittan (L), Karun sittan (L), Vellai samai (L)
Semiliguda	14	2	1	Bada suan (L)
BARNYARD MILLET				
Peraiyur	7	-	1	Sadai (L)
KODO MILLET				
Peraiyur	5	-	1	Karu varagu (L)

R- Released variety; L- Local variety; # Table 3.5 has details of the local varieties documented

Table 3.5: List of local varieties of small millets collected in Indian project sites

Project site	Local varieties	Number
FINGER MILLET		
Anchetty	*Kempu ragi, Karun gaddi, Siddu giddu, Gaddi ragi, Hasar gaddi, Haluguli, Ragalli shivalli, Bonda, Picha gaddi, Saratha*	10
Semiliguda	*Badu, Madei muskali, Dudh kerenga, Bodel, Sunamani, Mami, Bati, Bagha chhad, Bhalu, Sana, Khada, Mati, Kala kerenga, Dinda, Machhadim, Marda, Dasarabhodi, Chaula, Echhai, Jana, Denga semli, Bodi, Bada, Richika, Gangabali, Kadlipheni, Jam mandia, Chilli, Karenga, Raja, Subhra*	31
Bero	*Demba, Gibra, Lohardahiya, Hybrid, Dudha rice*	5
Jawadhu Hills	*Muttan kelvaragu, Perun kelvaragu, Karungittan kelvaragu*	3
Peraiyur	*Manjal keppai, Vellai keppai*	2
LITTLE MILLET		
Jawadhu Hills	*Sittan samai, Karunsittan samai, Perungolai samai, Koluthana samai, Vellai samai, Kallumannu samai, Siruvellai samai, Kambankollai samai, Siru samai, IR-8, IR-20 , IR-50, Karun samai, Kothu samai, Pudurnadu Vella samai*	9+3+3
Semiliguda	*Bada suan, Ganjei, Mami, Guruji, Bapa, Jura jotli, Kala suan, Machili, Dhobli, Sabera, Sakra, Kasam topa, Laiseri, Gailanj*	14
Anchetty	*Pullu samai, Siru samai*	2
Peraiyur	*Nattu samai*	1
BARNYARD MILLET		
Peraiyur	*Sadai kuduravali, Pullu kuduravali, Val kuduravali, Mallankinaru (M), M1, Arupukottai, Vilathikulam1*	7
KODO MILLET		
Peraiyur	*Siru(podi) varagu, Karu varagu, Senthazh varagu, Uppu varagu, Kozhikal varagu*	5
Jawadhu Hills	*Siru varagu*	1

Project site	Local varieties	Number
FOXTAIL MILLET		
Semiliguda	*Bada kangu, Rang kangu, Dala kangu*	3
Jawadhu Hills	*Nattu thinai*	1
Peraiyur	*Nattu thinai*	1
Anchetty	*Nattu thinai*	1

Finger millet – Anchetty presented a different picture than other three sites in terms of high penetration of released varieties (Table 3.4). Most of the area under finger millet in Anchetty is covered by two released varieties (GPU 28 and INDAF 5). The local farmers here have been cultivating many released varieties such as HR 911 and INDAF series for over two decades. But considerable number of local varieties was documented in the project site (7) and from the nearby area (3). High degree of varietal diversity was observed in Semiliguda, with 33 varieties, including 2 released varieties. Most of the area under finger millet in Semiliguda, Bero and Jawadhu Hills were with few popular traditional varieties.

Little Millet – A large number of local varieties of little millet were observed in Jawadhu Hills (15) as well as at Semiliguda (14). These included few varieties from the nearby areas. However, only *Sittan, Karun sittan* and *Vella samai* in Jawadhu Hills and *Bada suan* in Semiliguda were widely cultivated (Table 3.4).

Barnyard millet and Kodo millet – At Peraiyur site not much diversity was noticed either in barnyard millet or in kodo millet. Only traditional varieties were found to be under cultivation in each crop. Among them *Sadai* in barnyard millet and *Karu varagu* in kodo millet were more popular. Efforts were taken to identify the local varieties in the nearby area with similar agro-ecosystem and test in the project area.

Foxtail millet – Foxtail millet was grown as sole crop or as mixed crop in four out of the five sites on a limited scale. The area under foxtail millet has declined drastically in the past two decades.

Table 3.6: Status of hamlet level varietal diversity of small millets at the study sites

Site	Crop	Hamlets studied	Share of hamlets with different number of varieties (%)				
			1	2	3	4	5
Semiliguda	Finger millet	40	40	28	20	10	3
	Little millet	20	95	5	0	0	0
Bero	Finger millet	32	69	31	0	0	0
Jawadhu Hills	Little millet	36	31	47	14	8	0
	Finger millet	33	45	45	9	0	0
Anchetty	Finger millet	29	62	24	14	0	0
Peraiyur	Barnyard millet	10	70	30	0	0	0

Source: Baseline survey, RESMISA project, 2011.

The results of the study indicated that though there was presence of many varieties in the sites, not more than two varieties covered majority of the area in each of the four crops studied. Lot of variations were observed in prevalent varieties across the villages in the case of Jawadhu Hills and Semiliguda.

Further, varietal diversity at hamlet level was very limited in all the sites (Table 3.6). Most of the hamlets had only one or two varieties. Community biodiversity registers indicated that many small millet crops and their varieties vanished in the last two decades in the sites. This situation clearly indicated the need for systematic and sustained efforts for on-farm conservation and for increasing varietal diversity of small millets in the sites. As the baseline survey in the study sites indicated that more than 90% of the farmers have the practice of using farm-saved seeds, the best strategy for enhancing varietal diversity is creating more options regarding the preferred varieties with the involvement of farmers, and popularising the same for reaching large number of farmers. For the same purpose, community based PVS and on-farm conservation was attempted in the sites and their details are shared in Chapter 4 and 5.

Summary

At the start of the project there was totally no documented information about the status of varieties of focus crops at each of the project sites. Even the local farmers did not have the clear picture of the number and type of varieties that are prevailing in other *Panchayats* within the site. As mentioned earlier this information was very crucial to move forward with well designed working plan during the project period and also to suggest way forward after the project. The tools, methods and sources of information (transect walk, biodiversity fair, biodiversity block, morphological characterisation, CBR, compendium of released varieties and baseline survey report) all together were not only effective in giving the clear picture of varietal diversity in each study site, but also in creating valuable seed material of local traditional varieties, which forms an important biological asset of the local community. Documentation of around 100 traditional varieties/land races comprising 51 of finger millet, 32 of little millet, 7 of barnyard millet, and 6 each of kodo millet and foxtail millet, across five study sites could be considered as a good contribution of the project. With this status information by the end of the project period, documented as Community Biodiversity Registers, the local community can plan to conserve and develop on-farm crop and varietal diversity of small millets and can also easily assess the future changes.

4. Varietal Improvement in Small Millet Crops

Enhancement of varietal diversity through identifying most suitable location specific varieties in small millet crops, in addition to the prevailing popular varieties, was the key strategy followed in each project site for improving resilience and productivity of the cropping system. The results and the achievements made during the project period by adopting participatory varietal selection (PVS) are discussed in this chapter. As described in Chapter 2, PVS comprises three components, mother trials, baby trials, and informal research and development. Table 4.1 gives the details of types and number of trials taken up in five Indian sites during 2011-14 pertaining to four focus crops in the RESMISA project. Lot of planning and preparation took place in handling the large number of trials in all the project sites. The results of all these trials are discussed cropwise in the following sections.

Table 4.1: The number of PVS trials and the varieties tested in project sites during 2011-2014

Small millet crop	Project site	2011	2012		2013			2014		
		Mother trials	Mother trials	Baby trials	Mother trials	Baby trials	IRD	Mother trials	Baby trials	IRD & Populari -sing
Finger millet	Anchetty	27 (15)	14 (10)	34 (3)	12 (4)	34 (1)	62 (2)	--	87 (2)	435 (2)
	Bero	25 (6)	24 (9)	44 (2)	--	74 (2)	157 (2)	--	32 (1)	843 (4)
	Semiliguda	16 (21)	21 (10)	67 (2)	--	157 (2)	**(1)	--	143 (2)	989** (3)
	J. Hills	12 (7)	24 (10)	--	--	31 (4)	--	--	--	605 (3)
Little millet	J. Hills	33 (8)	22 (8)	19 (1)	14 (4), 11 (6)*	32 (2)	64 (1)	12 (3), 10 (3)*	92 (2)	306 (3)
	Semiliguda	16 (8)	22 (11)	--	14 (5)	72 (1)	--	--	--	--
Barnyard millet	Peraiyur	16 (19)	18 (10)	64 (3)	--	83 (1)	99 (1)	--	--	535 (3)
Kodo millet	Peraiyur	5 (4)	14 (10)	--	--	33 (2)	--	5 (9)	14 (3)	--

Values in parentheses are number of varieties in the trial; * Mother trials of short and long duration varieties, respectively;

** Bhairabi variety which was selected in the previous year trials was disseminated by the Government department.

4.1 Finger Millet

Among the Indian sites, finger millet is a focus crop in Anchetty, Jawadhu Hills (both in Tamil Nadu), Semiliguda (Odisha) and Bero (Jharkhand).

4.1.1 Project Site: Anchetty

i) Mother trials

At Anchetty mother trials were conducted during all the three years (Table 4.1). As most of the farmers in the region are cultivating improved varieties such as INDAF, GPU-28, HR-911 and MR, since long time, absence of traditional local varieties was clearly visible. The seeds of these improved varieties were easily accessed from the neighboring state of Karnataka. Hence it was aimed to enhance varietal diversity of the site by introducing suitable local as well as new improved varieties.

2011 - During 2011, though 15 varieties of finger millets were chosen for the site, each trial had a maximum of 6 varieties. The results of pooled data of all the trials are presented in Table-4.2. Average plant population varied among the varieties under test with a range of 56.1 to 97.3 per sq.m. The variation in the plant population may be due to difficulty in using uniform quantity of seeds while sowing using seed drill and due to variation in germination ability of those seeds. However, plant population observed in most of the varieties was found to be more than recommended level and the farmers usually go for high seed rate.

Table 4.2: Performance of finger millet varieties in mother trials at Anchetty, 2011

Sl. No.	Variety	Duration*	Plant population/m^2	Plant height (cm)	Tillers/ plant	Panicle length (cm)	Fingers/ panicle	Grain yield (kg/ac)
1	CO-7	E	93.0	68.3	2.4	5.9	5.98	480
2	CO-9	…	96.7	84.1	3.3	6.5	6.33	600
3	CO-10	E	76.1	74.7	2.1	6.8	5.74	784
4	CO-11	E	87.0	69.1	2.4	6.1	6.37	464
5	CO-12	E	96.9	81.3	2.9	6.9	6.31	700
6	CO-13	M	78.1	82.5	2.8	6.1	8.70	612
7	CO-14	M	65.0	75.3	3.0	7.5	7.34	608
8	GPU-28	M	56.1	90.8	2.4	8.8	7.23	852
9	GPU-66	M	81.3	86.4	2.1	7.0	6.07	800
10	GPU-67	M	60.0	68.2	2.3	6.3	6.00	600
11	*Kempu ragi*	M	97.3	75.8	2.3	5.5	5.50	684
12	*Bonda ragi*	E	91.2	73.8	2.3	6.4	5.30	536
13	*Picha gaddi ragi*	L	84.5	82.9	2.6	7.4	5.90	600
14	*Ragalli shivalli*	E	72.1	77.4	2.4	6.6	5.80	776
15	*Haluguli ragi*	M	94.3	73.0	2.2	7.3	6.30	644

*E- Early; M- Medium and L- Long

Except CO 7 and CO 11, all the varieties recorded plant height around 70 cm and above. Considering fodder as an important criterion, taller varieties are more preferred provided there is no lodging effect. GPU-28 was found to be the tallest variety with average plant height of 90.8cm.There was not much difference with respect to tillering ability, while CO-9, CO-12, CO-13 and CO-14 recorded slightly higher values. GPU-28 recorded highest value of 8.8 cm for panicle length followed by CO-14, *Pichagaddi ragi* and *Haluguli ragi*. Similarly, the highest number of fingers/panicle was noticed in CO-13 followed by CO-14 and GPU-28. Maximum grain yield (852 kg/ac) was recorded in GPU-28, while GPU-66 was also found to be equally good with 800 kg/ac. Most of the remaining varieties, including the traditional varieties, had shown grain yield of 600 kg/ac and above. Since different set of varietal combination was tried in different trials, it was not possible to get correct picture of relative performance. However, the performance of traditional varieties was equally encouraging in some trials. For instance, the grain yield of *Ragalli shivalli* ragi variety was found to be as high as 1200 kg/ac in one of the trials.

The details as well as results of the analysis from three FPA activities conducted in mother trials of 2011 are furnished in Annexure-1a (i – iv). Considering the overall score values in all the three FPA activities, *Kempu ragi, Haluguli ragi* and *Bonda ragi* among the traditional varieties and CO-14, CO-13, GPU-28 and GPU-66 among the improved varieties were found to be most preferred varieties of the local farmers. The criteria used by the farmers were crop stand, panicle size, number of fingers, plant height, grain quality (hardness) and duration. CO-13 and CO-14 were preferred because of more number of fingers per panicle, *Bonda ragi* for its compact panicle, and *Haluguli ragi* for fodder quality, while GPU-28, GPU-66 and *Kempu ragi* had big panicle size in addition to high yielding ability. Some liked long duration varieties to avoid rains during harvesting of the crop, while others were looking for earliness to avoid wild boar damage.

FPA in progress in finger millet mother trial at Anchetty, 2011

Finally three varieties, *Kempu ragi, Haluguli ragi* and GPU-66 were chosen for including in baby trials. The yields of CO-13 and CO-14 were not comparable to GPU-28, a popular variety of the region; and in addition, both showed incidence of finger blast in some trials.

2012 - During 2012, however, it was possible to have common set of test varieties which comprised some of the varieties of previous year trials and 3 additional varieties from the site itself. The results of mother trials conducted during 2012 are presented in Table 4.2. At Anchetty the farmers use seed drill for sowing the seeds and most of the trials were also conducted using the same technique. This helped in maintaining uniform density of plant population as indicated by the average values of plant population which was around 25 plants per square meter for different varieties tested. Varieties indicated variation for growth parameters which ranged from 72 to 103 cm for plant height, from 3.3 to 4.9 for productive tillers, from 6.3 to 9.3 and from 5.7 to 9.7 for number of fingers per panicle. CO-13 had bigger size panicles than other varieties, while the maximum finger length was noticed in *Gaddi ragi*, but it recorded the least number of fingers/panicle.

Bonda ragi recorded the highest grain yield of 824 kg/ac followed by GPU-67 and GPU-28, respectively. The maximum straw yield was found in *Gaddi ragi* but its grain yield was the least. According to farmers' opinion CO-13, GPU-28, *Saratha* and *Karun gaddi ragi* were the most preferred varieties (Annexure-2). All these varieties, except *Saratha*, are having relatively bigger panicles and the farmers were looking for varieties with high yielding ability. GPU-28 is already being cultivated by many farmers in the region. Only *Saratha* was considered for further evaluation in baby trials as *Karun gaddi ragi* happens to be a long duration variety, a trait not liked by many farmers.

Table 4.3: Performance of finger millet varieties in mother trials at Anchetty, 2012

Varieties	Growth and yield parameters							
	Duration	Plant Population/ m^2	Plant height (cm)	Productive tillers per plant	Finger length (cm)	No. of fingers	Grain yield (kg/ac)	Straw yield (Kg/ac)
GPU-28	Medium	25.5	85.6	3.7	8.3	6.8	797	2450
GPU-67	Medium	26.4	72.0	4.0	6.3	6.4	804	2460
CO-13	Early	25.4	86.0	3.3	8.4	9.7	728	1880
CO-14	Early	25.8	77.6	3.3	7.0	8.0	740	2030
Saratha	Medium	26.1	82.5	3.5	6.9	6.6	748	2270
Bonda	Early	24.0	79.4	3.8	7.5	6.5	824	2470
Picha gaddi	Long	26.2	95.1	4.3	6.6	5.9	760	2550
Karun gaddi	Long	26.2	85.6	4.1	8.4	6.3	704	2090
Ragalli shivalli	Early	26.6	79.1	4.1	6.8	7.0	662	2000
Gaddi ragi	Long	25.7	103.0	4.9	9.3	5.7	616	2780
MEAN	**--**	**25.8**	**84.6**	**3.9**	**6.86**	**7.63**	**738.3**	**2300**
SEM	**--**	**0.9**	**4.4**	**0.4**	**0.4**	**0.4**	**47.6**	**200**
CD(0.05P)	**--**	**NS**	**12.4**	**NS**	**1.0**	**1.2**	**NS**	**506**
CV (%)	**--**	**11.3**	**16.4**	**33.0**	**14.5**	**18.9**	**20.4**	**27.2**

2013 - Two improved varieties CO-15 developed from TNAU, Coimbatore, and ML-365 from UAS, Bangalore, were, somehow, missed to be included in the mother trials of previous years. The local farmers were, however, had no knowledge about them in spite of being released varieties for the region. These two varieties were tested along with two popular local varieties (GPU-28 and INDAF) as checks during 2013. Out of 12 trials conducted, complete field data was available from 9 trials. The mean values of growth and yield parameters are presented in Table 4.3. Days to 50% flowering varied from 74 to 85 days, indicating CO-15 was earlier by 7 to 10 days as compared to INDAF and GPU-28. GPU-28 recorded maximum height of 97cm followed by CO-15 (86cm), ML-365 (85cm) and INDAF (83cm).There was not much variation with respect to tiller numbers and panicle length among the varieties. GPU-28 recorded the highest grain yield (1035 Kg/ac) followed by ML-365 (975.6 Kg/ac), INDAF (868Kg/ac) and CO-15 (862.5 Kg/ac). The incidence of finger blast disease was noticed only in CO 15. It could be seen in Table4.4 that ML-365 showed a yield advantage of 12.32 % over INDAF but its yield was less (-11.11 %) as compared to GPU-28.

Table 4.4: Performance of finger millet varieties in mother trials at Anchetty, 2013

Varieties	Days to 50% flowering	Plant population /m^2	Plant height (cm)	Productive tillers	Finger length (cm)	Grain yield (Kg/ac)	Incidence of P&D**
CO-15	74	29	86	2.27	7.1	862.5	Blast
ML-365	82	28	85	2.43	8.1	975.6	Nil
INDAF	81	26	83	2.45	8.0	868.0*	Nil
GPU28	85	27	97	2.45	8.2	1035.0*	Nil

*Grain yield of INDAF from 5 trials and of GPU 28 from 4 trials; ** Pest and Diseases

Table 4.4: Comparison of yield performance of test varieties with check varieties, Anchetty 2013

Test variety	No. of trials	Yield performance (Kg/ac)		% increase	No of trials with yields		Check variety
		Test variety	Check variety		Increase	Decrease	
CO 15	4	980.0 (840-1200)	1035.0 (960-1560)*	-5.31	0	4	GPU-28
	5	792.0 (560-920)	868.0 (620-1240)	-8.76	2	3	INDAF
ML 365	4	920.0 (820-1340)	1035.0 (960-1560)	-11.11	2	1	GPU-28
	5	975.6 (820-1320)	868.0 (620-1240)	12.32	3	1	INDAF

*Figures in parentheses are range of mean values

Farmers' preference regarding the varieties studied is presented in Table 4.5. Majority of the farmers (70 %) indicated their first preference to ML-365 followed by INDAF (30 %). CO-15 got least preference because of its susceptibility to blast disease. The farmers indicated their interest in continuing with INDAF and GPU-28. But all the farmers, however, have indicated their willingness to grow ML-365 as a new variety. Hence, it was decided to evaluate its performance further in baby trials in the coming season.

Table 4.5: Farmers' preference for finger millet varieties in mother trials at Anchetty, 2013

Preference ranking	CO-15	ML-365	INDAF	GPU-28
1	0	7	3	0
2	0	3	3	4
3	0	0	0	0
4	10	0	0	0
Willingness to grow	0	10	--	--

ii) Baby trials

2012 - At Anchetty three varieties, namely, GPU-66, *Kempu ragi* and *Haluguli ragi* were evaluated in baby trials during 2012. The local checks included in the trials were GPU-28 and INDAF, both of which are improved varieties being cultivated by many farmers of the region. The crop suffered at initial stages due to lack of moisture but later recovered to the extent beyond the expectations. The average yield level of each variety was found to be very high and the performances of traditional varieties, *Kempu ragi* and *Haluguli ragi*, were found to be as good as those of improved varieties (Annexure-3). Promotion of all the three test varieties would certainly enhance varietal diversity in the site.

2013 - During 2013 there were 34 baby trials of *Saratha* at the site. This variety was tested against 4 farmers' varieties, namely INDAF, GPU-28, MR series and *Kempu ragi* as the checks. A different format was used for analyzing the yield data and farmers' feedback. The results indicated that yield performance of *Saratha* was less by 9.2 % than the overall performance of checks (Table 4.6). Its yield was found to be higher than *Kempu ragi* where both were tested in only one trial. Farmers' assessment was also in accordance with the quantitative data. The desirable traits of *Saratha* noticed by the

farmers are tolerance to dry spell and non-lodging, other aspects being more or less same as those of check varieties (Annexure-4(i)).

Table 4.6: Performance of Saratha variety of finger millet in baby trials, Anchetty 2013

Check Varieties	No of trials	Yield performance (Kg/ac)		% increase over check	No of trials with yield	
		Test variety	Check variety		Increase	Decrease
INDAF	18	905.1 (440-1200)*	996.6 (600-1360)	-9.2	4	13
GPU-28	12	758.3 (620-840)	843.3 (660-1020)	-10.1	4	8
MR	3	680.0 (500-820)	766.7 (740-780)	-11.3	1	2
Kempu ragi	1	820	740	10.8	1	0
Over all the checks	34	830.9 (440-1200)	914.7 (600-1360)	-9.2	10	23

*Values in parentheses are range of mean values

2014 - During 2014, two varieties, namely, GPU-66 and ML 365 were evaluated in baby trials. GPU-66 has been already evaluated in baby trials during 2012 and it could not be included in IRD in 2013 due to other reasons; but because of its inconsistent performance it was again included in the baby trials with available seed quantity. In general the crop growth suffered in most of the trials at initial stages due to lack of moisture but later recovered. The results of baby trials of both the varieties are shared below individually.

GPU 66 - There were 16 baby trials of GPU 66 at the site. The local checks included in the trials were INDAF varieties. The results indicated that the yields of GPU-66 were lower than the corresponding check varieties in all the trials. Overall performance in both grain and straw yield was less by 20.9 and 27.2 %, respectively, than that of checks (Table 4.7). Farmers' assessment was also in accordance with the quantitative data (Annexure 8(i)). While GPU 66 was assessed as similar to check variety in terms of duration, damage by grains during maturity and grain shattering, all the participating farmers noticed its grain and straw yields lower than their own varieties. However, majority of the farmers (87.5%) observed least lodging in GPU-66. It is assumed that inconsistent performance of GPU-66 might be due to it being sensitive to moisture stress, as similar opinion was expressed by the farmers of other sites. So it was not preferred by the farmers of Anchetty where rainfall pattern appear to be uncertain more frequently in recent years than in the past.

Table 4.7: Performance of GPU-66 variety of Finger millet in baby trials, 2014

S. No.	Yield parameters	No of trials	Performance of the trial		% increase	No of trials		Check variety
			Test variety	Check variety		INC	DEC	
1	Grain yield (kg/ac)	16	591 (440-720)*	748 (560-920)	-20.9	0	16	INDAF series
	Straw yield (kg/ac)	16	2165 (1400-2900)	2975 (1960-3940)	-27.2	0	16	

ML 365 – In all 71 baby trials of ML 365 were implemented during 2014 at the site. However, yield data was available for 62 trials, while farmers' opinion was recorded from 46 trials. The local checks included in the trials were INDAF series, GPU 28, MR, *Kempu ragi* and *Saratha*. The results indicated that grain yield performance of ML 365 was better than that of *Saratha*, but was less when compared to other four checks (Table 4.8). In the case of straw yield, it was found better than those of INDAF series. However, the differences in the yield levels were not very striking. Farmers' opinion indicated that ML 365 was similar to the check varieties in all the parameters except for grain and straw yield (Annexure 8 (ii)). Only 30 % of the participating farmers have saved seeds for the next season. As the performance of ML 365 was on par with the ruling varieties, all of which happen to be high yielders, it can be considered as a good alternative and can be promoted in the coming years.

Panicle of ML- 365

Table 4.8: Performance of ML-365 variety of Finger millet in baby trials, 2014

S. No.	Yield parameters	No. of trials	Performance of the trial		% increase	No of trials		Check variety
			Test variety	Check variety		INC	DEC	
1	Grain yield (kg/ac)	43	705 (540-900)*	734 (500-920)	-4.00	12	31	INDAF series
	Straw yield (kg/ac)	43	2753 (1700-3900)	2881 (1960-3940)	-4.44	11	32	
2	Grain yield (kg/ac)	3	720 (560-860)*	766 (620-900)	-6	0	3	GPU-28
	Straw yield (kg/ac)	3	2606 (2120-3140)	2980 (2740-3220)	-12.5	0	3	
3	Grain yield (kg/ac)	14	711 (560-840)*	708 (560-920)	0.42	6	8	MR
	Straw yield (kg/ac)	14	2834 (2160-3420)	2961 (2320-3860)	-4.2	3	11	
4	Grain yield (kg/ac)	1	880	800	10	1	0	*Saratha*
	Straw yield (kg/ac)	1	2760	3000	-8	0	1	
5	Grain yield (kg/ac)	1	740	800	-7.5	0	1	*Kempu*
	Straw yield (kg/ac)	1	2580	2880	-10.4	0	1	

iii) Informal research and development (IRD)

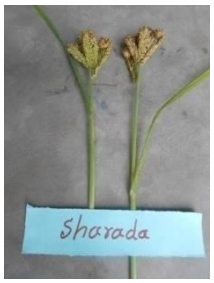
2013 - During 2013 three varieties of finger millet, namely GPU-66, *Kempu ragi* and *Haluguli ragi* were planned for wider dissemination through IRD, but due to non availability of sufficient seeds of GPU-66 the seeds of only other two varieties were distributed to the farmers.

Kempu ragi - The farmers' feedback information was collected from 29 trials. The results are furnished in Annexure 7(i). Assessments of the participating farmers were based on their perception of

Kempu ragi in respect of its growth and yield performances as compared to their own varieties, namely INDAF, GPU-28, and *Saratha. Kempu ragi* matured 10 to 15 days earlier than the checks. Its grain and straw yields were higher and panicle size bigger as compared to INDAF. It showed less lodging and grain shattering compared to the local varieties, but majority of the farmers, more than 50 %, opined that it is same as their own variety in tolerance to dry spell, grain yield and colour preference. Many of them (75.6%) indicated their willingness to save its seed for growing the crop next season.

Haluguli ragi - More than 40 farmers were provided with seeds of *Haluguli ragi* during 2013 for its evaluation against their own variety. Feedback from 33 farmers was available for analysis of their assessment. The results are furnished in Annexure 7(ii). Assessments of the participating farmers revealed that *Haluguli* failed to get desired preference on many aspects. In many cases the crop was lodging, showed less tolerance to dry spell, damage by rains at maturity and grain shattering, according to farmers' opinion ranging from more than 20 to 40%. As its yields were also not much higher than their own varieties, only about 14 farmers saved its seeds for future use.

2014 - During 2014, the seeds of *Saratha* and *Kempu ragi* varieties were distributed for wider dissemination through IRD and popularization, respectively. Farmers' feedback on the performance of these two varieties is as follows.



Saratha - About 85 farmers were provided with seeds of *Saratha* during 2014 for evaluation on their own fields. Feedback from 50 farmers was available for analysis of their assessment and the results are furnished in (Annexure 9(i)). According to the participating farmers *Saratha* was early in duration when compared to their check variety by 10 to 15 days and similar in terms of tolerance to dry spell and color preference. But on other aspects like lodging, damage by rains during maturity and grain shattering its performance was found to be poorer than the check variety. With respect to grain yield majority of the farmers observed that *Saratha* is giving lower yields than their check variety and higher in the case of straw yield. As the grain yield was lower, only about 30 % of the farmers saved seeds of *Saratha* for future use. Even though grain yield of *Saratha* is lower than the check varieties, it has consistently fared better in terms of the weight per unit volume and flouring percentage. These are the reasons behind the interest of farmers to grow *Saratha* in 2014 where it was introduced in 2013. Considering these aspects, *Saratha* needs further promotion in coming years in and around the working villages.

Kempu ragi - About 350 farmers were provided with seeds of *Kempu ragi* for popularizing the farmers' preferred variety. Out of them, 327 farmers have tried on their fields. Feedback from 50 farmers was available for analysis of their assessment and the results are furnished in Annexure 9(ii). Majority of the participating farmers observed that *Kempu ragi* was slightly earlier in duration as compared to their own varieties. On other aspects like tolerance to dry spell, lodging, damage by rains during maturity, grain shattering and colour preference it was similar to farmers' varieties. With respect to grain yield and straw yield majority of the farmers observed that *Kempu ragi* is almost same or better than their own varieties. Though only about 38 % of the farmers saved seeds of the particular variety as some mixtures were observed in the crop of some fields. Field staff noticed wider acceptance

of the variety in the site as there was increased demand for its seeds. Given the consistent performance of *Kempu ragi* in the last 3 years and wider acceptance, it needs further promotion even in the neighbouring villages of the project site.

iv) Synthesis of Finger Millet PVS Trials in Anchetty

Unlike in other project sites, only improved varieties of finger millets are cultivated in Anchetty; but there is lack of varietal diversity. Presently most of the cultivated area is under GPU-28 followed by INDAF series. There are only 2 local varieties being cultivated by few farmers in a particular village. Dependence only on 1 or 2 varieties might pose higher risks, especially under changing rainfall pattern as visualized in recent years. However, it was possible to identify *Kempu ragi*, *Saratha* and ML-365 through PVS during the project period, which involved testing of 8 local varieties and 13 released varieties (Table 4.9). The results have clearly shown *their* superior performance which is on par with the existing high yielding GPU-28. Now farmers have many options and access to good quality seeds of these varieties needs to be ensured to harness the advantages of enhanced varietal diversity.

Table 4.9: Synthesis of finger millet PVS trials in Anchetty, 2011-2014

Type of variety	2011	2012		2013			2014		Output
	Mother trial	Mother trial	Baby trial	Mother trial	Baby trial	IRD	Baby trial	IRD/ Popularising	FPV* identified
Traditional	*Kempu ragi, Bonda ragi, Picha gaddi, Haluguli ragi, Ragalli shivalli*	*Karungaddi, Gaddiragi, Bonda ragi, Pichagaddi, Ragalli shivalli, Saratha*	*Kempu ragi, Haluguli*	--	*Saratha*	*Kempu ragi, Haluguli ragi*	--	*Kempu ragi, Saratha*	*Kempu ragi, Saratha*
Released	CO-7, CO-9, CO-10, CO-11, CO-12, CO-13, CO-14, GPU-28, GPU-67, GPU-66	CO-13, CO-14, GPU-67, GPU-28,	GPU-66	CO-15, ML-365, INDAF, GPU-28		--	ML 365, GPU-66		ML 365
Total	**15**	**10**	**3**	**4**	**1**	**2**	**2**	**2**	**3**

*FPV - Farmers' preferred variety

4.1.2 Project Site: Jawadhu Hills

At this site finger millet is the second important crop after little millet and is being cultivated mainly for home consumption. Only two local varieties of finger millet, *Muttan* and *Perun kelvaragu,* are under cultivation in the region showing too low varietal diversity. Considering the importance of the crop and prevalence of suitable agro-climatic situations for finger millet in the site, increasing varietal diversity through introduction of suitable high yielding varieties was the purpose to initiate PVS activities at this site.

i) Mother Trials

2011 - During 2011, there were 12 mother trials with 7 varieties, two local and 5 improved ones. However, it was not possible to collect data on growth parameters, while data on grain yield was

available only from 7 trials (Table- 4.10). As a result, no decision was taken on the suitability of any variety tested.

2012 - However, the necessary precautions were taken during 2012 trials, wherein 10 varieties were tested. In addition to un-replicated trials one replicated trial (RCBD) was also conducted in one of the farmer's field. In general, the crop in most of the trials suffered due to lack of moisture during early stage of growth. Mean values of growth and yield parameters for 8 varieties are given in Table- 4.11, as the crops of two local varieties failed due to poor quality of seeds. The varieties showed significant differences only for finger length and grain yield, while the differences noticed in other parameters were statistically not significant. GPU-28 recorded the highest grain yield (687.0 kg/ac) followed by GPU-66 (599.3 kg/ac) and *Kempu ragi* (588.6 kg/ac). The remaining varieties, except PR-202 and L-5, were also found to be good yielders.

Table 4.10: Yield performance of finger millet varieties in mother trials at Jawadhu Hills, 2011

Variety	GPU-28	GPU-66	GPU-67	Muttan kelvaragu	Perun kelvaragu	L-5	VL-149
Grain yield (kg/ac)	680	400	530	800	490	700	…

Table 4.11: Performance of finger millet varieties in mother trials at Jawadhu Hills, 2012

Varieties	Growth and Yield Parameters						
	Plant population/ m^2	Plant height (cm)	Productive tillers /plant	Finger length (cm)	No. of fingers	Grain yield (kg/ac)	Straw yield (Kg/ac)
Ragalli shivalli	62.0	78.5	2.3	6.1	6.1	536.4	5140
GPU-28	62.6	76.1	2.0	6.6	6.1	687.0	4990
Saratha	52.2	79.6	1.9	6.1	6.4	562.1	4800
PR-202	50.1	71.1	1.5	5.2	5.4	452.1	4410
L-5	64.9	75.4	1.9	6.3	6.4	473.6	4670
Haluguli	61.7	74.4	1.9	6.4	5.7	555.7	5360
Kempu ragi	60.2	77.3	2.1	7.1	6.1	588.6	4860
GPU-66	58.3	75.9	2.1	6.6	6.1	599.3	5010
MEAN	**58.99**	**76.0**	**1.96**	**6.29**	**6.03**	**556.9**	**4910**
SEM	**3.55**	**3.08**	**0.2**	**0.31**	**0.33**	**37.14**	**22.80**
CD (0.05P)	**NS**	**NS**	**NS**	**0.9**	**NS**	**104**	**NS**
C.V %	**22.5**	**15.4**	**38.08**	**18.29**	**20.27**	**24.96**	**17.39**
CD for places	**13.2**	**11.4**	**0.7**	**1.1**	**1.2**	**138**	**850**

On the other hand, the results of replicated trial indicated significant differences among the varieties for all the parameters except for number of fingers and straw yield (Table-4.12). The yield levels were also higher than that of un-replicated mother trials, as the crop in RCBD trial was given with the recommended dose of NPK nutrients. *Kempu ragi* recorded the maximum yield of 911.3 kg/ac, which was found to be on par with the yields of GPU-28, *Haluguli ragi* and *Saratha* varieties.

Table 4.12: Performance of finger millet varieties in replicated mother trial (RCBD) at Jawadhu Hills, 2012

Varieties	Growth and Yield Parameters						
	Plant Population /m^2	Plant height (cm)	Productive tillers/ plant	Finger length (cm)	No. of fingers	Grain yield (kg/ac)	Straw yield (Kg/ac)
GPU-28	56.7	57.0	1.7	6.0	4.7	866.7	3000
L-5	61.7	55.3	1.0	5.7	3.7	742.0	2900
GPU-66	59.0	50.7	2.0	5.3	4.3	689.0	2800
PR-202	47.7	48.7	2.0	5.0	4.7	644.7	2530
Ragalli shivalli	40.3	47.3	1.0	5.0	4.0	689.0	2800
Kempu ragi	38.3	54.3	2.0	4.7	4.0	911.3	3030
Saratha	44.3	62.3	1.3	5.0	4.7	767.0	3000
Haluguli	34.7	63.0	1.0	6.7	4.0	822.0	2800
MEAN	**47.8**	**54.83**	**1.50**	**5.42**	**4.25**	**766.5**	**2860**
SEM	**4.76**	**0.78**	**0.10**	**0.19**	**0.22**	**54.80**	**15.70**
CV %	**17.24**	**2.47**	**18.54**	**6.21**	**14.86**	**12.37**	**9.52**
CD for var	**14.4**	**2.4**	**0.5**	**0.6**	**NS**	**166.0**	**NS**

As per FPA, GPU-28, *Ragalli shivalli*, GPU-66 and *Kempu ragi* were the most preferred varieties in that order (Annexure-2). Interestingly, there is good agreement between the quantitative analysis and FPA, as GPU-28, *Kempu ragi* and GPU-66 emerged as the most suitable varieties for Jawadhu Hills region.

ii) Baby Trials

2013 - Four identified varieties of finger millets, namely GPU-28, *Kempu ragi*, GPU-66 and *Ragalli shivalli*, were evaluated against two local varieties, *Muttan* and *Perun kelvaragu*, during 2013. Except for GPU-28 the number of trials for other 3 varieties were very few due to various reasons like insufficient seed quantity (GPU-66), change in farmers' decisions depending on the rainfall pattern and crop failure in some of the trials (Table 4.13). All the 4 test varieties recorded increased yields, both grain and straw, and values of per cent increase varied from 1.9 to 48.0 for grain yield and from 5.8 to 40.6 for straw yield over the mean values of two checks. Realization of yield advantage was considerably high in case of GPU-28 (58%) and *Kempu ragi* (41.3%). Farmers' perception regarding each variety was also recorded and the results are presented in separate tables (Annexure-4(ii-v)). In their opinion GPU-28 and *Kempu ragi* were the most preferred varieties because of their desirable traits such as high yielding ability, grain colour, resistance to blast and more or less of equal duration as their local varieties. Some of the farmers (more than 30%) also indicated more lodging, damage by rains and grain shattering at the time of maturity, especially in GPU-28 and *Kempu ragi.* Two farmers opined that GPU-66 is less tolerant to dry spell as compared to their varieties. Majority of them (more than 90%), however, expressed their willingness to grow these varieties. Considering the presence of only two local varieties in the site further evaluation of GPU-66 and *Ragalli shivalli* on more number of fields might help to enhance varietal diversity.

Baby trial of GPU 28 in Jawadhu Hills

Table 4.13: Performance of four finger millet varieties in baby trails, J. Hills, 2013

Test variety	Yield parameters	No of trials	Yield performance (Kg/ac)		% increase over check	No of trials showing		Check variety
			Test variety	Check variety		Increase	Decrease	
GPU-28	Grain yield (Kg/ac)	19	885.8 (634-1024)	560.8 (440-674)	58.0	18	1	*Muttan* *Perun - kelvaragu*
	Straw yield (Kg/ac)		4704.4 (1786-6570)	3344.8 (1860-5264)	40.6	17	2	
Kempu ragi	Grain yield (Kg/ac)	4	811.0 (636-954)	574.0 (536-610)	41.3	4	0	*Muttan* *Perun - kelvaragu*
	Straw yield (Kg/ac)		4737.5 (3086-5500)	3718.5 (2244-5264)	27.4	4	0	
Ragalli shivalli	Grain yield (Kg/ac)	5	620.8 (554-724)	568.0 (502-612)	9.3	4	1	*Muttan* *Perun - kelvaragu*
	Straw yield (Kg/ac)		3785.6 (2734-4800)	3578.0 (2660-4192)	5.8	4	1	
GPU-66	Grain yield (Kg/ac)	3	528.0 (502-568)	518.0 (450-600)	1.9	2	1	*Muttan* *kelvaragu*
	Straw yield (Kg/ac)		3588.0 (1786-5988)	3322.0 (2196-4844)	8.0	2	1	

iii) Informal research and development (IRD)

During 2014 three varieties of finger millet, namely GPU-66, GPU-28 and *Kempu ragi* were planned for wider dissemination through IRD and the results are shared below.

GPU 28 – Considering the impressive performance of GPU-28 during previous years, its seeds were distributed to 505 farmers of 59 villages in 5 *panchayats*. Performance results based on the feedback from 50 farmers are presented here. About 60% of the participating farmers found that GPU 28 variety was of the same duration as that of the local varieties (Annexure 9 (iii)). But on all other aspects like colour preference, tolerance to dry spell, lodging, damage by rains during maturity and grain shattering it was better. Majority of farmers (more than 50%) expressed that grain and straw yields of GPU-28 were better when compared to their own varieties. All the participating farmers were willing to try this variety next year, thereby indicating their positive feedback. Considering the spectacular performance of GPU 28 over the years, it needs further promotion in coming years so as to enhance varietal diversity in the site.

Kempu ragi - The seeds of this variety were distributed to 50 farmers in 20 villages of 5 panchayats during 2014. Based on the feedback information from 30 farmers *Kempu ragi* was found better than the local varieties with respect to tolerance to dry spell, lodging, damage by rains during maturity and grain shattering (Annexure 9(iv)). In the opinion of farmers *Kempu ragi* was either on par or better than their varieties as far as yield, duration and grain colour were considered. All the participating farmers were willing to try this variety next year, thereby indicating their positive feedback. Considering the better performance of *Kempu ragi* for past three years and also a popular traditional variety known for its taste it could enrich the local varietal diversity and needs further promotional activities.

GPU 66 - The seeds were distributed to 50 farmers from 18 villages in 4 panchayats for promotion, though the performance of the variety was found to be on-par or slightly better than the local varieties in 2012 & 2013. Opinion data was collected from 30 farmers (Annexure 9(v)). About 63% of the participating farmers found that GPU 66 matured earlier than the prevailing varieties. While GPU 66 was similar to the check variety in the case of colour preference, in many other aspects like tolerance to dry spell, lodging, damage by rains during maturity and grain shattering it was better. With respect to grain and straw yield GPU 66 was almost same or better than the check variety. All the participating farmers were willing to try this variety next year, thereby indicating their positive feedback. Considering the performance of GPU 66 variety for past three years, though it did not have striking advantages over the check varieties it needs to be considered as a good alternative and can be promoted in 2015.

iii) Synthesis of finger millet PVS trials in Jawadhu Hills

In three years 6 local varieties and 6 released varieties variety were tested through PVS trials (Table-4.14). Based on the results of the trials 3 varieties (GPU-28, GPU-66 and *Kempu ragi)* are suggested for promotion in the site. Baby trials were very few during 2013; but by reaching large number of farmers during 2014, it was possible to confirm their superior performance. Out of two local varieties *Muttan kelvaragu* appears to be more potential and with the additional 3 most preferred varieties identified, local farmers could feel better now to cultivate the variety of their choice.

Table 4.14: Synthesis of finger millet PVS trials in Jawadhu Hills, 2011-2014

Type of variety	2011	2012	2013	2014	Output
	Mother trial	Mother trial	Baby trial	IRD	FPV* identified
Traditional	*Muttan kelvaragu, Perun kelvaragu*	*Kempu ragi, Ragalli shivalli, Haluguli ragi, Muttan kelvaragu, Perun kelvaragu, Saratha*	*Kempu ragi, Ragalli shivalli*	*Kempu ragi*	*Kempu ragi*
Released	L-5, VL-149, GPU-28, GPU-67, GPU-66	PR-202, L-5, GPU-28, GPU-66	GPU-28, GPU-66	GPU-28, GPU-66	GPU-28, GPU-66
Total	**7**	**10**	**4**	**3**	**3**

*FPV- Farmers' preferred variety

4.1.3 Project Site: Bero

The site is blessed with plain fields with more fertile soils and assured rainfall; the productivity of finger millet crops is relatively high. The local varieties which are about 4 in number are losing their identity, except *Gibra,* a long duration variety, due to lack of seed selection practice by the local farmers. Farmers can realize better yields of finger millet if good quality seeds of high yielding varieties are available to needy farmers at right time.

i) Mother trials

2011 - There were 25 mother trials at this site during 2011, while complete experimental data was available only from 11 trials due to lack of proper planning of on-farm trials. The trials had two local

varieties, *Demba* and *Gibra*, and four improved varieties. The mean values of growth and yield parameters are presented in Table-4.15. Maximum average grain yield of 660 Kg/ac was noticed in A-404 followed by *Gibra* (620 Kg/ac), *Demba* (540 Kg/ac) and GPU-28 (480 Kg/ac). *Demba* produced highest straw yield and BM-2 the least, while it was more or less same in other varieties.

Table 4.15: Performance of finger millet varieties in mother trials at Bero, 2011

Sl. No.	Variety	Days to 50% flowering	Plant population /m^2	Plant height (cm)	No. of tillers/ Panicle	Length of panicle (cm)	No. of fingers/ panicle	Grain yield (Kg/ac)	Straw yield (Kg/ac)
1.	A-404	87	45	99.0	2.5	6.3	6.8	660	1480
2.	GPU-28	92	38	87.3	2.1	7.7	7.3	480	1430
3.	JWM-1	86	43	79.0	1.7	6.3	6.6	410	1400
4.	BM-2	83	41	68.8	1.9	5.8	6.5	370	1120
5.	*Demba*	88	39	86.3	2.2	7.0	7.3	540	1510
6.	*Gibra*	96	38	84.7	2.6	6.5	7.0	620	1300

Two FPA were conducted in mother trials located at Chairma and Rogo villages and the details of the locations and results are given in Annexure-1b (i, ii). At Chairma village, A-404 recorded the highest overall preference score of 33, as 7 and 6 farmers out of 15 each indicated 1st and 2nd preference, respectively for this variety. GPU-28 was the second most preferred variety with 30 overall scores as it recorded 6, 5, and 2 scores in 1st, 2nd, and 3rd rankings, respectively. Though the remaining 4 varieties got low overall preference score values ranging from 2 to 13, as compared to A-404 and GPU-28, it is interesting to note that farmers were able to identify some desirable traits in each of them. What traits of a particular variety attracted the farmers was made available through FGD, where each farmer was allowed to express his/her opinion. The outcome of the discussion is as follows. Majority of the farmers look for high yielding early maturing varieties with uniform crop stand. The farmers with irrigation facility would like to cultivate Rabi crop after finger millet, hence more preference for early varieties. *Gibra* is a long duration local variety but preferred by a small number of farmers because of its tastiness. A-404: uniform maturity, early duration, big panicle and grain size, taste; GPU-28: Big panicle size, uniform; *Demba*: Big panicle size, vigorous but lot of mixtures; JWM-1: Earliness, grain color (white grain), taste; BM-2: Earliness; *Gibra*: late duration but more tasty grains.

The results of second FPA held at Rogo village, however, gave a slightly different picture of farmers' preference. JWM-1 was the most preferred variety as 10 out of 24 farmers indicated their 1st preference to this variety because of its earliness, white bold grains and uniform crop stand. It recorded the highest overall preference score (40) followed by A-404 (39), and *Demba* (27). GPU-28 was not the first choice of any farmer here but at least 5 farmers indicated their 2nd and 3rd preference each for the variety. Another local variety *Gibra* too got good overall preference score (15) at this village. In the opinion of farmers late duration is desirable, as harvesting of *Gibra* did not coincide with that of rice crop, thereby reducing the work load during harvesting period. In addition, it has long panicle size with more number of grains and tasty. According to Dr. Haider, scientist from BAU, *Gibra* variety is usually maintained by the big farmers because of its taste but there is possibility of chaffy or shriveled grains due to moisture stress in the later stage of crop growth. Finger blast disease incidence is also noticed in this variety. The reasons, given by the farmers of Rogo village, for equally preferring A-404

were same as that of earlier group and they also informed that the variety might be resistant to grain shattering.

2012 - During 2012, 9 varieties of finger millet were tested in mother trials, one of them being replicated trial (RCBD). The data for *Gibra* and JWM-1, however, was not available from mother trials. The results of both the trials indicated not much variation in the performance of the varieties, while the differences found in the values were statistically significant only for finger length, finger number and plant height (Table-4.16 and 4.17). However, based on numerical values, GPU-66 (1156.7, 1022.0 kg/ac), *Lohardahiya* (1120, 866.7 kg/ac), *Hybrid*[3] (1076.7, 1226.7 kg/ac), GPU-67 (956.3, 998.0 kg/ac) and *Demba* (1006.7, 933.3kg/ac) could be considered as good yielders.

Table 4.16: Performance of finger millet varieties in mother trials at Bero, 2012

Varieties	Growth and Yield Parameters						
	Plant height (cm)	Plant Population/m^2	Productive tillers per plant	Finger length (cm)	No. of fingers	Grain yield (kg/ac)	Straw yield (Kg/ac)
Demba	92.8	20.8	3.2	6.8	6.2	1006.7	2240
Lohardahiya	88.8	20.3	3.0	6.3	5.8	1120.0	3240
Hybrid[1]	93.9	20.7	2.8	8.0	6.8	1076.7	2590
A-404	95.3	21.0	2.8	5.8	5.5	920.0	1780
GPU-28	92.5	21.7	2.5	7.5	5.8	1080.0	2450
GPU-66	96.3	20.1	2.7	7.5	6.5	1156.7	2700
GPU-67	83.1	20.1	3.1	5.8	5.8	956.3	2570
MEAN	**91.8**	**20.7**	**2.9**	**6.8**	**6.0**	**1045.2**	**2510**
SEM	**5.1**	**0.9**	**0.2**	**0.3**	**0.2**	**72.5**	**31.0**
CD(0.05P)	**NS**	**NS**	**NS**	**0.9**	**0.6**	**NS**	**NS**
CV (%)	**19.1**	**15.8**	**25.8**	**16.1**	**13.0**	**24.0**	**42.9**

Table 4.17: Performance of finger millet varieties in replicated mother trial (RCBD) at Bero, 2012

Varieties	Growth and Yield Parameters							
	Plant Population/ m^2	Plant height (cm)	Productive tillers per plant	Finger length (cm)	No. of fingers	No. of ear heads	Grain yield (kg/ac)	Straw yield (Kg/ac)
Gibra	24.0	122.3	4.0	16.0	6.3	5.7	955.3	6600
GPU-67	25.7	82.0	2.3	6.3	6.7	3.0	998.0	3770
Lohardahiya	23.3	109.0	3.0	7.3	7.0	5.0	866.7	4530
GPU-66	24.7	103.0	2.7	9.3	7.3	3.3	1022.0	4670
Hybrid[1]	24.7	105.3	2.3	10.7	8.3	4.0	1226.7	5530
GPU-28	24.0	108.7	2.0	8.7	7.0	3.0	844.3	3800
Demba	22.7	106.7	3.0	9.7	7.3	5.0	933.3	4670
A-404	24.0	97.7	3.0	6.3	6.0	5.0	944.3	3730

[3] Name given to the variety by the local people.

Varieties	Growth and Yield Parameters							
	Plant Population/ m^2	Plant height (cm)	Productive tillers per plant	Finger length (cm)	No. of fingers	No. of ear heads	Grain yield (kg/ac)	Straw yield (Kg/ac)
JWM-1	24.3	95.0	2.7	6.3	6.3	3.3	822.3	3700
MEAN	**24.1**	**103.3**	**2.8**	**9.0**	**6.9**	**4.1**	**957.0**	**4560**
SEM	**0.8**	**5.3**	**0.4**	**0.5**	**0.4**	**0.6**	**103.6**	**440**
CD (0.05P)	**NS**	**16.0**	**NS**	**1.6**	**NS**	**1.8**	**NS**	**1310**
CV (%)	**5.6**	**8.9**	**22.8**	**10.4**	**11.2**	**25.4**	**18.7**	**16.6**

Two FPA activities, one in mother trial and another in RCBD trial, were arranged at this site. Men and women groups, separately, participated in assessing the performance of the varieties. Interestingly, the outcome of both the analyses was found to be similar (Annexure-2). Farmers' preferred varieties were GPU-66, GPU-67, *Hybrid* and GPU-28. It appeared that farmers were interested in higher grain yields but some farmers expressed their preference for short duration varieties and varieties with white grain colour like JWM-1.

ii) Baby trials

2012 - Two improved varieties, A-404 and GPU-28, identified as the most promising ones during last year, were evaluated in baby trials during 2012 against four different traditional varieties that are being cultivated by the local farmers (Annexure-3). Average grain yield recorded in A-404 was 1156 Kg/ac as against 952 Kg/ac of local checks. GPU-28 also recorded higher yields (736 Kg/ac) than average yields of local checks (610 Kg/ac) included in the trials. The yield advantages in both the varieties workout to be more than 20% over the local varieties. Most of the farmers preferred both the varieties because of their high yielding ability. The other traits that attracted the farmers were the uniform crop stand and big panicle size, especially of GPU-28. Interestingly, the results of these trials revealed that the local varieties are also equally potential.

Baby trial of GPU 28 in Bero

2013 - During 2013, performances of additional two improved varieties, (GPU-66 and GPU-67, identified during 2012), were evaluated against farmers' varieties. Out of total 50 planned baby trials data was available from 38 trials and the same has been analyzed to draw inferences (Table-4.18). GPU-66 has recorded a marginal increase (3.74%) over farmers' check varieties. However in 50% of the baby trials, it showed increased grain yield over farmers' check variety. GPU-67 has performed well and recorded a significant increase (12.10%) in yield over farmers' check varieties. GPU-67 has recorded higher yield in comparison to farmers' check variety in 52.63% of the baby trials. GPU-66 and GPU-67 have recorded more straw weight (13% & 17.8%) than farmers' check varieties. As many as 24 and 25 farmers realized higher grain yields from GPU-66 and GPU-67, respectively, than their own varieties.

Table 4.18: Performance of GPU-66 and GPU-67 varieties of finger millet, Bero, 2013

Yield parameters	Test variety GPU66	Test variety GPU67	Check variety
Grain yield (Kg/ac)			
Mean	589.84	637.37	568.57
Range	200 -1320	240 – 1280	180 – 1160
% increase over check	3.74	12.10	
Number of trials with			
Increase yield	19 (50)*	20 (52.63)	
Decrease yield	19 (50)	18 (47.37)	
No change	0	0	Not applicable
Straw yield (Kg/ac)			
Mean	1930	2012.11	1708.57
Range	480 – 5060	460 – 5560	480 – 5200
% increase over check	13	17.8	
Number of trials with			
Increase yield	24 (63.16)	25 (65.79)	
Decrease yield	12 (31.58)	13 (34.21)	
No change	2 (5.26)	0	Not applicable
Farmers' opinion (%)			
Preferred	33 (89)	29 (80.56)	
Not preferred	4 (11)	7 (19.44)	Not applicable

* Figures in parentheses are percent values

Farmers' perception on test varieties was also recorded against eleven different parameters (Annexure-4 (vi & vii)). Most of the farmers were convinced that both the test varieties are high yielders as compared to their own varieties and more than 80% of them saved the seeds of these varieties for using during next cropping season. GPU-67 is earlier in maturity by 8-10 days while GPU-66 is of same duration as the local varieties. The two varieties were considered as similar as or even better than their varieties in respect of tolerance to dry spell, lodging and damage by rains, grain shattering, and straw yield according to the perception of majority of the farmers.

Farmers mentioned the desirable characteristics of GPU-67, such as uniform height, closed panicles which do not allow rain to enter and damage the grain, bold and hard grain, more number of tillers, less husk while processing, easier to harvest because of uniform height. GPU-66 got big panicle size with long fingers, more number of panicles, and good yield even in less rainfall. A few of them also reported some drawbacks of GPU-66. It has got less number of tillers and lodging problem. Male farmers felt that it is easier to harvest because of its tall plant height, unlike in GPU-67, but when lodging occurs harvesting will be laborious.

2014 - In addition, another improved variety from BAU, Ranchi, namely BBM-10 was considered for baby trial during 2014. This variety was suggested by the Scientist from BAU during 2013 and with limited seed quantity its crop was raised in the fields of two farmers in the same year. Its performance attracted the attention of the local farmers because of its big panicle size and high yielding ability. There were 32 baby trials during 2014. However the correct picture of its performance was not available due to insufficient field data. Hence it needs to be evaluated further during 2015 for its suitability for the site.

iii) Informal Research and Development (IRD)

2013 - A total of 200 farmers were supplied with seeds of A-404 and GPU-28 to raise crop in their fields during 2013. Finally 73 farmers growing A-404 and 84 farmers of GPU-28 were available for getting feedback on the performance of the test varieties. In addition, yield data of test variety and as well as that of farmer's variety was also collected from 18 fields of A-404 and 11 fields of GPU-28 in order to assess the relative performance based on the quantitative data (Table-4.19).

The results of yield assessment revealed that A-404 performed better than the farmers' varieties with 15.24% increased grain yield, while the yield performance of GPU-28 was not much impressive and recorded lower yields in 8 out of 11 trials. In general, overall yield levels of trials with GPU-28 (farmers' varieties as well) were lower than those with A-404 indicating improper sampling of fields for yield analysis. However, farmers' perception, which was based on larger sample size, regarding the performance of both the varieties was highly encouraging (Annexure-7 (iii & iv)). More than 80% of participating farmers opined that the grain yields of test varieties were found to be higher than their own varieties. About 50% of them also perceived higher straw yields from the test varieties. Majority of the farmers indicated their opinion as similar as or better than their own varieties with respect to other traits listed. The salient features of A-404, according to the farmers, are more tillers and long finger length. GPU-28 is characterized for its bigger panicle size and bold grains. Lodging has been observed in both the test varieties to the same extent as in the local varieties. Some farmers and also the field staff noticed yellowing of some tillers which fail to produce panicles in GPU-28. They attributed the symptom to the incidence of pests, which needs to be ascertained.

Table 4.19: Performance of A-404 and GPU-28 varieties of finger millet in IRD trials at Bero, 2013

Yield parameters	A-404	Check variety	GPU-28	Check variety
Grain yield (Kg/ac)				
Mean	754.44	655.56	490.91	523.64
Range	(400 – 1200)	(320 – 1080)	(160 – 880)	(200 – 880)
% increase over check	15.24	--	- 6.25	--
Number of trials with				
Increase yield	12		3	
Decrease yield	8		8	
No change	0		0	
Straw Weight (Kg/ac)				
Mean	1946.67	1857.78	1647.27	1669.9
Range	(1040 – 3200)	(480 – 4520)	(400 – 3200)	(560 – 3120)
% increase over check	4.78	--	- 1.35	--
Number of trials with				
Increase yield	10		3	
Decrease yield	7		7	
No change	1		1	
Farmers' opinion (%)				
Preferred	71 (97.26)		80 (95.24)	
Not preferred	2 (2.74)		4 (4.76)	

Almost all the participating farmers (more than 95%) showed willingness to grow the two test varieties in coming season, which in itself indicates the farmers' interests for improved varieties in addition to their own varieties for the region.

2014 - The additional two identified varieties, GPU-66 and GPU-67, were also included in IRD during 2014. There were 47 farmers who had the crop of GPU-66 and 247 farmers that of GPU-67 on their fields. Just for additional information yield performance of these varieties was also recorded from randomly selected fields, as many as 9 for GPU-66 and 36 for GPU-67 (Table 4.20). In majority of cases both the varieties recorded higher grain yields than the farmers' varieties, but straw yield values of farmers' varieties were much better. The results convincingly indicated that farmers could realize grain yield advantage up to 18 to 22% over their own varieties. Majority of the farmers indicated their preference for both the varieties like previous years.

Table 4.20: Yield performance of GPU-66 and GPU-67 under IRD at Bero, 2014

Yield parameters	Test variety GPU-66	Test variety GPU-67	Check variety
Grain yield (Kg/ac)			
Mean	888.9	860	730
Range	(520 – 1540)	(220 – 1600)	(480 – 1040)
% increase over check	21.77	17.8	--
Number of trials with			
Increase yield	6	21	
Decrease yield	3	15	--
No change	0	0	
Straw yield (Kg/ac)			
Mean	1913.3	1637.2	2135
Range	(960 – 3400)	(720 – 4300)	(1100 – 3280)
% increase over check	-10.4	-23.3	
Number of trials with			
Increase yield	5	28	
Decrease yield	4	8	
No change	0	0	--
Farmers' opinion (%)			
Preferred	8 (89%)	34 (95%)	
Not preferred	1(11%)	2 (5%)	--

Feedback from the participating farmers regarding the performance of these varieties in respect of different aspects was also recorded and same is given in Annexure 9 (vi- vii). According to majority of the farmers the performance of GPU-66 was found to be either same or better than their varieties with respect to duration, tolerance to dry spell or heavy rainfall, damage by rains during maturity, grain shattering, grain color, flour recovery and taste. Most farmers (89%) noticed less lodging in this variety. All the farmers opined that its grain yields were better than their own varieties while about 90% of them observed less straw yields.

Coming to GPU-67, its desirable features indicated by most of the farmers (more than 85%) were higher grain yield, high resistance to blast and least lodging as compared their own varieties. However, in case of the remaining traits assessed, except straw yield, majority of farmers expressed that GPU-67

performed either same or better than the local varieties. Like GPU-66 its straw yields were lower than the farmers' varieties in most of the cases (81%).

In order to popularize the two improved varieties, namely A-404 and GPU-28, which were identified as the farmers' preferred varieties through the first cycle of PVS, the seeds of A-404 were supplied to 315 farmers and that of GPU-28 to 234 farmers during 2014. As in case of IRD, 28 fields of A-404 and 31 fields of GPU-28 were selected randomly for collecting yield data in support of feedback information from the participating farmers. Yield performance of both the varieties is presented in Table 4.21 and the feedback was given in Annexure 9 (viii & ix). Though the results indicated that both the varieties showed yield advantage to the extent of about 5 to 9% over the farmers' varieties, the number of cases with higher values was about only half. Considering the maximum yields recorded as high as 1560 and 1460 Kg/ac for A-404 and GPU-28, respectively, as compared to 1040 Kg/ac of farmers' varieties the results revealed the higher yielding potential of both the test varieties.

Table 4.21: Yield performance of A-404 and GPU-28 varieties of finger millet at Bero, 2014

Yield parameters	Test variety A-404	Test variety GPU-28	Check variety
Grain yield (Kg/ac)			
Mean	832.1	765.2	730
Range	(360 – 1560)	(200 – 1460)	(480 – 1040)
% increase over check	9.2	4.8	--
Number of trials with			
Increase yield	14	15	--
Decrease yield	14	16	
No change	0	0	
Straw yield (Kg/ac)			
Mean	1504.3	1612.3	2135
Range	(660 – 3780)	(520 – 3000)	(1100 – 3280)
% increase over check	-29.5	-24.5	--
Number of trials with			
Increase yield	23	25	--
Decrease yield	5	6	
No change	0	0	
Farmers' opinion (%)			
Preferred	26 (93%)	31 (97%)	--
Not preferred	2 (7%)	1 (3%)	

When compared with the farmers' varieties A-404 was found to be earlier in maturity having higher level of resistance to blast disease and lodging, higher grain yielding ability and more taste, while its performance was either same or even better with respect to other traits according to majority of the farmers. On the other hand the farmers who had the crop of GPU-28 opined that its duration, tolerance to dry spell and flour recovery was similar to their varieties while many farmers noticed its better performance in tolerance to heavy rainfall (69% farmers), lodging (97%), resistance to blast (72%), grain yield (88%) and taste. However, GPU-28 was found to be same or even better than the local varieties with respect to tolerance to damage by rains during maturity, grain shattering and grain color. More than 60% of the farmers assessed lower straw yields in A-404 as well as in GPU-28.

In spite of the fact that there was not much yield advantage, especially in GPU-28, as per the quantitative data during 2014, almost all the farmers expressed their preference for both the varieties. The main reason being, apart from the test varieties possessing certain desirable traits mentioned above, the uniform and good crop stand of improved varieties due to better seed quality. While the crop of local varieties, which are usually being raised reusing the seeds of poor quality (farmers do not follow selection and grading processes), depict the scene of poor crop stand in most of the fields.

iv) Synthesis of Finger Millet PVS Trials in Bero

In four years 4 local varieties and 6 released varieties were tested in different PVS trials (Table- 4.22). The results of 4 cycles of PVS were highly encouraging for the site as four improved varieties of finger millet – A-404, GPU-28, GPU-66 and GPU-67, were identified as most preferred varieties and were well received by the local farmers. Farmers could realize yield advantage up to 15% from these varieties over the local varieties. BBM-10, a pre-release variety from the state agricultural university (BAU), was also found promising and needs further confirmation. Purification of all the local varieties is necessary to retain their identity; two of them, *Demba* and *Hybrid* varieties, have been found highly potential for the site. A sustainable mechanism to have easy access to quality seeds of these varieties and also of popular local varieties needs to be worked out.

Table 4.22: Synthesis of finger millet PVS trials in Bero site, 2011-2014

Type of variety	2011	2012		2013		2014		Output	
	Mother trial	Mother trial	Baby trial	Baby trial	IRD	Baby trial	IRD & populari -sing	FPV* identified	PV# for Further testing
Traditional	*Demba, Gibra*	*Demba, Gibra, Hybrid, Loharda hiya*	--	--	--		--	--	
Released	A-404, BM-2, GPU-28, JWM-1	A-404, GPU-28, GPU-67, JWM-1, GPU-66	A-404 GPU-28	GPU-67, GPU-66	A-404, GPU-28		A-404, GPU-28, GPU-67, GPU-66	A-404, GPU-28, GPU-67, GPU-66	
Pre-release	--		--		--	BBM - 10			BBM-10
Total	**6**	**9**	**2**	**2**	**2**	**1**	**4**	**4**	**1**

FPV- Farmers' preferred variety; PV- Potential variety

4.1.4 Project Site: Semiliguda

The site is characterized by high diversity of local varieties of finger millet but only 3-4 of them are more popular. Like in other sites the local varieties lack genetic purity resulting in poor yields. Though site comes under high rainfall zone with moderate soil fertility, crop productivity is very low. The presence of high yielding improved varieties is negligible. Identification of high yielding location-specific varieties and providing easy accessibility of quality seeds to the local farmers was one of the thrust interventions of the project at this site.

i) Mother Trials

2011 - At Semiliguda different varieties of both finger millet and little millet were evaluated in the same trials during 2011. However, the crop of little millet failed in most of the trials and varieties of finger millet also got affected in several cases. As Semiliguda each trial had different set of test varieties with varying numbers. The results from pooled data of as many as 21 varieties of finger millet, comprising improved and indigenous varieties, are presented in Table-4.23. The mean values of plant population varied from 25 to 89.8 per sq.m. It is observed that the plant density being practiced at this region is too high as compared to recommended practice. The varieties under test also showed considerable variation for pant height ranging from 27cm to112 cm. The values of tiller per plant varied from 1 to 2.67. Wide variation was observed in panicle size which was measured in terms of number of fingers per panicle (4 to 8.5), finger length (4.5cm to 10.5) and finger breadth (0.53 to 1.75). Values for grain yield varied from 180 to 960 Kg/ac, while straw yield from 800 to 3400 Kg/ac. *Kala kerenga* recorded the highest grain yield of 960 Kg/ac closely followed by *Sunamani* (900 Kg/ac) and *Mati* (840 Kg/ac). The yields of improved varieties, namely, Bhairabi, Chilika and Champavati were 660, 560 and 580 Kg/ac, respectively.

FPA was conducted in five localities and a large number of farmers, both men and women, participated. The feedback of individual farmers was collected at each locality and then the data was pooled for analysis of overall score. The details of FPA and the results are furnished in Annexure-1c (i, ii).

Table 4.23: Mean values of growth and yield parameters of finger millet varieties at Semiliguda, 2011

Sl. No.	Variety	Panicle Type	Duration	Plant popn/ m^2	Plant height (cm)	Tillers/ plant	No. of fingers/ panicle	Finger length (cm)	Finger width (cm)	Straw yield (Kg/ac)	Grain yield (Kg/ac)
1	*Badu*	Open	L	89.5	66.5	1.25	5.5	6.6	0.63	2580	660
2	*Madei*	Open	L	58.3	54.0	2.33	6.0	5.8	1.75	…	680
3	Chilika	Cmp	E	82.3	67.4	1.90	5.0	4.8	0.91	2220	560
4	Champavati	Cmp	E	68.5	65.8	1.20	5.3	5.2	0.97	1660	580
5	*Dudh Kerenga*	Semi-c	L	75.8	55.7	1.83	5.7	6.1	0.76	2060	640
6	*Bodel*	Semi-c	E	74.0	82.0	1.00	5.5	5.5	1.00	2500	660
7	*Sunamani*	Semi-c	E	89.8	83.3	2.50	6.0	5.0	0.66	2580	900
8	*Mami*	Cmp	L	79.7	67.0	1.00	5.0	5.5	0.75	2220	520
9	*Bati*	Semi-c	M	55.8	65.5	2.33	5.8	5.4	0.71	2300	720
10	*Bagha chhad*	Semi-c	L	57.8	48.7	2.00	4.8	5.5	0.77	2340	660
11	*Bhalu*	Semi-c	L	65.0	45.8	1.60	5.3	5.6	0.63	1980	380
12	*Sana*	Cmp	M	52.0	63.3	2.00	5.8	5.1	1.00	1360	400
13	Bhairabi	Cmp	E	79.2	68.0	1.54	5.3	4.9	0.85	1980	660
14	*Khada*	Semi-c	M	45.8	55.8	2.25	4.8	6.8	0.75	1540	480
15	*Mati*	Semi-c	M	45.3	56.0	2.67	5.0	6.0	0.67	2120	840
16	*Kala Kerenga*	Semi-c	L	45.0	37.0	2.00	5.5	5.8	0.53	3400	960
17	*Dinda*	Semi-c	L	32.5	87.5	1.50	8.5	10.5	0.63	3000	520
18	*Machhadim*	…	L	25.0	27.0	2.00	5.0	7.0	0.75	800	380

Sl. No.	Variety	Panicle Type	Duration	Plant popn/ m^2	Plant height (cm)	Tillers/ plant	No. of fingers/ panicle	Finger length (cm)	Finger width (cm)	Straw yield (Kg/ac)	Grain yield (Kg/ac)
19	*Marda*	Semi-c	L	68.0	59.0	1.00	…	…	…	1200	180
20	*Dasrabhodi*	Cmp	E	54.0	112.0	1.00	5.0	7.5	1.00	…	600
21	*Chaula*	Semi-c	L	62.0	63.5	1.50	4.0	4.5	1.00	…	…

Cmp- Compact; Semi-c- Semi compact; #E- Early; M- Medium; L- Long

The study clearly indicated that the recommended improved varieties, namely, Bhairabi, Champavati and Chilika are the most preferred varieties among the farming communities in the region. In the opinion of the farmers Bhairabi has got many desirable features like good growth and high yield even with less rainfall; early maturity, as a result they get more time to attend other activities after harvest; bigger size panicle, which is compact with more number of long fingers; and its grains are tastier than other varieties. In addition to these improved varieties, a few local varieties such as *Bati, Kala Kerenga, Bhalu, Sunamani, San mandia* and *Dasarabhodi* also recorded higher preference of some farmers. It is interesting to note that each of the varieties included in the analysis was preferred by one or other farmer, indicating the reason for vast diversity in the local germplasm of finger millet. Since the promising local varieties lack purity and some of them take long duration for maturity, it was decided to include only two improved varieties (Bhairabi and Chilika) in baby trials during 2012.

2012 - Mother trials of 2012, consisting 10 varieties of finger millet, 4 local and 6 improved, were well planned and conducted more systematically. Among them two were replicated trials (RCBD), one in the farmer's field and another in research farm. The results of mother trials in the farmers' fields across the site as well as that of RCBDs revealed considerable variation for growth and yield parameters among the varieties under test (Table-4.24, 4.25 and 4.26). In mother trials, GPU-66 had maximum average grain yield (626.8 kg/ac) closely followed by GPU-48 (596.9 kg/ac) and *Bati mandia* (578.5 kg/ac). GPU-48, GPU-66, GPU-67 and GPU-28 were top yielders in RCBD conducted in the farmer's field, while Bhairabi, GPU-66 and GPU-48 were found to be top yielders in RCBD trial at CPR, Berhampur. However, grain yields recorded in *Mati, Kala kerenga*, Chilika and GPU-28 in both the RCBDs were also high and the values were found to be on par with the highest values. High plant population and big panicle size appear to be the contributing factors for high yields in these varieties. It is to be noted that plant population density followed by the farmers of this site was too high as compared to other sites.

Field layout of mother trial of finger millet in Semiliguda

Table 4.24: Mother trial of finger millet at Semiliguda, 2012

Varieties	Growth and Yield Parameters						
	Plant popn/m^2	Plant height (cm)	Productive tillers/plant.	No of fingers/ panicle	Finger length (cm)	Grain Yield (Kg/ac)	Straw yield (Kg/ac)
Mati	82.1	71.7	2.1	4.7	5.1	487.5	1070
Bati	83.1	68.9	1.9	4.8	5.1	578.5	1180
Kala karenga	77.5	76.8	2.2	6.1	6.7	490.8	1240
Sunamani	86.7	68.6	1.8	4.9	5.4	439.2	920
Bhairabi	74.7	63.3	2.1	4.6	4.8	521.4	1030
Chilika	84.7	72.2	2.1	5.1	5.2	490.9	1080
GPU-28	84.0	72.1	2.1	5.8	6.3	499.0	1090
GPU-48	86.3	71.9	2.1	5.6	6.0	596.9	1060
GPU-66	85.8	73.7	2.3	5.8	6.4	626.8	1070
GPU-67	78.1	60.2	2.1	5.1	5.1	481.4	930
MEAN	**82.3**	**70.0**	**2.1**	**5.2**	**5.6**	**521.2**	**1070**
SEM	**3.9**	**2.9**	**0.1**	**0.2**	**0.2**	**35.8**	**50**
CD (0.05P)	**NS**	**8.0**	**NS**	**0.5**	**0.7**	**100.0**	**130**
CV (%)	**20.3**	**17.4**	**29.4**	**15.6**	**17.6**	**29.1**	**18.2**

Table 4.25: Replicated mother trial of finger millet at Semiliguda, 2012

Varieties	Growth and Yield Parameters							
	Days to 50% Flowering	Plant popn/m^2	Plant height (cm)	Productive tillers /plant	Panicle length (cm)	Number of fingers	Grain yield (Kg/ac)	Straw yield (Kg/ac)
Mati	92.3	71.0	79.7	2.7	7.7	6.0	1129.7	3100
Bati	74.3	78.0	68.3	3.3	5.0	6.0	952.0	1570
Kala karenga	96.7	83.7	83.0	3.3	6.0	6.0	1142.3	3370
Sunamani	87.0	68.0	79.0	2.3	5.3	6.0	882.0	1000
Bhairabi	79.0	77.0	68.0	2.3	5.0	4.0	799.3	870
Chilika	82.0	69.3	79.7	2.7	5.3	6.3	1085.3	1330
GPU-28	83.0	88.0	84.7	2.7	7.7	6.3	1225.0	970
GPU-48	89.0	66.0	87.7	2.7	6.3	7.3	1593.0	1330
GPU-66	88.0	75.0	85.7	2.3	8.0	6.7	1288.3	530
GPU-67	86.0	77.7	59.0	2.3	5.0	6.0	1261.7	1400
MEAN	**85.7**	**75.4**	**77.5**	**2.7**	**6.1**	**6.1**	**1135.9**	**1550**
SEM	**0.7**	**4.5**	**4.9**	**0.5**	**0.5**	**0.3**	**123.3**	**380**
CD(0.05P)	**2.1**	**13.2**	**14.5**	**NS**	**1.5**	**0.8**	**366.3**	**1120**
CV (%)	**1.4**	**10.2**	**10.9**	**31.1**	**14.6**	**8.0**	**18.8**	**42.4**

Table 4.26: Replicated mother trial of finger millet at CPR, Berhampur, 2012

Varieties	Growth and Yield Parameters							
	Days to 50% flowering	Days to maturity	Plant height (cm)	Productive tillers/ plant	Finger length (cm)	No. of fingers	Grain yield (Kg/ac)	Straw yield (Kg/ac)
Mati	71	102	94.7	1.7	10.5	6.9	733.3	2010
Bati	62	93	101.4	1.6	10.8	6.5	633.3	2650
Kala kerenga	76	107	105.7	1.7	11.9	6.6	733.3	2810
Sunamani	72	103	98.5	1.7	10.0	7.1	526.7	1850
Bhairabi	57	88	86.8	3.0	8.5	6.7	783.3	1910
Chilika	63	94	100.1	2.3	9.5	7.4	743.3	2080
GPU 28	62	93	94.5	2.1	10.3	7.1	743.3	2090
GPU 67	61	92	86.1	2.1	8.9	6.7	650.0	1910
GPU 66	61	92	94.8	2.0	10.3	7.1	766.7	1910
GPU 48	61	92	102.3	2.0	10.4	6.8	760.0	2180
MEAN	**65**	**96**	**96.5**	**2.0**	**10.1**	**6.9**	**707.36**	**2140**
SEM	**--**	**--**	**--**	**--**	**--**	**--**	**38.36**	**--**
CD(0.05P)	**--**	**--**	**--**	**--**	**--**	**--**	**114.0**	**--**
CV (%)	**--**	**--**	**--**	**--**	**--**	**--**	**9.38**	**--**

Farmers' assessment on the performance of varieties expressed during FPA activities held in the above trials is given in Annexure-2. In the opinion of farmers who participated in FPA activity, GPU-67, GPU-66 and Bhairabi were the most preferred varieties. Some farmers also showed their interest in *Kala kerenga* and GPU-28. High yielding ability was their first consideration; but non-lodging ability of GPU-67 and early duration of Bhairabi were also preferred by them.

ii) Baby Trials

2012 - During 2011, Bhairabi and Chilika, both recommended varieties, were preferred by the local farmers as most promising among the varieties tested in mother trials at Semiliguda, even though the region is blessed with a large number of local traditional varieties. It was noticed that the local varieties contain lot of mixtures resulting in poor yields, apart from losing their identity. Naturally farmers preferred the improved varieties over their local ones due to early maturity, uniform crop stand and high yields. The performance of the same two varieties in baby trials of 2012 is furnished in Annexure-3. Both the varieties have recorded increased grain yield in majority of the trials over the farmers' varieties. The yield advantage over the local check varieties, on an average, varied from 5-14 percent in Bhairabi and Chilika, respectively. Many farmers expressed their preference for both the varieties.

FPA in progress in Semiliguda, 2012

2013 - Another two improved varieties, GPU-66 and GPU-67, which were identified during 2012 were also evaluated in baby trials during 2013. The farmers' varieties used as check varieties in these trials

included *Badu, Dasarabhodi, Bhairabi, Bodel, and Chilika* and *Madei muskali.* All together, GPU-66 was tested in 100 and GPU-67 in 57 on-farm trials. In addition to feedback data from all the participating farmers, yield data was also collected from 30 trials of each variety, the results of which are presented in Tables 4.27, and 4.28. GPU-66 recorded higher grain yields over all the check varieties. The per cent increase in grain yield over different check varieties ranged from 23.7 to 82.9 with overall increase to the extent of 29.0%. However, straw yield of GPU-66 was more or less similar to those of check varieties with almost equal number of trials showing increased and decreased values for straw yields.

Table 4.27: Performance of GPU-66 variety of finger millet in baby trials at Semiliguda, 2013

S. No.	Yield parameters	No of trials	Performance of		Per cent increase over check	No of trials		Check variety
			Test variety	Check variety		Increase	Decrease	
1	Grain yield (Kg/ac)	15	886 (430-1490)*	716 (504-960)	23.7	14	1	*Bada*
	Straw yield (Kg/ac)		3443 (2540-4810)	3494 (2870-4580)	-1.5	6	9	
2	Grain yield (Kg/ac)	8	829 (736-1250)	668 (450-860)	24.1	5	3	*Dasarabhodi*
	Straw yield (Kg/ac)		3490 (2860-3870)	3188 (2500-3660)	9.5	2	6	
3	Grain yield (Kg/ac)	2	580 (450 -710)	458 (396-520)	26.6	2	0	*Bhairabi*
	Straw yield (Kg/ac)		3610 (3340-3880)	2905 (2620-3190)	24.3	2	0	
4	Grain yield (Kg/ac)	1	660	470	40.4	1	0	*Bodel*
	Straw yield (Kg/ac)		3080	3600	-14.4	1	0	
5	Grain yield (Kg/ac)	1	960	720	33.3	1	0	*Chilika*
	Straw yield (Kg/ac)		3470	3920	-11.5	0	1	
6	Grain yield (Kg/ac)	3	887 (700-1000)	485 (435-510)	82.9	3	0	*Madei muskali*
	Straw yield (Kg/ac)		4036 (3650-4540)	3156 (2860-3620)	27.9	3	0	
	Grain yield (Kg/ac)	**30**	**845 (430-1490)**	**655 (504-960)**	**29.0**	**26**	**4**	**Over all the checks**
	Straw yield (Kg/ac)		**3514 (2540-4810)**	**3357 (2620-4580)**	**4.7**	**14**	**16**	

*Values in parentheses are range of mean values

The perception of more than 80% of farmers revealed that GPU-66 possessed better yielding ability for both grain and straw as compared to their own varieties (Annexure- 4(viii)). Other parameters such as dry spell, lodging, grain shattering and blast incidence were not the major issues in majority of the cases (less than 10 to 40%) and performance of GPU-66 with respect to these traits was either better or same as those of local checks. In the opinion of the participating farmers the distinguishing features of

GPU-66 were its medium duration, high tolerance to dry spell, high grain yield, less grain shattering and high preference to colour. Most of the farmers (95%) indicated their interest to save the seeds of GPU-66 for cultivating during next year.

Performance of GPU-67 (Table 4.28) was more encouraging than that of GPU-66 as its grain as well as straw yields were higher than those of local check varieties in all the 30 trials selected randomly for yield assessment. The values of per cent increase for grain yield varied from 26.5 (*Badu)* to 74.5 (*Sana*) and for straw yield from 12.3 (*Bodi*) to 28.8 (*Sana)*, the overall yield advantage being 36.1% and 19%, respectively.

According to farmers' assessment, GPU-67 was found to be either early or same in duration as their own varieties in majority of cases (Annexure-4(ix)). About 65% of participating farmers realized its higher yielding ability, while about 37% felt so for straw yield. However, in respect of other parameters like tolerance to dry spell, damage by rain at maturity, grain shattering, and blast resistance, some of the farmers indicated that GPU-67 is more or less similar to their varieties but 33 farmers expressed that it had least lodging problem. Most of the farmers (84.21%) showed their willingness to save the seeds of GPU-67 for cultivating next year future use. In the opinion of the participating farmers the distinguishing features of GPU-67 are its short duration, high tolerance to dry spell, high grain yield, less grain shattering and preferred grain colour. Moreover, it has uniform grain maturity which attracted farmers.

Table 4.28: Performance of GPU-67 variety of finger millet in baby trials at Semiliguda, 2013

S. No.	Yield parameters	No of trials	Performance of		Per cent increase over check	No of trials			Check variety
			Test variety*	Check variety		Increase	Decrease	Equal	
1	Grain yield (Kg/ac)	7	820 (550-960)	600 (415-810)	36.6	7	0	0	*Bada*
	Straw yield (Kg/ac)		4427 (3520-5150)	3660 (3150-4230)	20.9	6	0	1	
2	Grain yield (Kg/ac)	3	698 (630-835)	516 (390-600)	35.3	3	0	0	*Dasarabhodi*
	Straw yield (Kg/ac)		4140 (3940-4280)	3537 (3130-3840)	17.0	3	0	0	
3	Grain yield (Kg/ac)	2	640 (550 & 730)	370 (355& 385)	72.9	2	0	0	*Bhairabi*
	Straw yield (Kg/ac)		3610 (3340 & 3880)	2905 (2620 & 3190)	24.3	2	0	0	
4	Grain yield (Kg/ac)	3	782 (720-900)	618 (394-790)	26.5	3	0	0	*Badu*
	Straw yield (Kg/ac)		4440 (4140-4860)	3897 (3520-4470)	13.9	3	0	0	
5	Grain yield (Kg/ac)	13	747 (405-1080)	565 (310-800)	32.2	13	0	0	*Bodi*
	Straw yield (Kg/ac)		4403 (3600-5150)	3920 (2910-4320)	12.3	13	0	0	
6``	Grain yield (Kg/ac)	1	540	400	35.0	1	0	0	*Marda*

S. No.	Yield parameters	No of trials	Performance of		Per cent increase over check	No of trials			Check variety
			Test variety*	Check variety		Increase	Decrease	Equal	
	Straw yield (Kg/ac)		3240	2820	14.9	1	0	0	
7	Grain yield (Kg/ac)	1	890	510	74.5	1	0	0	*Sana*
	Straw yield (Kg/ac)		4690	3640	28.8	1	0	0	
	Grain yield (Kg/ac)	**30**	**753.3 (405-1080)**	**553.3 (310-810)**	**36.1**	**30**	**0**	**0**	**Over all the checks**
	Straw yield (Kg/ac)		**4329 (3340-5150)**	**3637 (2620-4470)**	**19.0**	**29**	**0**	**1**	

*Values in parentheses are range of mean values

It makes some sense to mention here that there were another two varieties, namely GPU-28 and GPU-48, in mother trials of 2012 and both of them also recorded equally higher yields as the two varieties described above. However, they were not considered for further evaluation in baby trials during 2013 because of their lower preference values. More ever, GPU-28 and GPU-66 are similar in many aspects and the latter one was picked up owing to its better performance. Later there was demand for the seeds of GPU-28 and GPU-48 by some local farmers. As a result the seeds of GPU-28 and GPU-48 were procured and distributed to 63 and 80 farmers, respectively, for cultivation during 2014. The trials were executed and monitored as baby trials. The cropping season was very harsh for this region because of *Huddud* cyclone which hit the area during August, 2014. The early sown crop was most affected. It was possible to collect the feedback from 20 randomly selected farmers each on the performance of the two varieties and the same is presented separately in Annexure 8 (iii & iv). According to farmers' perception GPU-28 took more time for maturity than the local variety. The extent of lodging was either same or more, while grain shattering was less. Blast disease incidence and dry spell were not the issues and the extent of damage by rains during maturity was depended on the particular situation. However, most of the farmers (more than 85%) assessed its grain as well as straw yields and grain color better than their own varieties.

On the other hand, about 60% of farmers observed GPU-48 taking more time for maturity and the rest indicated either same or earlier in duration than their varieties. Similarly majority of the farmers assessed GPU-48 as either same or better as compared to their varieties in respect of lodging, grain shattering, tolerance to dry spell, damage by rains at maturity and resistance to blast disease. Though majority of the farmers indicated better performance of the test variety for grain and straw yields, it is important to note that its grain color and taste were considered as poor by some farmers. About 75% of farmers showed willingness to save its seeds for future use.

The results of baby trials of 2014 once again confirmed the earlier observations made on the performance of these two varieties and further efforts to promote them in the project site depends on the demand by the farmers.

iii) Informal Research and Development (IRD)

During 2014 the same two varieties, GPU-66 and GPU-67, were considered for IRD. The seeds of GPU-66 were distributed to 413 farmers and that of GPU-67 to 576 farmers. For understanding the farmers' perception regarding the two varieties, feedback was collected from 20 randomly chosen farmers for each variety. The results are presented in Annexure 9 (x & xi).

There was crop damage due to cyclonic effect and the extent of crop damage depended on the crop growth stage. Even then most of the farmers assessed both the varieties as better than their own varieties for grain and straw yields. GPU-66 matured later while the duration of GPU-67 was either same or earlier in majority of the cases. Crop lodging was considerably widespread in GPU-66 due to cyclonic effect mainly because of tall plant with big panicle, while it was not so in case of GPU-67 as its plants are comparatively dwarf with small panicle size. Performance of the two varieties was found to be similar with respect to other traits; though some of the farmers were not able to indicate their opinion in many cases but majority of them preferred both the varieties.

iv) Synthesis of Finger Millet PVS Trials in Semiliguda

In three years 18 local varieties and 7 released varieties were tested in the PVS trials and 3 farmer preferred varieties were identified (Table-4.29). In addition to the three most preferred varieties of finger millet, namely, Bhairabi, GPU-66 and GPU-67, another two varieties, GPU-28 and GPU-48, are also in demand in the site. Bhairabi attains maturity earlier than other varieties and hence it is most preferred, while GPU-67 attracted the farmers' attention due its uniform maturity. All these improved varieties have outperformed the local varieties and their uniform as well as good crop stand could be attributed to availability of their quality seeds. IRD activity of Bhairabi was not taken up during 2013 as the seeds of this variety were supplied to large number of farmers in the site by the Government agencies. Potentiality of the local varietal diversity remains still unexploited, which needs due consideration in future programs on varietal improvement in the site.

Table 4.29: Synthesis of finger millet PVS trials in Semiliguda, 2011-2014

Type of variety	2011	2012		2013		2014		Output	
	Mother trial	Mother trial	Baby trial	Baby trial	IRD	Baby trial	IRD/ Populari-sing	FPV* identified	PV# for Further testing
Traditional	*Sana, Khada, Mati, Kala kerenga, Dinda, Bati, Machhadim, Bhalu, Marda, Dasarabhodi, Chaula, Badu, Madei muskali, Bodel, Dudh kerenga, Sunamani, Mami, Baghachhad*	*Mati, Bati, Kala kerenga, Sunamani*	--	--	--	--	--	--	
Released	Bhairabi, Chilika, Champavati	Bhairabi, Chilika, GPU-28, GPU-48, GPU-67, GPU 66	Bhairabi, Chilika	GPU-67, GPU 66	Bhairabi*	GPU 28, GPU 48	Bhairabi*, GPU-67, GPU-66	Bhairabi, GPU-67, GPU-66	GPU-28, GPU-48

Type of variety	2011	2012		2013		2014		Output	
	Mother trial	Mother trial	Baby trial	Baby trial	IRD	Baby trial	IRD/ Populari-sing	FPV* identified	PV# for Further testing
Total	21	10	2	2	1	2	3	3	2

FPV- Farmers' preferred variety; *Seeds of these recommended varieties are being distributed by the state DOA

4.2 Little Millet

Little millet is the major crop at Jawadhu Hills, while it is being cultivated on smaller scale in Semiliguda. Site-wise progress of PVS activities undertaken during the project period are discussed in the following sections.

4.2.1 Project site: Jawadhu Hills

i) Mother Trials

2011 - During 2011, 33 mother trials with 8 varieties of little millet were conducted. Out of 33 mother trials, field data was recorded in 18 trials and the mean values for different growth and yield parameters are presented in Table-4.30. The study indicated that *Sittan, Karun sittan* and *Koluthana samai* are early maturing requiring about 85 days for maturity. CO-2, CO-3 and CO-4 matured in about 90 days, while OLM-203 (110 days) and *Vellai samai* (116 days) were comparatively late in maturity. Plant height ranged from 96.8cm (*Sittan* and *Karun sittan*) to 134.6 cm (Vellai *samai*). Plant population varied from 250 to 395 plants/m^2, which according to experts is too high for the crop. Maximum tillers per plant was recorded in OLM-203 (3.45) followed by *Koluthana samai* (3.18) and *Vellai samai* (2.95). OLM-203 also had biggest panicle size with 41.22 cm length, while the panicle length recorded in rest of the varieties was found to be around 38 cm. The highest grain yield (3.85 q/ac) was observed in CO-4 followed by *Karun sittan* (3.76 q/ac), *Sittan* (3.26 q/ac) and CO-3 (3.14 q/ac).

Table 4.30: Performance of little millet varieties in mother trials at Jawadhu Hills, 2011

Variety	Days to 50% flowering	Days to maturity	Plant height (cm)	Plant population /m^2	Productive tillers /plant	Panicle length (cm)	Grain yield (Kg/ac)
CO-2	52	88	100.89 (79-131)	394.5	2.59 (1.0-4.7)	38.11 (26.0-45.9)	293.0 (100-700)
CO-3	52	88	106.06 (74-135)	327.4	2.35 (1.0-4.0)	38.37 (33.7-43.7)	314.0 (75-850)
CO-4	50	88	108.22 (92-131)	303.7	2.66 (2.0-4.3)	37.62 (32.7-46.7)	385.0 (125-950)
Sittan samai	45	85	96.82 (72-131)	279.4	2.27 (1.0-3.3)	37.55 (28.3-45.7)	326.0 (160-500)
Koluthana samai	53	85	100.53 (68-136)	268.1	3.18 (2.0-5.0)	38.46 (29.0-44.3)	278.0 (100-805)
Karun sittan samai	43	83	96.83 (75-129)	338.9	2.00 (1.0-3.0)	37.53 (32.5-48.3)	376.0 (25-800)
OLM-203	70	110	119.08 (81-154)	282.1	3.45 (2.0-7.3)	41.22 (34.3-51.3)	129.0 (25-300)

Variety	Days to 50% flowering	Days to maturity	Plant height (cm)	Plant population /m^2	Productive tillers /plant	Panicle length (cm)	Grain yield (Kg/ac)
Vellai samai	80	116	134.64 (119-153)	254.2	2.95 (2.0-4.0)	37.91 (31.3-43.7)	103.0 (25-250)

Farmers' Preference Analysis - Three FPA were held in mother trials of little millet during 2011 at the site. The details of locations, number of participants and the scores of farmers' preference for each variety recorded are furnished in Annexure-1d (i- iii). At Puthur village (Activity-1), most of the farmers showed their preference for short duration varieties. Among the two local varieties *Sittan samai* got maximum preference scores (13), closely followed by *Koluthana samai* (12) and CO-3 (10). It could be seen that 3 out of 8 farmers indicated 1st and 3rd preference each for *Koluthana samai*, while 5 farmers gave 2nd preference and one farmer 1st preference to *Sittan samai.* At Nammiampattu village (Activity-2) also the farmers group selected early varieties. However, in this trial CO-4 got maximum preference score value of 14 followed by *Sittan samai* and CO-3 with 10 scores each and *Koluthana samai* having 9 scores. Pooling the weighted score values of both the activities the results indicated that *Sittan samai* recorded the highest value of 23 scores, while *Koluthana samai* and CO-4 got 21 scores each followed by CO-3 with 20 scores. It is interesting to note that *Koluthana samai* and CO-4 got maximum over-all 1st preference scores, 6 and 5 respectively. *Vellai samai* and OLM-203, both of them being relatively long duration varieties, were not preferred by the local farmers.

The outcome of FGD was also in accordance with the farmers' assessment of varieties in the field. Most of them expressed their preference for *Koluthana samai* and CO-4. Though *Koluthana samai* is a traditional variety in the region of Jawadhu Hills, the farmers expressed it is new for them and the reason for their liking is its big size compact panicle and early duration. In their opinion CO-4 is similar in duration and appearance as that of *Sittan samai,* the preferred local variety for its taste, and appears to be good yielder due its better crop stand. From this FGD it was clear that farmers are looking for high yielding short duration varieties which resemble in taste as that of *Sittan samai,* mainly to go for second crop during Rabi season. One farmer, however, indicated his 2nd preference for *Vellai samai,* a long duration local variety, because the harvesting of short duration varieties is being affected by the usual rains during that period.

In another FPA activity, which was held on 24th October 2011 at Velichanur village, two groups, each having 8 and 10 farmers, took part in assessing the varieties in the trial. Since the assessment given by the first group was not in order (all the 8 farmers indicated same preference) due to lack of following the correct procedure, the scores were not taken into consideration. The members of that group did not participate in the FGD also. The results of the analysis (Activity-3), as recorded from another group, are presented in Annexure-1d (iii). It is interesting to note that all the 10 farmers indicated their 1st preference to the three local varieties, namely *Sittan samai, Koluthana samai* and *Vellai samai,* which recorded over all preference scores of 21, 20 and 7, respectively. Though the farmers of this village also showed more interest for early duration varieties like in the previous activity, *Vellai samai* and OLM-203 were also liked by the farmers. The FGD yielded very valuable information as most of the farmers took active participation in the discussion. The characteristics of *Sittan samai* are early duration, drought tolerance and tastiness, according to farmers' opinion.

2012 - During 2012, mother trials (un-replicated) as well as replicated trials (RCBD) were conducted with 9 varieties of little millet. However, because of miss identification of seed source of one variety (IR-20), the data of only 8 varieties were considered for the analysis. Significant differences were noticed for plant population, plant height and grain yield (Table-4.31). Even the values for grain yield of all the varieties, except *Siruvellai* and JK-8, were found to be statistically on par, indicating 6 out 8 varieties are equally potential for the region. However, the maximum grain yield was recorded in *Perungulai samai* (506.3 kg/ac) followed by IR-8, CO-4, *Karun sittan* and *Sittan.* In RCBD, significant differences among varieties were noticed only for plant height and panicle length (Table-4.32). *Perungulai* was again recorded the highest yield (405.3 kg/ac) and the yield of *Karun sittan* was also same. Plant population was relatively less in RCBD, because of line planting, as compared to the one in mother trials, where sowing was done by broadcasting.

The results of FPA also indicated the same pattern of varietal preference (Annexure-2). In the opinion of farmers, *Perungulai*, JK-8, *Sittan*, CO-4 and *Karun sittan* were, in the order of preference values, the preferred varieties. Perungulai was highly preferred by the farmers for its traits like visually attractive long semi-compact panicle, plant height, higher grain and straw yield. JK-8 was early and more uniform with semi-compact panicle, for which it was identified. CO-4 was already included in baby trials in 2012 based on the last year assessment.

Table 4.31: Mother trial of little millet varieties at Jawadhu Hills, 2012

Varieties	Growth and Yield Parameters				
	Plant population/m^2	Plant Height (cm)	Productive tillers/Plant	Panicle Length (cm)	Grain yield (kg/ac)
Koluthana	250.6	95.7	3.0	37.2	467.4
Siruvellai	223.5	88.0	3.2	34.7	411.8
Karun sittan	235.1	92.8	3.0	34.8	471.1
JK-8	232.1	83.9	3.2	35.3	359.4
Perungulai	236.8	94.5	2.9	35.7	506.3
CO-4	228.1	96.9	3.3	37.9	475.3
Sittan	205.5	92.1	3.3	35.2	469.7
IR-8	240.8	86.2	3.1	35.0	485.3
MEAN	**231.6**	**91.3**	**3.1**	**35.7**	**455.8**
SEM	**8.3**	**2.4**	**0.2**	**0.9**	**22.4**
CD(0.05P)	**23.1**	**6.6**	**NS**	**NS**	**62.7**
CV (%)	**15.5**	**11.3**	**26.5**	**10.4**	**21.4**

Table 4.32: Replicated mother trial of little millet at Jawadhu Hills, 2012

Varieties	Plant population	Plant Height (cm)	Productive tillers/plant	Panicle length(cm)	Grain yield (kg/ac)	Straw yield (Kg/ac)
Koluthana	181.1	93.0	3.7	44.7	321.7	1600
Siruvellai	177.8	76.0	2.7	39.3	294.0	1200
Karun sittan	203.3	85.7	3.7	42.3	405.0	1530
Perungulai	111.1	103.7	3.3	43.7	405.3	1500

Varieties	Plant population	Plant Height (cm)	Productive tillers/plant	Panicle length(cm)	Grain yield (kg/ac)	Straw yield (Kg/ac)
Sittan	174.4	86.3	3.0	46.0	366.3	1330
IR-8	166.7	79.7	2.7	37.3	288.7	1070
CO-4	196.7	102.3	3.0	45.0	313.0	1170
JK-8	188.9	72.0	2.3	37.7	297.7	1100
MEAN	**175.0**	**87.33**	**304**	**42.0**	**336.5**	**1310**
SEM	**23.89**	**2.89**	**0.34**	**1.89**	**47.57**	**14.90**
CV %	**23.61**	**5.75**	**19.48**	**7.77**	**24.49**	**19.71**
CD (0.05P)	**NS**	**8.8**	**NS**	**5.7**	**NS**	**NS**

2013 - Little millet mother trials (short duration varieties) - During 2013 separate trials were conducted for short duration and long duration varieties of little millet. Out of 20 trials planned, complete data was available from 14 trials. Four short duration varieties of little millet were included in these trials. Mean values of growth and yield parameters are presented in Table 4.33. Days to 50% flowering varied from 47.1 to 79 indicating *Sittan* and *IR-20* were short duration while Payur-2 and *Kadari-1* were of moderate duration. Plant population varied considerably due to poor seed germination in *Kadari-1* and Paiyur-2. *Kadari-1* recorded maximum plant height of 133.7 cm followed by Paiyur-2(119.1 cm), *IR-20* (95.6 cm) and *Sittan* (93.6 cm). Productive tillers varied from 2.11(*Sittan*) to 4(*Kadari-1*). Length of panicle recorded in *Kadari-1* was maximum (47.2 cm) followed by Paiyur-2 (42.7 cm), while the values were more or less same (38.0 cm) for *IR-20* and *Sittan*. Paiyur-2 recorded the highest grain yield (714 Kg/ac) followed by *IR-20* (709Kg/ac), *Sittan* (671 Kg/ac) and *Kadari-1* (568 Kg/ac). Yield of *Kadari-1* was significantly lower than other three varieties tested. However, *Kadari-1* recorded maximum straw yield of 4303 Kg/ac followed by *Sittan* and *IR-20*. It was noticed that in spite of having maximum tillers and panicle length in *Kadari-1* the yield was low due to more chaffy grains as the crop suffered moisture stress at maturity. Paiyur-2 and IR-20 recorded higher yields in majority cases and showed about 6% grain yield increase over *Sittan* while *Kadari-1* recorded about 40 % increase of straw yield over that of *Sittan* (Table 4.34).

Table 4.33: Growth and yield parameters of short duration varieties of little millet at J. Hills, 2013

Varieties	Days to 50% flowering	Plant Popln /m^2	Plant height (cm)	No of Tillers	Productive Tillers	Panicle length (cm)	Grain Yield (Kg/ac)	Straw yield (Kg/ac)	Tolerance to stress
Sittan	52.9	332.2	93.6	2.54	2.11	37.8	671	3100	High
IR-20	47.1	256.7	95.6	4.44	3.50	38.0	709	3043	Moderate
Paiyur-2	63.2	217.8	119.1	5.80	3.30	42.7	714	2921	High
Kadari-1	79.0	170.0	133.7	7.07	4.00	47.2	568	4303	High
MEAN	**60.6**	**22.04**	**111.2**	**3.22**	**4.99**	**41.6**	**665.7**	**3341.9**	**--**
Sem	**1.37**	**1.50**	**7.43**	**0.18**	**0.41**	**0.79**	**29.35**	**166.23**	**--**
CD at 5%	**3.93**	**4.29**	**21.25**	**0.51**	**1.18**	**2.25**	**83.93**	**475.43**	**--**
CV%	**8.47**	**25.45**	**25.00**	**20.6**	**30.93**	**7.08**	**16.49**	**18.61**	**--**

Table 4.34: Comparison of short duration varieties of little millet in mother trials, J. Hills, 2013

S. No.	Test variety	Yield parameters	Performance of varieties	% increase over *Sittan*	No of trials with yields	
					Increase	Decrease
1	Kadari-1	Grain yield (kg/ac)	568 (280-800)*	-15.4	3	11
		Straw yield (kg/ac)	4303 (2820-5520)	38.8	11	3
2	*IR-20*	Grain yield (kg/ac)	709 (536-1120)	5.7	11	3
		Straw yield (kg/ac)	3043 (1844-4640)	-1.8	7	7
3	Paiyur-2	Grain yield (kg/ac)	714 (480-900)	6.4	10	4
		Straw yield (kg/ac)	2921 (2088-4080)	-5.8	5	9
4	*Sittan*	Grain yield (kg/ac)	671 (520-960)	----	----	-----
		Straw yield (kg/ac)	3100 (1700-5000)	----	----	----

*Figures in parentheses are range of mean values

The opinion of the participating farmers on the performance of varieties is given in Table 4.35. It could be seen that more than 42% of farmers indicated their first preference to Paiyur-2 and IR-20 while *Kadari-1* was considered as least preferred variety. However, *Sittan* recorded more than 42% preference in second and third ranking position each. As a result, most of the farmers showed their willingness to grow *Sittan* and IR-20 which are already popular in the site. About 79% of participating farmers also showed interest to grow Paiyur-2 which is a released variety from TNAU for the region. The desirable traits like short duration, high grain and straw yield (*Sittan* and IR-20) were the criteria for farmers' assessment. In addition *Sittan* was found withstanding high rainfall as well as showing tolerance to dry spell. Because of long duration and more grain shattering combined with low yielding ability Kadari-1 was not preferred by the farmers.

Table 4.35: Farmers' preference ranking for little millet varieties (short duration) at J. Hills, 2013

Preference ranking	Sittan samai	Paiyur-2	IR-20	Kadari-1
1	1 (7.14)*	6 (42.86)	6 (42.86)	1 (7.14)
2	6 (42.86)	4 (28.57)	4 (28.57)	0
3	6 (42.86)	4 (28.57)	4 (28.57)	0
4	1 (7.14)	0	0	13 (92.86)
Willingness to grow	12 (85.71)	11 (78.57)	12 (85.71)	0

*Figures in parentheses are % values

Farmers' preference analysis conducted in one of the mother trials at Amatankollai village, where 14 farmers participated, also indicated that *IR-20* and *Sittan* were the most preferred varieties. Since these

two varieties are already popular in the site, Paiyur-2 and *Kadari-1* need to be evaluated in the fields of more number of farmers for one more season.

Little millet mother trials (long duration varieties) - From 22 trials of long duration varieties planned, complete data was available from 11 trials. Out of six long duration varieties included in the trial, one variety (Kolab) was early duration variety, due to mistaken identity as that of OLM-203. The mean values of growth and yield parameters are presented in Table-4.36. Days to 50% flowering varied from 49 (*Kolab*) to 122 (*Vella samai*). *Siru samai* and *Kallumannu samai* were of same duration. *Kala suan* and *Bada suan* recorded maximum plant height of 133 cm followed by *Siru samai* (127.6 cm), *Vellai samai* (128.8cm), *Kallumannu samai* (109.1 cm) and Kolab (85.3 cm). Productive tillers varied from 2.89 to 6.8, least value was noticed in *Kolab* while the values for the long duration varieties being more or less similar. This might have reflected the effect of plant population recorded for *Kolab*, which had the highest plant density. Length of panicle recorded in *Vellai samai* was the maximum (45.1 cm) followed by *Kallumannu samai and Siru samai* (43.5 cm). *Siru samai* recorded the highest grain yield (675.5 Kg/ac) followed by Kolab, Vellai samai, Kallumannu samai, *Kala suan* and *Bada suan*. However, *Vellai samai* recorded the highest straw yield (3797.5 Kg/ac) closely followed by other long duration varieties (3412.7 – 3647.3 Kg/ac). Grain yield increase of *Siru samai* was to the extent of 12% over *Vellai samai* with 9 out of 11 trials showing increased yields (Table 4.37).

Table 4.36: Performance of long duration varieties of little millet in mother trials, Jawadhu Hills, 2013

Test Varieties	Days to 50% flowering	Plant population/ m^2	Plant height (cm)	No. of tillers/ plant	Productive Tillers	Panicle length (cm)	Grain yield (Kg/ac)	Straw yield (Kg/ac)
Siru samai	115	129	127.7	6.75	6.41	43.5	675.5	3647.3
Kala suan	86	125	133.0	6.95	6.80	41.7	535.6	3512.7
Kolab	49	284	85.3	2.90	2.89	35.5	634.9	2402.5
Vellai samai	122	109	128.8	8.67	6.64	45.1	604.7	3797.5
Kallumannu samai	114	107	109.1	6.61	5.70	43.5	600.0	3509.5
Bada suan	97	140	133.0	7.27	6.30	40.2	521.8	3412.7

Table 4.37: Comparison of long duration varieties of little millet in mother trials, Jawadhu Hills

S. No.	Test variety	Yield parameters	Performance of varieties	% increase over *Vellai samai*	No of trials with yields	
					Increase	Decrease
1	*Siru samai*	Grain yield (Kg/ac)	675.5 (400-800)	11.7	9	2
		Straw yield (Kg/ac)	3647.3 (2060-6000)	-4.0	5	6
2	*Kala suan*	Grain yield (Kg/ac)	535.6 (428-788)	-11.4	2	9
		Straw yield (Kg/ac)	3512.7 (1340-7400)	-7.5	3	8
3	*Bada suan*	Grain yield (Kg/ac)	521.8 (400-640)	-13.7	2	8
		Straw yield (Kg/ac)	3412.7 (1300-8200)	-10.1	4	7
4	*Kallumannu*	Grain yield (Kg/ac)	600.0	-0.8	6	5

S. No.	Test variety	Yield parameters	Performance of varieties	% increase over *Vellai samai*	No of trials with yields	
					Increase	Decrease
	samai		(444-700)			
		Straw yield (Kg/ac)	3509.5 (1320-5240)	-7.6	5	6
5	*Vellai samai*	Grain yield (kg/ac)	604.7 (468-760)	--	--	--
		Straw yield (Kg/ac)	3797.5 (1292-6080)	--	--	--

*Figures in parentheses are % values

Assessment of 12 participating farmers on the overall performance of varieties is given in Table-4.38. It could be seen that more than 46% of farmers indicated their first preference to *Siru samai* because of its ability to withstand dry spell; grain shattering was also very less. *Kolab* was also preferred by some farmers (30.8%) because of its short duration, maturing within 90-95 days though it was not considered for this objective. Majority of the farmers (85%) showed interest to grow *Siru samai* while some farmers also indicated more or less similar preference to grow *Vellai samai, Kallumannu samai* and *Bada samai.*

Long duration little millet varieties tested in Jawadhu Hills, 2014

Table 4.38: Farmers' preference ranking for little millet varieties (long duration), J. Hills, 2013

Preference	Siru samai	Kala suan	Kolab	Vella samai	Kallumannu samai	Bada suan
1	6 (46.2)	0	4 (30.8)	1 (7.7)	1 (7.7)	1 (7.7)
2	5 (38.5)	0	3 (23.0)	3 (23.0)	1 (7.7)	0
3	1 (7.7)	0	1 (7.7)	2 (15.4)	3 (23.0)	5 (38.5)
Willingness to grow (%)	12 (84.6)	0	8 (7.6)	6 (46.1)	5 (30.7)	6 (46.1)

*Figures in parentheses are % values.

2014 - Seeds of four new collections of little millet, 2 short duration varieties (*Vellai samai and IR-8*) and 2 long duration varieties (*Kothu samai and Karun samai*), were procured from Pudur nadu. In order to assess their suitability in the project site about 10-12 mother trials were implemented during 2014. But the field data was incomplete, especially for yield parameters, due to unavoidable circumstances and hence relevant information could not be obtained. However, the performance of both the long duration varieties appeared promising and need to be tested with proper planning during next season.

ii) Baby trials

2012 - As per the plan two varieties, namely, *Koluthana* and CO-4 were included in baby trials during 2012. Data from the trials involving *Koluthana samai* were not considered due to wrong seed source as

the crop did not resemble as that of *Koluthana*. The yield levels of CO-4 were not much encouraging when compared with those of local checks (*Sittan, Siruvellai, Siru samai and IR-8).* However, some farmers showed their willingness to continue with this variety due to more plant height and high yielding ability (Table-4.39).

Table 4.39: Performance of CO-4 variety against Local varieties of little millet at Jawadhu Hills, 2012

Village panchayat	Number of trials	Average Grain Yield (kg/ac)			Local varieties tested	Farmers' willingness	
		CO-4	Local	Increase/ Decrease		Yes	No
Nammiampattu	5	358	376	2/3	*Sittan, Siruvellai and Siru samai*	2	3
Kuttakarai	4	342	348	2/2	*Sittan and IR-8*	3	1
Kovilur	6	343	343	2/4	*Sittan and IR-8*	4	2
Melasilambadi	4	304	374	0/4	*Sittan and IR-8*	1	3

2013 - During 2013 there were 32 baby trials (19 of *Perungulai* and 13 of *Koluthana*) in 19 villages coming under 4 panchayats of the site. These two varieties were tested against 4 farmers' varieties, namely *Sittan*, IR-20, IR-50 and IR-8 as the checks. The performance of *Perungulai* against *Sittan* and IR-20 is given in Table-4.40. The results indicated that yield performance (both grain and straw) of *Perungulai* was higher in majority of the trials except for fodder yield against IR-20. *Perungulai* recorded grain yield advantage of 20.5% over *Sittan* and 15.4% over IR-20, indicating its high yielding ability. As for as fodder yield is considered the increase was 17.6% over *Sittan* while it was less by 6.1% compared to IR-20. Considering the overall performance of *Perungulai* with 19.2% increase in grain yield and 8.9% increase in fodder yield it was evident that it attracted the attention of participating farmers.

Table 4.40: Performance of Perungulai variety of little millet in baby trials, J. Hills 2013

S. No.	Yield parameters	No. of trials	Performance of		% increase	No of trials		Check variety
			Test variety	Check variety		INC	DEC	
1	Grain yield (kg/ac)	10	617 (380-840)*	512 (226-720)	20.5	7	3	*Sittan*
	Straw yield (kg/ac)		3024 (1920-4360)	2571 (1664-3348)	17.6	7	3	
2	Grain yield (kg/ac)	9	652 (366-778)	565 (352-692)	15.4	7	2	*IR-20*
	Straw yield (kg/ac)		2759 (1834-3430)	2937 (2610-3574)	-6.1	3	6	
3	Grain yield (kg/ac)	19	634 (366-840)	537 (226-720)	19.2	14	5	Over 2 checks
	Straw yield (kg/ac)		2989 (1834-4360)	2744 (1664-3574)	8.9	10	9	

*Figures in parentheses are range of mean values

The feedback of farmers' perception of the test variety as compared to the check varieties are furnished in Annexure-5(i). It could be seen that *Perungulai* was found to be similar or slightly longer in duration than the check varieties. Its performance was found same as the check varieties with respect to

tolerance to dry spell, lodging and grain shattering according to more than 70% of participating farmers. Most of the farmers observed its higher yielding ability (84.2% for grain yield and 63.1% for straw yield) over their own varieties, while 68.4% of them indicated their preference for its colour. It is interesting to note that almost all the participating farmers (94.7%) have shown interest to save the seeds of *Perungulai* variety for cultivation during the next year. The main features of *Perungulai* noticed by the farmers were higher yielding ability (grain and fodder yield), long compact panicle, more grain weight, bigger grain size, less chaffy and white colored grains.

Performance of *Koluthana* in baby trials against 4 local checks is given in Table-4.41. Here too the test variety gave higher yields in most of the trials as compared to the checks. The average grain yield varied from 550 Kg/ac (against *IR-8*) to 614 Kg/ac (against *IR-50*) with a yield advantage ranging from 1.2% (over *IR-20*) to 64.2% (over *IR-50*). On an average the yield advantage was 18% for grain yield and 13.3% for straw yield when compared with all the checks together. However, its performance was found to be on par with that of *IR-20*.

Table 4.41: Performance of Koluthana variety of little millet in baby trials, Jawadhu Hills 2013

S. No.	Yield parameters	No. of trials	Yield performance of		Per cent increase over check	No of trials		Check variety
			Test variety	Check variety		Increase	Decrease	
1	Grain yield (Kg/ac)	7	590 (442-870)*	456 (350-628)	29.4	7	0	*Sittan*
	Straw yield (Kg/ac)		3196 (2272-4730)	2510 (2176-2972)	18.2	7	0	
2	Grain yield (Kg/ac)	4	599 (438-750)	592 (484-800)	1.2	1	3	*IR-20*
	Straw yield (Kg/ac)		2989 (2550-3362)	3134 (2556-3916)	-4.6	1	3	
3	Grain yield (Kg/ac)	1	550	450	22.2	1	0	*IR-8*
	Straw yield (Kg/ac)		3150	3100	1.6	1	0	
4	Grain yield (Kg/ac)	1	614	374	64.2	1	0	*IR-50*
	Straw yield (Kg/ac)		2586	2126	21.6	1	0	
5	Grain yield (Kg/ac)	13	591 (438-870)	501 (350-800)	18.0	10	3	Over all the checks
	Straw yield (Kg/ac)		3081 (2272-4730)	2718 (2126-3916)	13.3	10	3	

*Values in parentheses are range of mean values

The perception of the participating farmers regarding *Koluthana* in comparison of their own varieties was also highly encouraging (Annexure-5(ii)). Eleven out of 15 farmers (73.3%) were able to realize its higher grain yielding ability, while its performance with respect to most of the traits assessed, especially crop duration, tolerance to dry spell, lodging, grain shattering, straw yield and grain colour, was as good as that of their own varieties. The farmers' interest in the test variety was evident from the fact that all the farmers have saved the seeds for growing it during next season. In the opinion of

the participating farmers the distinguishing features of *Koluthana* are its long compact panicle, more grain weight and higher grain yielding ability.

2014 - During 2014 there were 75 baby trials for IR 20 in 17 villages coming under 4 panchayats of the site. It was tested against the prevailing farmers' varieties, mainly *Sittan*. It was not possible to collect yield data, however, feedback was recorded from 49 farmers on the performance of IR-20 and the results are given in Annexure 8(v). The results indicated that IR 20 was slightly longer in duration than the check variety. But in other aspects like tolerance to dry spell, lodging, damage by rains, grain shattering and colour preference it was similar to the check variety. In the opinion of majority of farmers (more than 90 %) grain yield as well as straw yield was either same or even better than the check variety. Majority of the farmers (73.4 %) expressed willingness to grow in coming seasons. In order to assess quantitatively the extent of its superiority, especially for grain yield, it needs to repeat the trials one more season.

During 2014 there were 17 baby trials of *Siru samai* in 10 villages coming under 3 *panchayats* of the site. It was tested against the prevailing farmers' varieties, mainly *Vellai samai* (long duration variety) in Nammiyampattu and short duration varieties in other villages. Farmers' opinion was recorded in 14 trials, 13 from Nammiyampattu and one from Kovilur. The performance of *Siru samai* was found to be either same or better with respect to tolerance to dry spell, grain yield and colour preference as compared to farmers' varieties (Annexure 8(vi). Most of the farmers noticed less damage by heavy rains, least grain shattering, more duration and better straw yield in *Siru samai*. With respect to lodging, farmers gave varied responses for *Siru samai*. All the farmers, however, showed willingness to grow further, indicating that it attracted the attention of participating farmers. As in case of IR-20, *Siru samai* also needs to be evaluated once again in the following season.

iii) Informal Research and Development

2013 - Seeds of CO-4 were distributed to 64 farmers from 22 villages in 4 *panchayats* for testing on their fields on an area of about 150-200 sq.m each during 2013 cropping season. Farmers' feedback information was collected from 59 trials and the results are furnished in Annexure-7(v). Assessments of the participating farmers were based on their perception of CO-4 in respect of its growth and yield performances as compared to their own varieties, namely *Sittan samai*, *IR-20*, *Siruvellai samai* and *IR-8*. The former 2 varieties were more common than the other two varieties. They found that CO-4 takes more days for maturity, about a week than their varieties. However, in respect of tolerance to dry spell, lodging, grain shattering and grain colour CO-4 is similar to the local varieties according to majority of the farmers. More than 74% of participating farmers expressed its higher yielding ability, while about 17% farmers found its yield as good as their own varieties and lower yields in some cases (22.03%). Because of its tall plants the straw yield was found to be higher in majority of trials (74.58%) and same as that of local varieties in 10 trials (16.95%). Only 5 farmers felt that its straw yield was lesser than their own varieties. Most of the farmers, about 73%, did express their willingness to grow CO-4 during next season. CO-4, an improved variety from TNAU, would certainly add to the existing varietal diversity of little millet in the site. Majority of the farmers' opinion is that CO-4 appears to be similar to *Sittan* and its main features are tall plant, long panicle, good crop growth, high yield, good grain quality, slightly long duration, lodging in certain cases and suffers badly if there are no sufficient rains.

2014 - Similarly during 2014, three varieties, namely *Perungulai, Koluthana* and CO-4 were taken up under IRD and popularization activities. Farmers were provided with 1 kg seeds of these varieties for cultivating in about 150 -200 Sq. m area. Farmers' feedback information was collected from 50 trials and the results are furnished in Annexure 9 (xii- xiv). Assessments of the participating farmers were based on their perception of the tested varieties in respect of its growth and yield performances as compared to their own varieties, mainly *Sittan samai.*

Perungulai - Seeds were distributed to 87 farmers from 20 villages in 4 *panchayats*. Most of the participating farmers found that in respect to duration, tolerance to dry spell, lodging, grain shattering and grain colour, *Perungulai* was almost same as that of their local variety (Annexure 9 (xii)). However, 50-54 % of the participating farmers expressed its higher yielding ability in terms of grain and straw yields. Only concern expressed by the one third of the participating farmers was lodging. About 78% of the farmers have expressed their willingness to save seeds for the next year, thereby indicating the positive orientation towards *Perungulai* variety. Given the consistent better performance of *Perungulai* for the past 3 years across the site villages, it could be considered as highly suitable for the location and necessary initiatives need to be taken for its wider dissemination in and beyond the working villages.

Koluthana - Seeds were distributed to 144 farmers from 22 villages in 4 *panchayats*. About 56% of the participating farmers found that *Koluthana* variety matured earlier than the prevailing variety (Annexure 9(xiii)). In other aspects like lodging, grain shattering, damage by rains during maturity and grain colour *Koluthana* was almost same as that of their local variety. However, 64 % and 68 % of the participating farmers expressed its higher yielding ability in terms of grain and straw yields, respectively. Only concern expressed by the one third of the participating farmers was less tolerance to dry spell. About 86% of the farmers have expressed their willingness to save seeds for the next year. Given the consistent better performance of *Koluthana* for the past 3 years across the site villages, it could also be considered as highly suitable for the location and necessary initiatives need to be taken for its wider dissemination in and beyond the working villages.

CO 4 - Seeds of CO-4 variety were distributed to 75 farmers of 13 villages in 4 *panchayats* and feedback from individual farmers was collected in 50 cases (Annexure 9(xiv)). In many aspects like duration, tolerance to dry spell, lodging, grain shattering, damage by rains during maturity and grain colour, CO 4 was almost same as that of their local variety. Majority of farmers opined that its grain and straw yielding levels were either same (40-54 % cases) or even better (36-48 % cases) indicating its marginal superiority over the local varieties. On the other hand one third of the farmers observed less tolerance in CO-4 to dry spell and lodging. About 78 % of participating farmers indicated their willingness to save its seeds. The performance of CO 4 variety for the past four years indicated that though it did not have striking advantages over the local varieties, it can surely be considered as one of the alternative variety for the existing short duration little millet varieties. As the agriculture department is actively promoting CO 4 variety, future efforts can be made keeping this in mind.

iv) Synthesis of Little Millet PVS Trials

There are two groups of varieties viz. short duration types maturing in 100-120 days and long duration ones maturing in 150-170 days, which are being cultivated with equal importance in the site. In

general, yielding ability of the existing varieties of little millet, both traditional and improved, is very low as compared to other small millet crops. In the last 4 years, 17 traditional varieties and 7 released varieties were tested (Table- 4.42) and with the available genetic resources it was possible to identify CO-4, *Koluthana*, and *Perungulai* varieties among short duration group. In addition, *IR-20*, Paiyur-2 and *Vellai samai from Pudur Nadu* in short duration group and *Siru samai, Kothu samai and Karun samai* in long duration group were also short listed as promising varieties to be tested in the coming years.

Table 4.42: Synthesis of little millet PVS trials in Jawadhu Hills, 2011-2014

Type of variety	2011	2012		2013		
	Mother trial	Mother trial	Baby trial	Mother trial	Baby trial	IRD
Traditional-Short duration	*Sittan samai, Karun sittan, Koluthana*	*Sittan samai, Karun sittan, Koluthana, Siruvellai, Perungulai, IR-8*		*Sittan samai, Kadari-1, IR-20*	*Perungulai, Koluthana*	--
Traditional-Long duration	*Vellai samai*			*Kallumannu, Vellai samai, Kala suan, Bada suan, Siru samai*		
Released	CO-2, CO-3, CO-4, OLM-203	CO-4, JK-8,	CO-4	Paiyur-2, Kolab	--	CO-4
Total	**8**	**8**	**1**	**10**	**2**	**1**

Table 4.42: Synthesis of little millet PVS trials in Jawadhu Hills, 2011-2014 - continued

Type of variety	2014			Output	
	Mother trial	Baby trial	IRD/ Popularising	FPV identified	PV# for further testing
Traditional-Short duration	*Sittan samai, Vellai samai* from Pudur nadu and *IR 8* from Pudur nadu	*IR 20*	*Perungulai, Koluthana*	*Perungulai, Koluthana*	*Vellai samai* from PN, *IR-20*
Traditional-Long duration	*Vella samai, Kothu Samai, Karun samai*	*Siru samai*			*Siru samai, Kothu samai* and *Karun samai*
Released		--	CO-4	CO-4	Paiyur 2
Total	**6**	**2**	**3**	**3**	**6**

FPV- Farmers' preferred variety; #- PV- Potential variety

4.2.2 Project Site: Semiliguda

i) Mother trials

2011 - Sixteen mother trials involving 8 little millet varieties (6 traditional and 2 released) were taken up in 2011. But due to long dryspell after sowing and insect damage all the trials failed. So the same varieties were included in the 2012 mother trial.

2012 - There were several mother trials during 2012, out of which two were replicated trials (RCBD) at the site. Because of heavy rainfall during early stages of crop growth, the performances of little millet

varieties in the trials were adversely affected. Yield levels in the mother trials across the site varied from as low as 70 to 182 kg/ac. However, the performance of varieties was found to be better in RCBD trial at CPR, Berhampur. The average values of growth and yield parameters of mother and RCBD trials are furnished in Table-4.43 and 4.44, respectively. The values of all the parameters showed considerable variation among the varieties, but the differences among values were not significant for plant population and grain yield in mother trials. However, the maximum grain yield of 182 kg/ac was recorded in *Bada suan*, which was followed by *Kala suan* with 174kg/ac. On the other hand in RCBD trial, RLM-43, a short duration variety, recorded the highest yield (472.3 kg/ac) closely followed by OLM-203 with 455.7 kg/ac, which is a popular improved variety of medium duration.

The FPA was conducted in RCBD trial at the research centre, Berhampur. All most all the participants showed their preference to *Bada suan,* as in their opinion the variety is easy for harvesting and threshing; it also performs well on sloppy lands.

Table 4.43: Mother trial of little millet varieties at Semiliguda, 2012

Varieties	Growth and Yield Parameters						
	Duration	Plant population/ m^2	Plant Height (cm)	Productive Tiller/Plant	Panicle Length (cm)	Grain Yield (kg/ac)	Straw yield (Kg/ac)
Bada suan	Long	40.7	68.6	2.16	24.7	182	1020
Kala suan	Long	37.7	67.7	2.16	26.5	174	820
TNAU-140	Medium	38.8	36.9	2.60	20.3	70	1190
Ganjei local	Long	33.2	71.3	1.95	25.0	136	900
OLM-203	Long	41.4	32.9	2.30	16.5	88	1430
Kolab	Short	46.2	28.3	2.30	14.9	116	1520
RLM-40	Short	39.1	28.9	2.10	12.6	110	1330
Machili Suan	Long	45.6	54.3	1.97	21.6	88	1040
CO-2	Medium	42.3	32.1	2.70	19.7	108	1410
Mami Suan	Short	41.7	26.0	2.07	14.5	126	1190
JK-8	Short	37.8	50.6	1.98	17.1	136	660
MEAN	**--**	**40.4**	**45.2**	**2.21**	**19.4**	**121.3**	**1140**
SEM	**--**	**3.3**	**3.7**	**0.14**	**1.5**	**0.1**	**60**
CD(0.05P)	**--**	**NS**	**10.3**	**0.39**	**4.3**	**NS**	**340**
CV (%)	**--**	**31.1**	**32.0**	**23.9**	**30.0**	**88.5**	**40.6**

Table 4.44: Replicated mother trial of little millet varieties at CPR, Berhampur, 2012

Varieties	Growth and Yield Parameters						
	Days to 50 % flowering	Days to Maturity	Plant Height (cm)	Productive tiller/ Plant	Panicle Length (cm)	Grain yield (kg/ac)	Straw Yield (Kg/ac)
Bada Suan	72	103	131.4	1.9	32.0	255.7	1110
Mami Suan	48	78	100.8	2.9	25.5	283.3	1500
Ganjei local	66	97	130.4	1.9	32.7	255.7	1180
Kolab	40	70	114.9	3.2	31.9	383.3	1410

Varieties	Growth and Yield Parameters						
	Days to 50 % flowering	Days to Maturity	Plant Height (cm)	Productive tiller/ Plant	Panicle Length (cm)	Grain yield (kg/ac)	Straw Yield (Kg/ac)
OLM 203	70	101	103.6	3.2	32.5	455.7	1300
RLM 43	43	73	110.3	3.0	33.7	472.3	1240
JK 8	46	76	105.5	3.0	31.1	294.3	1260
Machili Suan	72	103	133.6	1.9	30.1	266.7	1160
CO-2	60	91	120.7	3.0	32.5	311.0	1260
Kala Suan	74	105	123.9	1.8	29.0	289.0	1420
MEAN	**59.1**	**89.7**	**117.51**	**2.58**	**31.1**	**326.7**	**1284**
SEM	**--**	**--**	**--**	**--**	**--**	**30.5**	**--**
CD (0.05P)	**--**	**--**	**--**	**--**	**--**	**90.8**	**--**
CV (%)	**--**	**--**	**--**	**--**	**--**	**16.2**	**--**

2013 - Little millet mother trials (Long duration varieties) - During 2013, out of 20 trials planned, complete data was available from 14 trials. The same set of long duration varieties included at Jawadhu Hills was planned to evaluate at this site also but the seeds of *Siru samai* failed to germinate and the seeds of a short duration variety (Kolab) were used in place of OLM-203.The mean values of growth and yield parameters of five varieties are presented in Table-4.45. Days to 50% flowering varied from 76 *(Kolab)* to129 *(Vellai samai).* Plant population varied considerably due to poor seed germination (59 to 107 plants/sq.m). *Kallumannu samai* was recorded maximum plant height of 128.8 cm followed by *Vellai samai* (112.5 cm), *Kala suan* (65.9 cm), *Bada suan* (65.8cm) and *Kolab* (58.3cm). Productive tillers varied from 1.37 *(Bada)* to 1.85*(Kolab).* Length of panicle recorded in *Kallumannu* was the maximum (40.67 cm) followed by *Vellai samai* (37.87 cm), while the values were comparatively less in case of *Bada, Kala* and Kolab.

There was no flowering in *Kallumannu* and *Vellai samai* in eleven trials due to dry spell and hence yield data from only 3 trials was recorded. There was not much difference of grain yield between *Bada suan* (733.0 Kg/ac) and *Kala suan* (787.9 Kg/ac). Grain yield of *Kallumannu* was higher than that of other varieties including *Vellai samai.* The straw yield of *Kallumannu samai* was comparatively more due to tall plant height as well as more plant population. *Bada* and *Kala suan* showed the incidence of shoot fly in three trials, while it was noticed on *Kallumannu samai* in one trial. *Bada* and *Kala suan* were found to be relatively more tolerant to moisture stress than other varieties.

Table 4.45: Performance of long duration varieties of little millet in mother trials, Semiliguda 2013

Varieties	Days to 50% flowering	Plant popn/m^2	Plant height (cm)	Productive tillers	Panicle length (cm)	Grain yield (Kg/ac)	Straw yield (Kg/ac)	P&D incidence	Tolerance to stress
Bada suan	108	71	65.8	1.37	28.87	733.0	2824.3	3	High
Kala suan	96	68	65.9	1.41	28.31	787.9	2834.3	3	Moderate
Kolab	76	59	58.3	1.85	27.27	444.4	2372.9	Nil	Low
Kallumannu	121	107	128.8	1.73	40.67	843.3*	4120.0*	1	Low
Vellai samai	129	107	112.5	1.67	37.87	520.0*	3426.7*	Nil	Low

*Data taken from only three trials out of 14 trials

The opinion of the participating farmers on the performance of varieties is given in Table-4.46. It could be seen that all the farmers indicated first preferences for *Bada suan* and second preference for *Kala suan*. Since the crops of *Vellai* and *Kallumannu samai* (seeds collected from Jawadhu Hills) failed in most of the trials, farmers were unable to indicate their preference regarding these varieties. According to farmers the salient features of *Bada suan* are high yielding ability, better grain quality, ability to withstand adverse climatic conditions and least affected by weeds. Hence, all of them showed willingness to grow *Bada suan*, while one farmer got interested in *Kala suan*.

Table 4.46: Farmers' preference ranking for little millet varieties (long duration), Semiliguda

Preference ranking	Bada suan	Kala suan	Kolab
1	14	0	0
2	0	14	0
3	0	0	14
4	0	0	0
Willingness to grow	13 (92.8%)	(7.2%)	0

ii) Baby Trials

2013 - The seeds of *Kala suan*, a long duration variety identified through mother trials of last year (2012), were distributed among 72 farmers of different villages in three clusters, which were formed based on different agro-climatic conditions of the site. *Kala suan* was tested in baby trials along with *Bada suan*, as the check variety. For quantitative assessment, yield data of *Kala suan* and *Bada suan* were collected in 29 randomly selected trials and the results are presented in Table-4.47. However, perception of the participating farmers regarding the test variety was not encouraging. The results indicated that the grain and straw yields of *Kala suan* were lower in majority of the trials than that of *Bada suan* and the extent of decrease in yields were 27.2% and 21%, respectively.

Table 4.47: Performance of Kala suan variety of little millet in baby trials, Semiliguda, 2013

Yield parameters	No. of trials	Yield performance of		Per cent increase	No. of trials with		
		Kala suan	Bada suan		Increase	Decrease	Equal
Grain yield (kg/ac)	29	400.75 (115-800)	550.4 (105-830)	-27.2	7	21	1
Straw yield (kg/ac)		2950.6 (2000-3820)	3736.1 (2100-5000)	-21.0	3	25	1

*Figures in parentheses are range of mean values

In the views of participating farmers *Kala suan* was either similar or slightly short duration than the check variety (Annexure-5 (iii)). Among 48 farmers' responses, 24 indicated that it had more, 9 as same and remaining 15 as less tolerance to dry spell as compared to their varieties. This year, there was no severe problem for damage by rains during maturity as well as grain shattering among the responded farmers' field trials. Majority of the farmers (more than 55%) opined that its lodging was also similar to their own varieties. Though majority of the farmers, more than 50%, considered the yielding ability of

Kala suan less, about 22% of them indicated as better, and remaining farmers felt same as of their own varieties.

2014 - In order to popularize the existing varieties of little millet, the purified seeds of *Kala suan* as well as that of *Bada suan* were distributed to about 200 farmers during 2014. Interestingly the crops of both the varieties were excellent compared to those of previous years, despite the devastating effect of cyclone. The farmers' perception regarding the performance of these two varieties during the year was, however, not much different from that of last year. Majority of the farmers showed more preference to *Bada suan* than to *Kala suan*. During the year 3 new local varieties of medium duration were collected from the neighboring areas and included in the biodiversity blocks of 2014. They appear to be promising and need proper evaluation.

iii) Synthesis of Little Millet PVS Trials in Semiliguda

In the last three years 10 local varieties and 6 released varieties were tested in PVS trials (Table- 4.48). Since *Bada suan* is the only popular long duration variety of little millet in the site, it was felt the need of introducing 1 or 2 suitable high yielding long duration varieties. In one of the trials at the research centre (CPR, Berhampur) during 2012, *Kala suan* was identified as a result of farmers' preference analysis. It is similar in appearance to *Bada suan* in many respects except for purple pigmentation, especially in the panicle. But the results clearly indicated that it failed to find the farmers' acceptance. OLM-203, an improved variety with same duration as that of *Bada* or *Kala suan,* is also not well received by the local farmers. The search for new varieties needs to be continued.

Table 4.48: Synthesis of little millet PVS trials in Semiliguda, 2011-2014

Type of variety	2011	2012	2013		2014
	Mother trial	Mother trial	Mother trial	Baby trial	Popularisation
Traditional	*Bada suan, Ganjei, Mami suan, Guruji, Bapa, Jura jotli*	*Bada suan, Kala suan, Ganjei, Mami Suan, Machili suan*	*Bada suan, Kala suan, Vellai samai, Kallumannu samai*	*Kala suan*	*Bada suan, Kala suan*
Released	OLM-203, Kolab	OLM-203, Kolab, CO-2, JK-8, RLM-40, TNAU140	Kolab	--	--
Total	**8**	**11**	**5**	**1**	**2**

4.3 Barnyard Millet

4.3.1 Project Site: Peraiyur

i) Mother Trials

2011 - Totally 19 varieties of Barnyard millet were evaluated during 2011, but each mother trial had different set of varietal combination. The results of pooled data from all the trials (14) are presented in Table-4.49. Most of the varieties attained 50% flowering between 50 to 65 days indicating not much variation in duration. Average plant population among the varieties in different trials ranged from 14,000 to 23,000 plants/ac. Mean height of the plants in all the varieties was recorded more than 100 cm and CO-2 recorded the highest value of 142.1 cm. Number of tillers/plant varied from 2.9 (TNAU 157) to 4.7 (CO-2). The maximum panicle length of 26.5 cm was recorded in CO-2 followed by *M* (26.3 cm)

and *V-1* (25.9 cm). Highest number of branches per panicle (49.5) was noticed in *V-1* followed by *M* (48.4), *Pullu* (40.4) and CO-2 (40.3). Panicle weight and grain weight /panicle were found to be considerably high in CO-2 and *Sadai kuduravali* as compared to the rest of the varieties. Next best was *Pullu kuduravali*. As a result the estimated grain yield observed in CO-2 and *Sadai* was 1213 and 1134 kg/ac, respectively, while the values for other varieties were less than 800 kg/ac. VL-29, *Pullu* and *M* recorded more than 700 kg/ ac grain yield, indicating the next best varieties.

Table 4.49: Performance of barnyard millet varieties in mother trials at Peraiyur site, 2011

S. No.	Variety	Days to 50% flowering	Plant popn (x1000)	Plant height (cm)	No. of tillers/ plant	Panicle length (cm)	No. of branch/ panicle	Panicle weight (g)	Grain wt /panicle (g)	Grain yield (Kg/ac)
1	*Sadai*	64.5	20.0	124.1	4.2	23.5	37.4	17.0	13.5	1134
2	*Pullu*	62.6	17.2	118.1	3.6	21.5	40.4	14.7	11.5	712
3	VL-29	48.9	22.8	111.3	4.3	21.2	33.2	11.5	8.1	794
4	VL-172	50.6	19.2	117.6	3.3	22.1	31.1	11.1	8.7	551
5	*M*	60.4	16.4	128.1	4.6	26.3	48.4	12.9	9.9	747
6	*M-1*	59.3	15.2	116.8	3.6	21.6	39.6	12.3	9.4	514
7	M-2	61.2	15.2	115.1	3.7	23.6	34.8	10.8	9.0	506
8	M-3	61.5	15.2	115.6	3.7	21.2	34.2	12.7	9.5	534
9	*V-1*	62.0	16.0	135.4	4.4	25.9	49.5	15.0	9.7	683
10	V-2	59.0	16.8	111.1	3.4	20.4	33.0	10.3	7.7	440
11	V-3	59.0	17.6	111.3	3.7	21.5	37.2	10.7	8.0	521
12	V-4	59.0	17.2	116.5	3.5	21.2	35.8	12.9	9.3	560
13	CO-2	63.3	20.0	142.1	4.7	26.5	40.3	17.0	12.9	1213
14	TNAU151	62.3	17.2	103.4	3.6	19.7	32.3	6.5	3.9	241
15	TNAU153	62.5	18.0	112.5	3.2	20.3	35.5	6.3	3.9	225
16	TNAU157	63.7	14.0	109.4	2.9	19.7	33.0	6.1	3.7	150
17	TNAU159	62.7	16.8	115.8	4.1	18.4	29.7	5.9	3.5	241
18	TNAU160	62.7	16.8	112.1	3.7	21.4	32.5	6.9	4.2	261
19	Val	66.5	22.0	114.6	4.0	23.9	36.0	12.2	7.4	651

Farmers' Preference Analysis - One of the mother trials of Barnyard millet located at Kottaipatti village was chosen for the FPA activity, which was held on 15-12-2011. The mother trial consisting 12 varieties of Barnyard millet was sown on 8-10-2011 in the field of Mr. Sankarpani. The condition of the crop was good with most of the varieties at maturity stage and a few at milky stage. A group of 7 farmers participated in the analysis; though the number appears to be less they all had good experience regarding the crop. The preference score values of the farmers are furnished in Annexure-1e. Among 12 varieties tested, CO-2 got maximum overall score of 15, followed by *M*. In the opinion of farmers the variety had good stand, large size compact panicle, good tillering, higher seed weight and fewer husks. Variety M also had long compact panicle with less chaffiness and attractive stand. *M-1* and *Pullu*, whose performance found to be similar to *Sadai*, have also gained first preference by some farmers.

Due to lack of proper identification, most of the entries in the trial appeared similar though called by different names. It is necessary to initiate a systematic work for collection, purification and characterization for proper documentation and utilization of local germplasm of Barnyard millet. Farmers also expressed their concern on weed problem, might be Striga, incidence of smut and Aphids as they might cause yield losses to some extent.

2012 - During 2012, the cropping season was not ideal as onset of monsoon was delayed for a long period and rainfall was also scanty. The trials were badly affected. The expected field data could not be collected. Ten varieties of barnyard millet were tested in the trials. The available data indicated that *Sadai, Arupukottai* and *M* varieties as top yielders with more than 1000 kg/ac grain yield (Table-4.50). These varieties also secured maximum preference values during FPA (Annexure 2). Since *M* variety was already included in baby trial during 2012, *Arupukottai* was chosen for including in baby trials of 2013.

Table 4.50: Performance of barnyard millet varieties in mother trials at Peraiyur site, 2012

Varieties	Plant height (cm)	Panicle length (cm)	Grain yield (Kg/ac)	Straw yield (Kg/ac)
Sadai Kuduravali	137.2	24.2	1131.0	2540
M	129.4	24.8	1005.3	2210
M-1	127.2	24.0	954.4	2060
Arupukottai	131.6	22.2	1048.0	2390
Pullu Kuduravali	142.3	24.5	623.5	1620
CO-2	131.6	22.2	785.0	1810
V-1	119.8	23.0	851.5	1900
V-2	130.2	24.2	685.0	1700
V-4	122.2	22.2	813.0	1950
Val	127.4	23.6	700.9	1840

ii) Baby trials

2012 - Varietal diversity in Barnyard millet was found to be very limited in Peraiyur site and based on the results of mother trials of previous year (2011), three varieties were selected for baby trials of 2012. (Table-4.51). CO-2, *M* and *M-1* were the test varieties which were evaluated against the popular local variety *Sadai kuduravali*. CO-2 is an improved variety from TNAU, while *M* and *M-1* are the selections made in one of the local seed source (Mallankinaru). *M* is lightly purple pigmented while *M-1* plants are free from such pigmentation. All of them recorded higher grain yield over the local check, but the differences in yields were not much. However, most of the farmers showed their willingness to cultivate them. In order to enhance the local varietal diversity in barnyard, all of them need to be promoted.

Table 4.51: Performance of CO-2, M and M1 varieties in baby trials at Peraiyur site, 2012

Test variety	Number of trials	Average grain yield (Kg/ac)			Check varieties	Farmers' willingness	
		Test variety	Check variety	Increase/ Decrease		Yes	No

Test variety	Number of trials	Average grain yield (Kg/ac)			Check varieties	Farmers' willingness	
		Test variety	Check variety	Increase/ Decrease		Yes	No
CO-2	15	1040 (560-1400)	992 (480-1360)	12/3	*Sadai Kuduravali*	Most of the farmers preferred all the test varieties due to their high yielding ability; *Sadai* is a popular local variety but needs purification	
M	16	1196 (760-1420)	1104 (720-1360)	15/1	*Sadai Kuduravali*		
M-1	16	1148 (680-1480)	1076 (628-1424)	12/3	*Sadai Kuduravali*		

2013 - *Arupukottai*, being chosen from mother trials of 2012, was tested in 83 baby trials during 2013. The test variety used in all these trials was *Sadai,* a popular local variety. Its grain yield varied from as low as 200 Kg/ac to 1040 Kg/ac, with overall average yield of 594 Kg/ac. Some of the trials were badly affected by moisture stress. Since yield data from check variety was not recorded, results of only farmers' feedback (Annexure-6 (i)) are discussed here. Duration of the test variety was same (77.1% cases) or slightly earlier (22.9% cases) than *Sadai* in the opinion of majority of farmers. Its tolerance to dry spell was similar or slightly better, while lodging and grain shattering were not major issues among the traits. About 61% farmers expressed that it showed more damage by rains during maturity, while in rest of the trials it was as good as that of *Sadai.* Majority of the farmers indicated its higher yielding ability, only about 40% of farmers mentioning its lower yields than the check variety. The main features of *Arupukottai* noticed by the farmers are high yielding ability (grain and fodder yield), compact big panicle and less chaffy grains. About 23% of farmers saved seeds for use in next season.

iii) Informal Research and Development

2013 - The objective of this trial was to confirm the suitability of *M (Mallankinaru)* variety, which was identified through mother-baby trials during previous years, by testing in the fields of large number of farmers in the site. The farmers' feedback information was collected from 99 trials during 2013 and the results are furnished in Annexure-7(vi). Assessments of the participating farmers were based on their perception of *M* in respect of its growth and yield performances as compared to their own variety, namely *Sadai*. They found that *M* takes more days for maturity, about 10-15 days than their local variety. According to the views of farmers, performance of *M* is similar to that of local variety in duration (about 90% cases), grain shattering (46.2% cases) and damage by rains at maturity (72.2%). About 66% of the farmers were of the opinion that *M* variety showed more tolerance to dry spell than the check variety. More than 46% of participating farmers expressed that *M* variety has better yielding ability, both gain and straw, while about 29-35% of them said as same and about 16-25 % as less yielding as compared to their own varieties.

2014 -In the same way two more varieties, CO-2 and *Arupukottai*, which were identified in 2011 and 2012 were also subjected to IRD. The seeds of CO-2 were distributed to 230 farmers, of them 50 farmers shared their opinion on its performance (Annexure 9(xv)). Another 28 farmers received the seeds of *Arupukottai* variety and feedback was collected from all of them (Annexure 9(xvi)). Unfortunately, crops of both the varieties suffered to some extent due to moisture stress because of long dry spell after the seed germination stage. Good rains were received in the region only after two months and consequently increase in moisture level helped the crop to recover.

Majority of the farmers opined that the performance of CO-2 was either same or better than their variety for duration and tolerance to dry spell. Lodging, damage by rains at maturity and grain shattering were, however, not the critical issues and there was not much difference between the performance of CO-2 and the local varieties on these aspects, if any, according to some farmers. About 30-36% of the farmers assessed the grain and straw yields of CO-2 as low compared to their own varieties, while the remaining farmers indicated its yield performance either same or better. About 74% of farmers saved the seeds of the variety for future use showing favourable response for the variety.

Prevalent and selected varieties of barnyard millet at Peraiyur

As for as *Arupukottai* variety is concerned, according to the participating farmers its performance was not poor in most of the parameters listed except for yields, where only less than 18% of them indicated as poor (Annexure 9(xvi)). Perception of the majority of the farmers, however, indicated that *Arupukottai* was either same or better than the local varieties in respect of each parameter studied. For instance, 56% of the farmers assessed *Arupukottai* as same and 25% as better than the local popular variety *Sadai*. It was pleasing to see the pure crop of *Arupukottai* in one of the fields but most of the fields of this variety had some mixtures. Probably this might be the one of the reasons for only half of the participating farmers showed willingness to save its seeds. So, purification was also taken up in the selected fields with good crop stand to get quality seeds of this traditional variety.

iv) Synthesis of Barnyard Millet PVS Trials in Peraiyur

In the project period 12 local varieties, 3 released and 5 pre-release varieties were tested in the PVS trials (Table-4.52). The local popular variety *Sadai* performed consistently well during all the four years and remained farmers' most preferred variety. But it was found to be losing its identity in the site due to mixtures. However, the identified other two local varieties, *M and Arupukottai* and one released variety CO-2 were also found to be equally good and need to be promoted with quality seeds to reach more number of farmers. Another variety *M1* was also found to be equally good as *M* variety, but due to lack of sufficient quantity of seeds it was not possible to take up trials for further evaluation. Considering the yield potential of *Sadai*, the seeds of this variety were supplied to AICSMIP Centre, Bangalore, for inclusion in national formal evaluation programs.

Table 4.52: Synthesis of barnyard millet PVS trials in Peraiyur, 2011-2014

Type of variety	2011	2012		2013		2014	Output	
	Mother trial	Mother trial	Baby trial	Baby trial	IRD	FPV* dissemi-nated	FPV* identified	PV# for further testing
Traditional	*Sadai, Pullu, M, M1, M2, M3, V1, V2, V3, V4, Val*	*Sadai, Pullu, Arupukottai, M, M1, V1, V2, V4, Val*	*M, M1*	*Arupu-kottai*	*M*	*M, Arupukottai*	*M, Arupukottai*	*M1*
Released	CO-2, VL-29, VL-172	CO-2.	CO-2	--		CO-2	CO-2	--

Pre-release	TNAU-151, 153, 157, 159, 160	--	--	--	--	--		--
Total	**19**	**10**	**3**	**1**	**1**	**3**	**3**	**1**

FPV- Farmers' preferred variety; #- PV- Potential variety

4.4 Kodo Millet

4.4.1 Project site: Peraiyur

i) Mother Trials

Kodo millet crop, Peraiyur

2011 - At Peraiyur site, area under Kodo millet is less as compared to Barnyard millet and its varietal diversity is also not much in the local germplasm. Only four varieties, two improved and two local, were tested in 5 mother trials during 2011. The field data was recorded only from two trials as the crop in other trials got damaged due to water logging in the field. The results indicated that both the local varieties are late maturing, taller in height with bigger panicle size as compared to the improved varieties (Table-4.53). The improved varieties, however, showed better tillering ability than the local varieties. In general grain yield was low due to poor crop growth. The highest panicle weight (1.96 g) and grain weight per panicle (1.72 g) was recorded in *Siru varagu* indicating its high yielding ability. Both the improved varieties (GPUK-3 and RBK-155) produced almost same grain weight per panicle. Observation in the field revealed that the crop stand of both the local varieties was better than the improved varieties. The local varieties were also free from leaf disease, while both the improved varieties were found to be susceptible to the disease. Such studies on Kodo millet need to be taken up in the areas where the crop is being grown extensively in order to increase the productivity of the crop using the local resources.

Table 4.53: Performance of Kodo millet varieties in mother trials at Peraiyur, 2011

S. No.	Variety	Days to 50% flowering	Plant popln/m^2	Plant height (cm)	No. of tillers/ plant	Panicle length (cm)	Fingers /panicle	Panicle weight (g)	Grain weight(g) /panicle
1	*Senthazh*	88	55	92.1	7.0	10.2	3.0	0.94	0.72
2	*Siru varagu*	88	43	84.4	8.5	8.0	3.0	1.96	1.72
3	GPUK-3	58	32	74.9	12.5	5.8	3.5	1.20	0.96
4	RBK-155	58	38	80.7	12.5	6.3	3.0	1.34	0.90

2012 - Due to unfavorable rainfall pattern, crop performance was very poor in most of the trials during 2012. Though there were 10 varieties in the trials crop of 3 varieties failed completely. Among the remaining varieties under test, *Uppu varagu* recorded the highest yield of 512 kg/ac (Table-4.54). The grain yields recorded in *Siru varagu, Senthazh*, and *Kozhikal varagu* were found to be almost similar, around 450 kg/ac. Both men and women groups preferred *Siru varagu, Uppu varagu* and

TNAU-111 based on better panicle and grain sizes of these varieties. *Siru varagu* is also known as *Podi varagu*, which along with other two varieties, *Uppu varagu* and TNAU-111, was recommended for evaluation in baby trails during 2013.

Table 4.54: Performance of Kodo millet varieties in mother trials at Peraiyur, 2012

Varieties	Grain yield (Kg/ac)	Straw yield (Kg/ac)
Karu varagu	384	17.4
Siru varagu	452	17.8
Senthazh	456	17.9
Kozhikal	452	15.7
Uppu varagu	512	18.2
TNAU-86	358	16.3
TNAU-111	350	15.3

2014 - In order to retest some of the improved varieties which were affected badly during 2012 because of unusual rainfall pattern, additional mother trials were planned again during 2014. Totally 9 varieties were tested with different set of varietal combination. The results obtained from the pooled data of 5 trials are presented in Table 4.55. Most of the varieties, except RBK 155, attained 50% flowering between 88 to 90 days indicating not much variation in duration. RBK 155 took only 62 days to reach this stage. Average plant population among the varieties ranged from 17 to 25 plants/sq m. Mean plant height recorded in RBK 155 was the least (40.1 cm), while the values for all other varieties varied between 60 to 77 cm. Number of tillers/plant varied from 17 (RBK 155) to 28 (*Karu varagu*). The maximum panicle length of 11 cm was recorded in *Senthazh varagu* followed by *Karu varagu* (10.1 cm). *Karu varagu* recorded highest grain yield of 432 Kg/ac followed by *Uppu varagu* (348 Kg/ac). *Podi varagu, Senthazh varagu*, TNAU 86, and *Kozhikal varagu* recorded more than 300 Kg/ ac, while RBK 155 was the lowest yielder with just 176 Kg/ac. Straw yields varied from 1960 to 4400 Kg/ac. In general the yields of kodo millet crop were low for the year because of long dry spell during vegetative stage, as there were no rains for a period of two months after sowing.

Table 4.55: Performance of Kodo millet varieties in mother trials at Peraiyur site, 2014

Sl. No.	Variety	Days to 50% flowering	Plant popn/ (Sq.m)	Plant height (cm)	No. of tillers/ plant	Panicle length (cm)	Grain yield (Kg/ac)	Straw yield (Kg/ac)
1	*Uppu varagu*	88	23	70.9	24.0	09.0	348	4000
2	*Podi varagu*	88	23	73.5	24.0	08.6	304	3840
3	*Senthazh varagu*	89	19	60.1	26.0	11.0	320	4400
4	*Kozhikal varagu*	88	21	77.1	26.0	09.1	333	4000
5	CO-3	88	17	71.0	23.0	08.6	240	3500
6	TNAU 86	89	18	67.0	24.0	07.1	320	3900
7	RK 390-25	88	19	71.1	22.1	08.3	267	3460
8	RBK 155	62	16	40.1	17.1	05.0	176	1960
9	*Karu varagu*	89	25	72.0	28.0	10.1	432	4240

Preference analysis indicated that *Karu varagu* was the most preferred variety with maximum overall score of 27 followed by *Podi* and *Uppu varagu* (Annexure 8(vii)). In the opinion of farmers the variety showed good crop stand, more number of panicles and panicle length, good tillering and more straw yield. Uppu and Podi varagu also had more straw, grain yield with good stand.

So the above results indicated once again that none of the available improved varieties were found suitable for the site; and most of the farmers did not prefer any of them because of their poor performance.

ii) Baby Trials

2013 - Three Kodo millet varieties, *Uppu varagu, Podi varagu* and TNAU-111, were considered for baby trials but due to non-availability of TNAU-111 seeds, only two varieties were evaluated during 2013. There were 17 baby trials of *Uppu varagu* along with a local check, *Karu varagu*. Though the test variety recorded higher grain yields in 11 out of 17 trials, overall yield increase was only about 3 per cent over the check variety (Table-4.56).

Table 4.56: Performance of Uppu varagu variety of Kodo millet in baby trials at Peraiyur, 2013

Yield parameters	No of trials	Yield performance of		% increase	No of trials with	
		Uppu varagu	Karu varagu		Increase	Decrease
Grain yield (kg/ac)	17	753 (480-1000)	729 (520-980)	3.29	11	6
Straw yield (kg/ac)		4180 (3740-4680)	4141 (3800-4540)	0.94	9	8

According to the opinion of majority of farmers, *Uppu varagu* had similar performance as that of the check variety for duration, lodging, damage by rains at maturity, grain shattering and straw yield (Annexure-6 (ii)). Majority of them (58.8%) also expressed that it was less tolerant to dry spell than *Karu varagu*. About 40% of participating farmers indicated higher grain yields, 30% as same and another 30% lower yields of *Uppu varagu* as compared to *Siru varagu*. Majority of them indicated their willingness to grow *Uppu varagu* but only few farmers saved the seeds, as most of them sell the produce at threshing yard itself.

There were 16 baby trials of *Podi varagu* with *Karu varagu* as the check variety during 2013. In 11 trials *Podi varagu* recorded higher grain yields than *Karu varagu* and the overall yield increase was only about 4 per cent (Table 4.57). The straw yields of both the varieties were also almost same.

Table 4.57: Performance of Podi varagu variety of kodo millet in baby trials at Peraiyur, 2013

Yield parameters	No of trials	Performance of		% increase	No of trials		Check variety
		Test variety*	Check variety		Increase	Decrease	
Grain yield (kg/ac)	16	641 (380-840)	616 (226-720)	4.05	11	5	*Karu varagu*
Straw yield (kg/ac)		4250 (3920-4840)	4258 (3980-4780)	-0.18	7	9	

The results of farmers' perception about the test variety are given in Annexure-6 (iii). *Podi varagu* was either same (56.3% cases) or earlier in duration (43.7% cases) compared to the check variety, as per the farmers' feedback information. Most of the farmers (68.7%) opined that it is less tolerant than *Karu varagu* to dry spell, while it was considered as similar with respect to lodging, grain shattering, and damage by rains as that of check variety. The straw yields of test variety were same or less than that of *Siru varagu*, as viewed by many of the farmers.

2014 - Three varieties, *Uppu varagu*, *Podi varagu* and RBK-155 were tested together again during 2014 along with *Karu varagu* in 14 trials. The results revealed again the superiority of local check, *Karu varagu.*

iii) Synthesis of kodo millet PVS trials in Peraiyur

The varietal diversity in Kodo millet at the site is not much and their yielding ability is at more or less same level. In the project period 5 local varieties, 4 released varieties and 4 pre-release varieties tested (Table-4.58). None of the improved varieties tested during last four years showed satisfying performance. Though *Uppu varagu,* a local variety appeared to be promising but considering the least preference by the farmers, there is a need for further efforts in order to bring new available high yielding varieties for testing or to initiate varietal improvement through genetic manipulation using local germplasm.

Panicles of popular varieties of kodo millet at Peraiyur

Table 4.58: Synthesis of kodo millet PVS trials in Peraiyur, 2011-2014

Type of variety	2011	2012	2013	2014		Output
	Mother trial	Mother trial	Baby trial	Mother trial	Baby trial	PV# for further testing
Traditional	*Siru varagu, Senthazh*	*Podi varagu, Senthazh, Karu varagu, Uppu varagu, Kozhikal varagu*	*Uppu varagu, Podi varagu*	*Podi varagu, Senthazh, Karu varagu, Uppu varagu, Kozhikal varagu*	*Uppu varagu, Podi varagu*	*Uppu varagu*
Released	RBK-155,	CO-3	--	CO-3, RK 390-	RBK 155	

Type of variety	2011	2012	2013	2014		Output
	Mother trial	Mother trial	Baby trial	Mother trial	Baby trial	PV# for further testing
	GPUK-3			25, RBK-155		
Pre-release	--	TNAU- 51, TNAU-86, TNAU-111, TNAU- 81	--	TNAU-86	--	
Total	**4**	**10**	**2**	**9**	**3**	**1**

PV- Promising variety

Organoleptic test

The identified varieties of small millets through PVS were subjected to organoleptic test for assessing with respect to certain desirable attributes related to consumption such as taste, colour, dough consistency, cooking time and general appearance. For the assessment two different local recipes were prepared using the grains of finger millet, little millet and barnyard millet at three project sites. At each site a group of evaluators consisting both men and women were given orientation regarding the criteria for assessment. The details regarding types of recipe in each crop and number of evaluators are furnished in table below (Table 4.59) and the results of tests conducted at site are presented in the following sections.

Table 4.59: Details of organoleptic test in small millets at project sites

Project site	Small millet crop	Varieties tested	Recipes	Number of evaluators	
				Women	Men
Anchetty	Finger millet	*Kempu ragi*, ML-365, *Saratha*, GPU-28, Indaf	*Ragi mudde (Kali),*	5	5
			Ragi rotti (bread)	5	5
Jawadhu Hills	Little millet	CO-4, *Koluthana, Perungulai*, *IR-20, Sittan, Siru samai, Vella samai*	*Samai* cooked rice,	6	6
Peraiyur	Barnyard millet	CO-2, *M, Sadai, Arupukottai, M1*	*Sadham* (cooked rice)	5	5

Project site: Anchetty

Five varieties of finger millet, including 3 identified and 2 popular local varieties were subjected to organoleptic test at the site by involving the members of the local community. Before preparing the two selected recipes for the test, flour recovery was assessed by using equal quantity of grains from each variety for milling (Table 4.60). The results indicated not much variation for flour recovery among the varieties tested as the percent recovery values were within 0.5 by weight and within 4.11 by volume. ML-365 recorded maximum of 71.07 % flour recovery by volume followed by GPU-28 (70.54%) and *Kempu ragi* recorded the least value (66.96%).

Table 4.60: Assessment for flour recovery of finger millet varieties at Anchetty

Variety	Grain quantity (Kg)	Flour quantity (Kg)	Flour quantity (by volume)*	Flour recovery (%)	
				By weight	By volume
Kempu ragi	2.8	1.998	1.875	71.36	67
Saratha	2.8	1.994	1.9	71.21	68
ML-365	2.8	1.996	1.99	71.29	71
GPU-28	2.8	1.988	1.975	71	71
Indaf	2.8	1.984	1.925	70.86	69

*A measuring vessel locally called half *Padi* was used to measure the volume of flour

The scores given to the two recipes (*Ragi mudde and Ragi rotti*) by the individual evaluators are given in Annexure 10(i). For *ragi mudde, Saratha* variety ranked first with mean score of 2.0 (on 5-point scale, score 1=the most and score 5=the least preferred) followed by GPU-28 (2.7) and *Kempu ragi* (3.1). In addition to taste, smell and consistency of *ragi mudde* recipe, the evaluators observed the quantity of water required for preparing the recipe using same quantity of flour. *Saratha* flour took more water and GPU-28 flour less water as compared to other 3 varieties to get same consistency of the recipe. The recipe from *Kempu ragi* was light brown in colour while it was dark brown in case of other varieties; and it had a different smell while cooking and it got attracted by the participants. The participants also expressed that dough volume of Kempu ragi appeared to be more (5 ½ *mudde* ie balls of approximately of equal size) than that of other four varieties (only 5 balls).

Measuring finger millet flour (left); preparation of ragi mudde (center) and ragi rotti (right) at Anchetty

"Kempu ragi may not be good for Kali but it is best for ragi rotti. Everybody likes its colour, smell and smoothness."
Konnamma, Female farmer of Anchetty

Project site: Jawadhu Hills

Organoleptic test at Jawadhu Hills included seven varieties of little millet (5 identified and two popular local varieties). Grains of these varieties (1 Kg each) were de-hulled to get rice for preparing the two recipes, cooked rice and *uppuma*. Rice recovery percent estimated for each variety was also recorded. The highest recovery percent value of 65 was noticed in *IR-20* followed by CO-4 (64), *Sittan* (62), *Vella*

samai (58), *Perungulai* (57), *Koluthana* (55) and *Siru samai* (54). The score values given by the evaluators for each of the two recipes are furnished in Annexure 10(ii). *Sittan* ranked first for both the recipes with average score value of 3 for cooked rice and 2.9 for *samai uppuma*. The cooked rice of *Sittan* was whiter in colour than from other varieties, appearing similar to the normal rice of major cereal. *IR-20* and *Vella samai* were ranked next best for cooked rice recipe, while *Siru samai* and *Koluthana* for *samai uppuma*.

A few observations made by the participants on other attributes are also important. CO-4 grains took more time than the grains of other varieties for cooking rice. In case of *Koluthana* cooking of rice grains was not uniform as some grains remained uncooked. The cooked rice of CO-4, *Vella samai* and *Sittan* was non-sticky, while that of *Perungulai* showed more stickiness.

Cooking of recipes of little millet (left) and the recipes kept ready for testing (right – cooked rice in the vessels and *uppuma* in the plates arranged with code names)

Project site: Peraiyur

Two recipes of barnyard millet were prepared using equal quantity of rice after de-hulling the grains of five varieties. Out of these 4 varieties were from PVS and the other one was popular local variety, *Sadai*. Ten evaluators, 5 men and 5 women, ranked each variety after assessing the two recipes based on taste, colour, appearance and stickiness. The score values given by the individual evaluators are given in Annexure 10(iii). For *sadham* recipe *Arupukottai* variety ranked first with average score value of 1.7. Out of 10 evaluators 7 have given first rank to *Arupukottai*, indicating common acceptance. Sadai was ranked the second best variety (1.9) as for as *sadham* recipe is considered. The score values of *M* and *M1* were almost equal while CO- ranked the least.

It appeared that assessing the varieties based on other recipe (gruel) was little difficult for the evaluators as the differences among average score values was not much, ranging from 2.5 (*Sadai*) to 3.4 (*M*). As per the results, however, *Sadai* scored as first, *Arupukottai* the second and *M1* as third. It is interesting to note that Sadai and Arupukottai were considered most preferred varieties for both the recipes tested.

Evaluators tasting the recipes of Barnyard millet at Peraiyur

The above test was conducted for the first time by the location research staff at each of the three sites. They felt that it was difficult to differentiate the recipes based on the taste when there are more samples but paired-ranking tool helped to some extent. However, developing a systematic protocol with a set of attributes for each recipe would help to make the procedure more effective, which facilitates scoring individual attribute separately. Anyway, the present study helped in realising the importance of the local varieties, especially *Kempu ragi* and *Saratha* varieties of finger millet, *Sittan* and *Vella samai* of little millet, and *Sadai* and *Arupukottai* varieties of barnyard millet in preparing the local popular recipes chosen for the study, hence the possible reason for their preference by the local community.

Summary

One of the main concerns of the RESMISA project was varietal improvement and enhancing varietal diversity of focus small millet crops in each of the project sites. For this purpose PVS was considered as an ideal approach to provide an opportunity to farmers for evaluating local, released and pre-release varieties under their own farm management and agro-climatic conditions. Four cycles of PVS were conducted in all the project sites for the focused four small millet crops during the project period, in spite of encountering various weather aberrations. The project team made special efforts to select farmer experimenters representing different soil types, altitudes, and socio-economic groups. In the four cycles of PVS trials 72 local varieties, 39 released varieties and 10 pre-release varieties of small millets were tested with the cooperation of around 1397 men and 1077 women farmers. In each site for each crop, minimum of 9 to maximum of 25 varieties were tested, including the released varieties from different provinces and local varieties from the nearby areas. The summary of the results in the last four years is given in Table 4.59.

Table 4.59: Results of PVS trials conducted in all the sites during 2011- 2014

Small millet crop	Project Site	No. of varieties included in PVS			No. of farmer preferred varieties identified				Potential varieties identified for further testing
		Local	Released	Pre-Release	Local	Released	Pre-Release	Total	
Finger millet	Anchetty	8	13		2	1		3	
	Bero	4	6	1		4		4	1
	Semiliguda	18	7		--	3		3	2
	Jawadhu Hills	6	6		1	2		3	
Little millet SD	Jawadhu Hills	10	6	--	2	1	--	3	3

Little millet LD		7	1	--		--	--		3
Little millet	Semiliguda	10	6	--		--	--		
Barnyard millet	Peraiyur	12	3	5	2	1		3	1
Kodo millet		5	4	4	--	--	--		1

SD- Short duration; LD- Long duration

One to four farmers' preferred varieties were identified per crop per site. These included 8 released and 7 local varieties. Besides these, 3 released, 1 pre-release and 6 local varieties were identified as potential varieties that need further testing. However, it was not possible to identify farmer preferred varieties for kodo millet in Peraiyur and long duration little millet in Semiliguda in addition to the existing local popular varieties.

Though yield appeared to be the main criteria for assessing the superiority of a variety, farmers' selection criteria included several other varietal traits/ dimensions. In addition to yield related attributes (tillering, panicle size and bold grains), farmers considered crop duration, non-shattering of grains at maturity, and fodder yield as important attributes while assessing varietal performance. Women farmers, in particular, were more concerned with non-lodging, uniform maturity and grain quality traits, such as colour, taste, grain hardiness and keeping quality. The results also revealed that some of the popular traditional varieties from the nearby area were also found suitable for the site (Eg: *Perungulai* variety of little millet in Jawadhu Hills and *M* variety of barnyard millet in Peraiyur). PVS also brought immediate benefits to the target farmers in having access to a large number of potential varieties. They have already with them the seeds of promising varieties identified by them, while the selected varieties have been included in the seed production programme at each project site.

During the 2014 cropping season 7 farmers' preferred varieties identified through PVS were disseminated to 1557 men and 1304 women farmers through the farmers' experimental groups and other community organisations. It is expected that this would lead to varietal diversity at individual farm, at hamlet and at village levels. Further, as these varieties have shown yield increase of 10 to 25 per cent over the check varieties, it is expected that the production would also increase in the coming years. Further a popular local variety of barnyard millet namely *Sadai kuduravali* from Peraiyur site was included in the Initial Varietal Trial (IVT) by AICSMIP because of its good genetic potential.

Finally, by going through the significant qualitative and quantitative results mentioned above, one can assess the efficiency and effectiveness of PVS in addressing the issue of low productivity as well as the sustainability of small millets production in situations like rainfed farming ecosystems. They provide the valuable evidences for those who are advocating wider application of PVS and also for those who are eager to make participatory crop improvement strategy as national mainstream initiative by bringing together different players of PPB and CPB for the benefit of vast number of farming communities of South-East Asian countries. The critical analysis of importance of PVS and strategy for institutionalization of PVS as well as PPB is further discussed in detail in chapter 6, 'Outcomes, lessons learned, conclusion and way forward'.

5. Facilitating Access to Crop and Varietal Diversity of Small Millets

Facilitating access to seeds is the common way forward for on-farm conservation and dissemination of varieties identified through PVS. So, as a follow up of documentation and characterisation of small millets varietal diversity, and PVS, the project had taken up the following activities to achieve on-farm conservation and improving varietal diversity and productivity.

Sources of seed for small millets in project sites

Any intervention related to seed production need to take into account the prevailing seed systems in the target production area. Hence, study of sources of seed for small millet crops was conducted in all the five Indian project sites. The study results are shared cropwise below.

Finger millet: The study revealed that most of the households in Jawadhu Hills (95.24%), Semiliguda (84.5%) and Anchetty (67.07%) sourced the seeds of finger millet from their own farm, while only 46.6 percent of households in Bero depended on that source (Table 5.1). In Bero, fellow farmers also served as an equally important seed source (44.46%). But in Anchetty only 23.17% farmers accessed seeds from their fellow farmers. Only a few finger millet farmers have sourced their seeds from government department and weekly market during the survey year. However, the second major source of seed was government department at Semiliguda site, especially through the block agriculture extension officer (14.73% HHs) to get seeds of released varieties such as Champavati, Chilika and Bhairabi. Weekly market and private agents served as sources of seed only in Bero and Jawadhu Hills sites, that too only to a limited extent (8 and 4 percent households, respectively).

Table 5.1: Seed sources accessed by finger millet growers (%HHs) in project sites

Sources of seed	Anchetty	Bero	Semiliguda	J. Hills
Own farm (reuse)	67.07	46.60	84.50	95.24
Fellow farmers	23.17	44.46	0.78	1.19
Non-government organisations	1.22	--	--	--
Government agencies	4.88	0.97	14.73	--
Weekly market/private agents	1.22	7.77	--	3.57
Total HHs in the sample	82	103	129	84

Source: Baseline survey, RESMISA project, 2011.

The predominant dependence on own farm-saved seeds and within their respective villages by the households of Anchetty site is surprising, given the fact that 89 percent finger millet farmers use the released varieties. Even the disaggregated varietywise source of seed data corroborates this pattern. This may be because they are using those varieties which were released long back (INDAF 5 in 1991, GPU 28 in 1998, MR 1 in 1998) and not the recent ones; and may be the agriculture extension department does not focus on these varieties presently. This situation is different from the adjacent Kodihalli Hobli in Karnataka, where the Agriculture Extension Department has been supplying GPU 28 during the study period.

Little millet: Farm-saved seeds were the only predominant seed source for little millet at Semiliguda (100% HHs) and Jawadhu Hills (97.06% HHs) as per the study results (Table 5.2). In addition, the fellow farmers were the second seed source for about 3 percent households at the latter site. It brings out the fact that no improved varieties of little millet were available at the study sites and the local farmers had to depend on their farm-saved seeds of traditional/ local varieties.

Table 5.2: Seed sources accessed by small millet growers (% HHs) in project sites

Sources of seed	Little millet		Barnyard millet	Kodo millet
	J. Hills	Semiliguda	Peraiyur	Peraiyur
Own farm (reuse)	97.06	100.00	53.33	90.91
Fellow farmers	2.94	--	33.33	--
Non-government organisations	--	--	3.33	--
Government agencies	--	--	--	--
Weekly market/private agents	--	--	10.00	9.09
Total HHs in the sample	136	29	30	11

Barnyard millet and Kodo millet: The major seed source for barnyard millet was own farm-saved seeds (53.33% HHs) followed by fellow farmers (33.33% HHs) at Peraiyur (Table 5.2). For kodo millet, the second important millet crop at Peraiyur, the most dependent seed source was farm-saved seeds (90.91% HHs). It is important to note that about 9-10 percent households sourced the seeds of both the crops through weekly market and private agencies. Since the consumption level of these millets by the local community has drastically come down in recent years, most of the produce is marketed immediately after harvest, even before reaching the house for storage. The farmers who marketed their whole lot of produce might have sourced their seeds in the following season through other sources like fellow farmers, weekly market or private agents.

It can be seen from the above findings that most of the farmers in all the project sites depend on their own seed source irrespective of the type of crop and variety. Further as cultivation of local varieties was predominant in these sites, farm-saved seeds were the main source for majority of the farmers for the focus crops. Informal seed exchange is very limited, even if it happens not beyond their relatives or friends within the village.

Varietal diversity demonstration plots and on-site conservation

Through concerted effort it was possible to understand the status of existing varietal diversity of focused small millet crops in each site. Though their number varies considerably across the sites but in most of the sites the number is not more than 2 at *Panchayat* level. Local farmers might be having fair knowledge about presence of other varieties than their own but they rarely get chance of observing their performance due to their busy work and also due to occurrence of such varieties at far off locations. Under such circumstances it is very difficult for anybody to comprehend and also to appreciate the presence of varietal diversity in any crop of a locality. To overcome these inevitable situations, varietal diversity demonstration blocks was taken up in the project sites. By growing all the available varieties together in a farmers' field with suitable field layout plan, a demonstration plot was established in each *Panchayat* for the benefit of local and other neighbouring farmers. This activity

was taken up in 2013 and 2014 for facilitating on-site conservation and purification of traditional varieties of small millets. Exposure visits for the local farmers and office bearers of community organisations were arranged to create awareness regarding the local varietal diversity.

Table 5.3: Number of small millet varieties in demonstration blocks at project sites, 2013-14

Crops	Year	Anchetty	Bero	Semiliguda	Jawadhu Hills	Peraiyur
Finger millet	2013	15	11	40	--	--
	2014		11	40	--	1
Little millet	2013	--	--	27	17	--
	2014	--	--	10	20	1
Barnyard millet	2014		--	--	--	4
Kodo millet	2014		--	--	--	3
Foxtail millet	2014		--	--	--	2

Farmers visit to the varietal diversity demonstration block for finger millet at Semiliguda, 2014

Varietal diversity demonstration blocks provided an opportunity to create interest among the farmers in certain specific varieties, there by paving the way for demand generation and easy access to the seeds of such varieties of their interest. So, maintenance of such demonstration blocks of biodiversity of focus small millet crops at each specific site gains more importance.

Biodiversity fund

Biodiversity fund was initiated at five sites to motivate the farmers' experimental groups to conserve endangered local varieties beyond the project period. The farmers' groups, which are functioning in project areas of DHAN Foundation, were lent Rs. 10000 to 20000 from the biodiversity fund as revolving fund for one year. The interest accrued through such loans of community organisations has generated income from the biodiversity fund. The financial requirements for establishing biodiversity blocks, and incentives for custodian farmers will be met in future from the income from the fund. By March 2015, 15 farmers' groups in Bero, 7 in Semiliguda, 11 in Jawadhu Hills, 5 in Peraiyur and 22 in Anchetty were involved in this initiative.

Revival of small millet crops/ varieties

An attempt was made for reintroduction of small millet crops/varieties, which have disappeared or disappearing in the project sites, by facilitating access to the seeds of these varieties. The interested farmers (1058 male and 743 female farmers) cultivated them either as main crop or mixed crop in 2013 and 2014. The purpose was to bring these lost crops and varieties to the food basket. Foxtail and little millets were reintroduced in three sites and proso in two sites; while barnyard and kodo millets were reintroduced in one site each (Table 5.4). Proso and foxtail millets were well received by the farmers of Anchetty and Jawadhu Hills sites, both for consumption and production in the following season. Foxtail millet was cultivated as mixed crop in cotton at Peraiyur, but the farmers preferred the variety with yellow seed than the one with red seed. Similarly, the farmers of Jawadhu Hills showed much interest in cultivating barnyard millet, while little millet crop failed to impress the farmers of Anchetty and Bero. In addition to reintroduction of lost small millet crops, promotion of rare traditional local varieties of finger millet and little millet was also initiated in three project sites. Four such varieties of finger millet, two at Anchetty and one each at Peraiyur and Bero, and four rare varieties of little millet at Semiliguda were promoted (Table 5.4). This initiative has resulted in revival of foxtail millet in three sites, proso in two sites, kodo and little millets in one site, and promotion of 1 to 3 local varieties of finger millet in two sites and 4 varieties of little millet in one site.

Table 5.4: Details of revival of small millet crops/varieties in project sites, 2014

Sl. No.	Project sites	Crops for which revival was attempted	Remarks
1	Jawadhu Hills	Proso millet (500), foxtail millet (400), barnyard millet (5)	Proso millet, foxtail millet were well received by the farming community
2	Anchetty	Foxtail millet (457), little millet (45), kodo millet (7) & proso millet (13); *Hasar gaddi* (24), *Karun gaddi* (21) varieties of finger millet	Growing foxtail millet as mixed crop in finger millet was well received by the farmers
3	Semiliguda	*Kala suan* (25) & *Bada suan* (129)varieties of little millet; *Bada mandia* (45), *Badi mandia* (32) and *Sunamani* (38) varieties of finger millet	The promoted varieties were well received by the farmers
4	Peraiyur	Foxtail millet (144), little millet (3) & finger millet(19)	Growing foxtail millet was well received by the farmers
5	Bero	Little millet (8), *Gibra* (3) and *Demba* (44) variety of finger millet	Little millet failed due to its poor yields

Figures in parenthesis are number of farmers.

Mr. Raman, a farmer in Anchetty expressing his happiness about good crop of foxtail millet

Successful proso millet crop in Jawadhu Hills

Community based seed production of small millets

Community based seed production and supply has been initiated in all the project sites with the support of interested farmers from local community organisations. Training on seed production was given to 40 men and 40 women farmers and staff in three sites Anchetty, Jawadhu hills and Peraiyur. In all the project sites quality seed production of identified local varieties was taken up during 2013 through interested local farmers, which were procured on payment basis to distribute among the needy farmers in 2014. Breeder/ foundation seed was organised for released varieties for supporting seed production. In 2013, about 7530 kg of seed of 32 varieties of six small millet crops was procured from these farmers. Out of 32 varieties 14 (7 traditional and 7 improved varieties) were selected farmers' preferred varieties through PVS and the remaining 18 were popular local varieties of six small millet crops. The seeds so collected have been distributed to large number of farmers for cultivation during 2014 cropping season. The total number of farmers reached (2861) across 5 Indian sites comprised 1557 men and 1304 women farmers.

Seed production of GPU-28 variety at Semiliguda

Seed production of Sadai variety of barnyard millet at Peraiyur

Seed production of Bada suan variety of little millet at Semiliguda

Seed production of foxtail millet at Peraiyur

Continuing the same activity during 2014, a total of 11360 Kg quality seeds of small millet varieties were procured. Out of this 6901 Kg seeds were from 10 varieties of finger millet, 1026 Kg from 8 varieties of little millet, 3233 Kg from 4 varieties of barnyard millet and 200 Kg seeds from one variety

of foxtail millet (Table 5.5). In all 46 seed producers of local community from across the five project sites took part in the seed production activity. In addition to this, a minimum of 5 Kg purified seeds of traditional varieties included in varietal diversity demonstration blocks at each of the project sites were also collected. Efforts were also made to collect the seeds of varieties of other crops such as pulses, sorghum and vegetables from other sources. The whole objective was to bring back the traditional practice of seed collection and preservation of local crops by creating awareness regarding the value of good quality seeds as well as the local crop and varietal diversity, and also through facilitating access to seeds of these local crops.

Table 5.5: Details of community based seed production of small millets varieties in project sites, 2014

Crop	Variety	Number of farmers involved	Seed quantity (Kg)		Sitewise seed procurement
			Seed produced	Seed procured	
Finger millet	*Kempu ragi*	3	2000	1000	Anchetty (700), J.Hills (300)
	Demba	1	151	151	Bero
	GPU-28	6	2679	1829	Anchetty (750), J.Hills (200), Semiliguda (300), Bero (579)
	GPU-66	4	1200	900	Semiliguda (800), J.Hills (100)
	GPU-67	3	936	936	Semiliguda (400), Bero (536)
	GPU-48	1	100	100	Semiliguda (100)
	A-404	2	413	413	Bero
	BBM-10	1	408	408	Bero
	ML-365	2	1220	964	Anchetty
	Saratha	1	1600	200	Anchetty
Total		**24**		**6901**	
Little millet	*Perungulai*	2	322	200	J Hills
	Koluthana	1	264	200	J Hills
	Karun samai	1	200	100	J Hills
	Siru samai	1	115	100	J Hills
	IR-20	1	300	200	J Hills
	Pennagaram local	1	400	70	Anchetty
	Anchetty local	1	45	30	Anchetty
	Bada suan	2	126	126	Semiliguda
Total		**10**		**1026**	
Barnyard millet	CO-2	3	635	635	Peraiyur
	M	2	1298	1298	Peraiyur
	Arupukottai	1	75	75	Peraiyur
	Sadai	2	1225	1225	Peraiyur
Total		**8**		**3233**	
Foxtail millet	White grain	4	345	200	Anchetty

Summary

The study on sources of seeds of different varieties of local crops revealed that only the farm-saved seeds were the predominant source in all the study sites. This was mainly because farmers were cultivating traditional varieties of their choice and non availability of seeds of improved varieties through other concerned agencies. Informal exchange of seeds within each study site was also limited. These situations, combined with absence of local practice of seed selection, brought out three important production constraints of small millets – depending on poor quality seeds, lack of knowledge on availability of better suitable varieties and non-existence of any local mechanism to access the seeds of individual farmer's choice. If the seed chain of one variety is broken, then there is less probability of bringing back that variety for cultivation due to limited seed exchange practices. The initiatives under taken during the present project period namely, establishing varietal diversity demonstration blocks, biodiversity fund, revival of lost crops/ varieties, community based seed production and dissemination mechanism to address these issues, have attempted to bring the seeds of small millet crop varieties to individual farmers so that they can be part of their farm saved seed set. The results in the project were encouraging for facilitating access to crop and varietal diversity at community level. Based on this experience and also insights from other related works it is possible, however, to work out a sustainable mechanism that could serve the local seed requirement beyond the project period.

6. Emerging Outcomes, Lessons Learned & Conclusion and Way Forward

Synthesising the emerging outcomes from a project of this nature helps in understanding the value of the project to the project community. On the other hand synthesizing the learning from the project helps to understand the effectiveness of approaches and methods followed in achieving the outcomes and the ways for moving forward. It also throws light on the relevance of the project approaches and methods for other areas and other crops and the possibilities of scaling up. The following sections share the emerging outcomes, lessons learnt and conclusion and way forward.

Emerging outcomes

Improvement in awareness and capacity of small millet farmers

Large number of farmers participated in the various research activities across the five sites by offering their limited land, time and other resources. In the four cycles of PVS itself around 1397 men and 1077 women farmers participated. For the first time in their life they were taking part in research and working with scientists on an issue very much relevant to their livelihoods. In the process they improved and applied their embedded knowledge on the ecosystem and cultivation of small millets for selection of suitable varieties for the benefit of large number of farmers in their location. Through their involvement in the trials, farmers became aware of the advantages to be gained from testing different varieties available from across the region and other parts of the country. They were able to compare between 9 and 22 varieties of small millets in each project site. They had accessed varieties from other parts of India and in their region, which otherwise would not have been possible. Some farmers involved in the varietal selection have adopted one or more of these varieties on a large proportion of their land. A set of farmers in each site also built their capacity for seed production and were instrumental in dissemination of the identified varieties and popular varieties.

Improvement in crop and varietal diversity of small millets

The RESMISA project has resulted in reintroduction of small millet crops which vanished in the last two decades like proso millet and foxtail millet in Jawadhu Hills and Anchetty, little millet in Anchetty and foxtail millet in Peraiyur at the location, *panchayat* and hamlet levels. Similarly the project resulted in introduction of potential local finger millet varieties in Anchetty and Semiliguda and local little millet varieties in Semiliguda. Purification of some of the potential local varieties like *Kala suan* and *Bada suan* of little millet and *Dasarabodi* finger millet variety at Semiliguda, *Demba* and *Gibra* finger millet varieties at Bero and *Sadai* and *Arupukottai* barnyard millet varieties at Peraiyur were attempted and the purified seeds were disseminated to large number of farmers for wider adoption. In the course of PVS one to six

Purified Kala suan variety of little millet at Semiliguda

potential varieties were introduced from various parts of the site and outside the site, which have increased varietal diversity. A record of currently existing varieties and their features and biodiversity fund have been created in each site, which will help the local community in systematically undertaking conservation even beyond the project period.

Increased access to quality seed of promising varieties

Formal seed chain almost does not meet the seed requirement of farmers pertaining to small millets in most of the sites. Wherever they do, only released varieties are considered. In RESMISA project through community based seed production 1557 men and 1304 women farmers were disseminated with the varieties that were identified through PVS trials and other popular varieties in 2014. By the end of 2014 season 11360 kg of small millet seeds were procured for wider dissemination to large number of farmers. Farmer organizations in the sites have and are playing a leading role in seed distribution and are investing in the adoption of the promising varieties in their regions.

Box No. 1: Innovative effort of a farmer in reviving an old variety of little millet at Anchetty

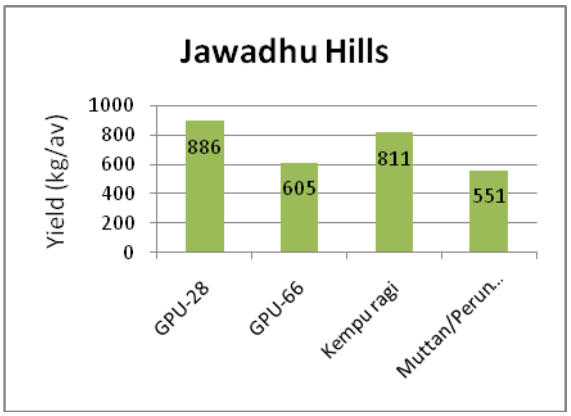
Anchetty farmers revealed that as many as five small millet crops including little millet were under cultivation in the past, but now they were left with only finger millet, which is their staple food. In order to bring back again some of these old small millet crops in the site, the field staff of RESMISA project procured the seeds of these crops from other known sources for distribution among the interested local farmers. This young farmer, Mr. Madesh, who is a keen observer, got interested in the new initiative. During his routine visit to his fields accidently he noticed little millet plants in the finger millet crop of *Saratha* variety. Usually on other occasions these plants would not have caught his attention as they are generally considered as weeds. Surprisingly, such plants of little millet were present only in the fields of *Saratha* variety of finger millet.

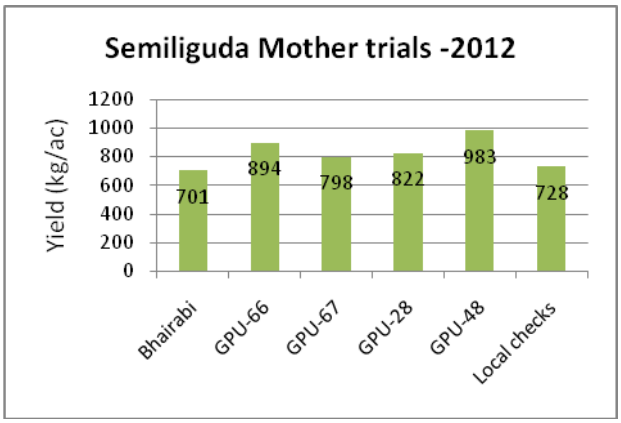
Driven by curiosity, Madesh collected the seeds from individual plants of little millet in one of such fields at the time of maturity. From the seeds so collected, which was about half a Kg, he raised a pure crop of little millet on his field (see the picture at left), producing around 40 kg of seeds in 2014 cropping season. The crop stand with semi-compact panicle of this unknown variety was attractive and appeared to be promising one. It is worth to understand its potentiality and possible origin through systematic study. However, the credit goes to Madesh for reviving the lost variety of little millet, may be called as ‘Anchetty local’. Local farmers were impressed by this variety and have expressed their willingness to grow in their farms in the coming year.

Increased productivity and choice of varieties for farmers in rainfed areas

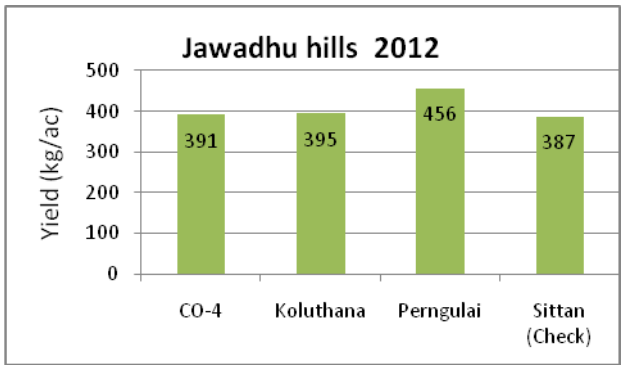
Several of the preferred varieties of small millet (including released and local varieties), offer considerable yield advantage, compared to prevailing varieties, though yield is only one of the parameters considered for expressing their preference by the farmers. So multiplication and adoption of these higher yielding varieties have led to increased productivity realisation by the farmers.

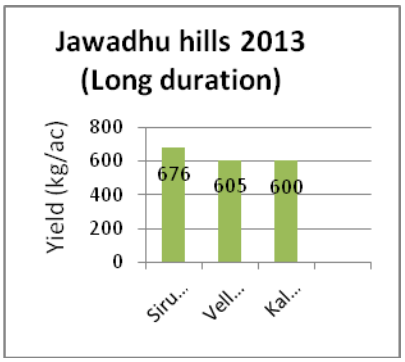
Finger millet: In Jawadhu Hills the yield advantage realized from the identified varieties was in the range of 47 to 61 percent over the prevailing varieties and in Semiliguda it ranged from 29 to 36 percent.



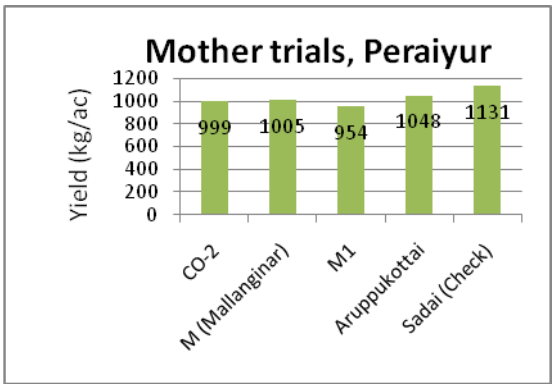


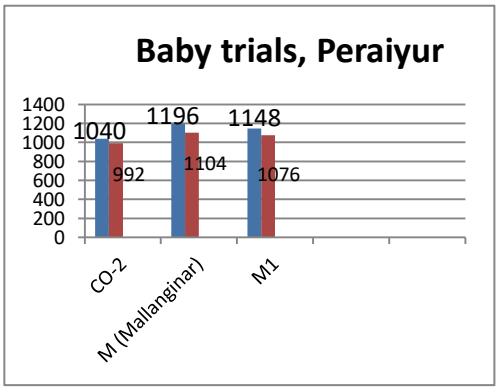
Little millet: Farmers were able to realize a yield advantage of 12 to 19 percent by cultivating the newly identified varieties.





Barnyard millet: Three traditional varieties, *M* and *M1* from Mallankinaru and *AK* from Arupukottai and one released variety CO-2 were found promising. Farmers realized yield advantage of 5 to 10 percent from these newly identified varieties over that of *Sadai* in baby trials. Now the farmers have more choices to choose the more suitable varieties of their interest.





Gender

All project activities internalized gender analysis in their implementation and outcome analysis. Considerable number of women participated in the project activities on priority. For example in PVS 43.5 % of the farmer experimenters were women. The project provided a unique opportunity to women for enhancing their research skills and empowered them to work with scientists and development institutions in technology evaluation and development. Further women organisations (groups in most of the locations and federation in Semiliguda) furthered their purpose of improving the livelihoods of their members by taking part in the RESMISA project.

"RESMISA has enabled me to take many research activities in my field. I am able to compare performance of different varieties, preserve seed in better way; and use improved package of practices for better production." Mrs. Samari Khila, from Phuladhaba village of Semiliguda Block, Koraput District.

Improvement in the capacity of the organisations involved

The local varieties of small millets in the project sites were included in the germplasm collection in All India Coordinated Small Millets Improvement Project. In the course of the morphological characterisation and nutritional analysis a few local varieties have been identified with desirable traits and nutrition values. This information will be helpful in future crop improvement activities. Sadai, a local barnyard millet variety from Peraiyur was included in national evaluation program considering its high yielding ability. The project resulted in building the capacity of the project team on on-farm conservation, PVS and seed production. A manual on PVS and seed production was developed in regional languages for capacity building of staff.

Lessons learned

The following section shares the crucial learning gained by the project team members in the course of four years of the project.

1. Varietal diversity at hamlet level varied across the villages in each site. Higher level of varietal diversity was observed in remote underdeveloped sites like Semiliguda or remote villages in the

site like Kuttakarai in Jawadhu Hills. Almost all the local varieties in each site were found with varying levels of mixtures and some are in the verge of losing their identity. The main reasons noticed were lack of indigenous practice of seed selection and absence of deliberate attempt to maiintain purity of varieties among local farmers. The community biodiversity register indicated that local varieties were vanishing at a fast pace in all the project sites leading to narrow genetic base as in Anchetty. None of the organisation was involved in on-farm conservation. Considerable efforts are needed to slow down and stop further erosion of crop and varietal diversity.

2. Social events like biodiversity fairs and field days at the locations of biodiversity blocks, which provided festive atmosphere, were found most effective in involving the local people in documentation, conservation and utilization activities. Both men and women farmers actively participated in various activities during the project period.

3. Interest shown by most of the farmers for reviving vanished crops and varieties on providing seed and encouragement was remarkable. A case in point is acceptance of foxtail millet and proso millet in Jawadhu Hills. This shows that it can be an important way for promoting varietal and crop diversity.

4. The project identified the set of tools and practical strategies for supporting on-farm conservation in the project sites, which is given in box 1 & 2.

5. The fact that local varieties in the nearby area and old released varieties were preferred by the farmers, when compared to some of the recent released varieties and pre-release varieties indicate the need for use of wider set of germplasm for identification of suitable varieties for a site.

6. Quite a good number of traditional local varieties from the nearby area with similar agro-eco system were identified as most preferred varieties in all the four crops (Chapter 4), indicating their superiority and as well as their potentiality in further breeding programmes.

Box No. 2: Set of tools for documentation and characterisation of varietal diversity

1. Transect walk
2. FGD
3. Sample survey
4. Community Biodiversity register
5. Biodiversity block
6. Morphological characterisation
7. Physical collection of panicles

7. The important learning was about knowing the skills and ability of farmers, both men and women, in assessing the performance of individual varieties. On several occasions their opinions were as good as or even better than those of breeders, as they consider holistic set of parameters, including flour recovery and taste. By having PVS trials on their own fields they had an opportunity of closely observing the performances of test varieties right from seedling stage through maturity. Effective learning and sharing of ideas between each other happened during farmers' preference analysis activities.

8. The significant achievements made in enhancing the varietal diversity in each project site within a short period of 4 years clearly brings out once again the fact that PVS is an effective and efficient approach with scientific soundness. It was possible to show through this project that the results from un-replicated mother trials were comparable in reliability with those of replicated trials conducted on farmers' fields as well as on research farms. The success of PVS can be attributed,

among many other reasons, to organising research in farmers' fields on significant numbers and for the effective participation of women and men farmers in the research activities.

9. With systematic training it is possible to build the capacity of local staff for their effective engagement in research on seed systems.

10. PVS activities could be continued where unexploited local varietal diversity still exists, for instance Semiliguda site.

11. Considering the limited success in identifying alternate suitable varieties through PVS in kodo millet and little millet, there is need to strengthen breeding programmes through creating new variation using potential local germplasm. Further improvement depends on the newly created variation through hybridization and selection processes. For achieving this end participatory plant breeding (PPB) could be initiated along with PVS if initial study indicates very poor varietal diversity in the region. In any case it requires at least 4-5 years of work before getting newly developed lines. Since creation of new variation through hybridization and handling of early generation breeding populations require technical skill as well as field and lab facilities, it is important to have collaboration with research organisations. Once such agreement is finalised, breeding objectives (increasing yielding ability, early duration, resistance to locally important pests & diseases, grain quality, etc.) will be set in consultation with the local farmers and scientists. Based on this, right type of parents will be identified either in the local collections or from other sources. Emphasis should be given to the local varieties. Early generations of breeding populations, fromF_1 to F_4 need to be handled on the research farms; it would be ideal to arrange visits of interested farmers to these plots during cropping seasons have the feeling of segregating populations. The promising lines from advanced generations need to be evaluated in the same way as that of PVS at the target production areas.

12. Farmers in the site were aware of the various ways for improving the quality of seeds obtained from their farms in terms of seed vigour andwere practicing them. But over the years they have left these practices and were using small millet grains as seed in most of the project sites.

13. The need of developing a decentralized sustainable seed system at community level clearly emerged in the project. For establishing such a 'community based unit of seed production and distribution', certain basic requirements such as size and scale of the unit; skill development for quality seed production; infrastructure needed for seed processing, testing and packaging; internal quality control system; registration of the unit; and seed dissemination mechanism, need to be considered while developing a detailed location specific action plan. This is an area that needs more attention in the project areas.

14. It is possible to combine on-farm conservation, varietal improvement and seed production in a geographical unit as part of local seed systems, in a way that meets the needs of the local community. This approach is more effective than doing these activities in isolation as done by many agencies.

15. The lessons learnt from working on small millet crops is applicable to many other crops and the integrated approach followed in RESMISA project can be adopted for these crops also.

Box No. 3: Practical strategies for supporting in situ conservation on-farm

A well functioning local community organisation like a farmers' federation have to take up the responsibility for in situ conservation on-farm to make it a reality and to give continuity beyond the project period. The possible strategies identified and attempted with the local community organisations are shared below.

1. Assessment of status of agro-biodiversity and preparing an action plan – The information collected from various means including CBRs from all the Panchayats of particular block on agricultural biodiversity needs to be processed and analyzed systematically for crop groups namely cereals, pulses, oil seeds, cash crops, fruits and vegetables, medicinal and aromatic species, tree species, etc. Depending on the status of each crop species they need to be classified into different categories namely major, minor, rare, endangered and extinct. Similarly varieties within species need to be classified as popular, common, rare and extinct. Based on this information a status report and an action plan for conservation needs to be prepared, which could be an important document at block level..

2. Establishing varietal diversity demonstration (VDD) blocks – Since the traditional practice of seed selection and preservation of local varieties has almost vanished, establishing varietal diversity demonstration blocks for conserving local traditional crops and varieties was attempted in the project. The main purpose of this block is to maintain the local varieties in the location over the years by the local community organisation as conserver of local varieties. The other important purposes are a) to create awareness among local communities regarding the existence of crop and varietal diversity in their locality by exposing them to these varieties in an accessible location; b) to motivate and kindle interest in some of them in extending their helping hand in the whole process of conservation. For making these blocks possible, the community organisation need to procure adequate quantity of seeds of all local varieties every year to meet the two year seed requirements for blocks. This will help in continutity of VDD blocsk even if there is complete crop failure in a particular year.

3. Identification and encouraging farmers growing rare varieties - Cultivation of some of the varieties is restricted to one or two hamlets and if not protected, they will also vanish soon. Given this situation farmers growing rare varieties need to be identified and encouraged through suitable recognition, as a gesture for their special interest in preserving them. Wherever possible custodian farmers who have a proven track record of conserving local varieties need to be identified and to be encouraged in their endeavour. Exchange of seeds of vanished crops and varieties from these farmers needs to be encouraged.

4. Reintroduction and popularizing vanished crops and varieties – Some of the varieties and crops vanished mainly because there was a break in the seed chain. So there is a possibility of reintroducing these crops and varieties with the interested farmers, if seed support is provided. Based on this understanding, demand to be generated among the community for the vanished crops and varieties and seed supply to be arranged for reintroduction either as sole crop or as mixed crop in the existing cropping patterns. Exchange of seeds of such crops could be facilitated from these farmers for further promotion in the target areas.

5. Community seed production of the potential local varieties – To ensure regular seed supply seed production of important varieties need to be taken up in the location by traiing local farmers on seed production.

6. Biodiversity fund: Biodiversity fund is created in each location to systematically involve the local community organisations in conservation and to generate funds to meet the expenditures related to the above mentioned activities in a sustained manner. The allocated funds will be used as credit in the local community organisations to meet the requirements of the community and in the process to generate interest income, which will meet the conservation related expenditures.

16. Anchoring and championing by an existing well functioning local community organisation is needed to make 'in situ conservation on-farm' a reality. Role of a local community organisation is also very vital in participatory varietal selection and local seed production. Given the 'public good' nature of these activities, State financial, capacity building and technical support to such organisation is needed.

17. The project clearly brings out the need for collaboration of research organisations, development organisations and community organisations for bringing about significant positive changes in the local seed system, which is an important support for the livelihoods of the farmers. On the other hand, there is need for moderating the collaboration for ensuring effective participation of farming community in the research activities, given the power equations and difference in perspective and working culture.[4]

18. The project experience indicated that on-farm conservation, PVS and improving local seed system are a continuous process and for them to be established at community level require long years of investment. Further investment is required in the project sites to build on the RESMISA project work and move further.

Conclusion and way forward

The integrated model of conservation, varietal improvement, and local seed system envisaged under the RESMISA project and discussed in this book, not to be considered as a new concept. In fact, it is an effort to revive and strengthen the age old system implemented by local community in the light of scientific knowledge, emerging systems and organisations. RESMISA project proved that such an effort is possible in the case of small millets and there is adequate number of evidences across the world for various other crops (SEARICE 2007; De Boef et al 2013). The experience of RESMISA project also underlined the need for new professionalism and effective collaboration of community organisations (Cos), Non-government organisations (NGOs) and research organisations for reviving and strengthening community biodiversity management in an integrated way at an appropriate scale. The scaling up of such an approach would require the following:

1. Making '*in situ* conservation on-farm' mandatory role of local bodies and providing necessary resources and support for the same through National Biodiversity Authority, COs and NGOs. A specific purpose fund called conservation fund can be created in local body level for meeting the conservation expenditures and to support custodian farmers on an ongoing basis. Investment by Maharashtra state for conservation through Maharashtra Gene Bank Programme can be considered by many other states.
2. Recognition and award for custodian farmers and local bodies at district level and state level for their contribution to on-farm conservation.

[4] See arguments on the need for new professionalism in plant genetic resources expounded by De Boef et al. 2013.

3. Institutionalisation of participatory crop improvement approaches[5] in State Agriculture universities (SAUs) and National Agricultural Research Systems (NARSs). This may include making PPB and PVS complementary for the current methods of plant breeding. Adoption of participatory crop improvement approaches by zonal research stations in collaboration with farmers' organisations and NGOs would help in refining their districtwise recommendation of varieties.
4. Recognising the development role of the local seed systems and supporting for strengthening the same for graduation into community based local seed systems with viable linkage with formal varietal improvement organisations and seed chain.[6]
5. Structured investment for bringing about new professionalism in community biodiversity management (De Boef et al 2013) that recognises and supports the central role of local farmers in on-farm conservation, varietal improvement and local seed systems. This may include inclusion of participatory crop improvement approaches and methods in the syllabus of plant breeding courses, orientation to scientists in NARS and SAUs and NGO professional on participatory crop improvement and capacity building of local bodies.
6. Support for proven traditional local varieties on par with the released varieties for seed production and supply (like seed village concept) and for cultivation support.
7. Support for demonstrating the integrated model discussed in this report in each district for various focus crops on a pilot basis to eligible organisations to generate more evidences and momentum.

The possibility of a programme as suggested above to become a reality largely depends on the political will, favorable policy environment, social commitment, and financial and organizational support. The needed financial support, in Indian context, could be from ICAR, NBPGR, NBA, and concerned state and central departments. It is envisaged that scaling of the integrated model would considerably improve the resilience and empowerment of the farming community, particularly rainfed farming families spread across the underdeveloped states of India.

[5] There have been many efforts in this direction. Ceccarelli (2012) sites that a review of plant breeding methodologies in the CGIAR conducted in 2001 recommended that it should form an "organic part of each Center's breeding programme".

[6] The experience of similar initiative in Ethiopia and Uganda is shared by Marja H. Thijssen et al (2013).

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Annexure

Annexure 1 - Details of Farmers Preference analysis (FPA) activities in Indian project sites, 2011

Annexure 1a: FPA activities at Anchetty

Details of FPA activities at Anchetty, 2011

Name of the farmer	Village/Panchayat	Number of varieties in the trial	Participating groups	Farmers in the group		Date of conducting FPA
				F	M	
Kallaveerappa	Attinattam	8	I	-	12	5.11.2011
			II	5	7	
Shivakumar	Attinattam	6	I	-	6	5.11.2011
Shantmallappa	Kottaiyur	8	I	-	21	6.11.2011

Results of FPA activity at Kallaveerappa farm at Attinattam

Name of variety	Participating group-I				Participating group-II				Overall score			
	Preference score				Preference score							
	1st	2nd	3rd	Total	1st	2nd	3rd	Total	1st	2nd	3rd	Total
Halukuli ragi	7 (21)	2 (4)	2 (2)	(27)	2 (6)	2 (4)	2 (2)	(12)	(27)	(8)	(4)	(39)
Pichagatti ragi	0 (0)	1 (2)	1 (1)	(3)	0 (0)	1 (2)	0 (0)	(2)	(0)	(4)	(1)	(5)
Bonda ragi	0 (0)	1 (2)	0 (0)	(2)	1 (3)	4 (8)	1 (1)	(12)	(3)	(10)	(1)	(14)
Kempu ragi	5 (15)	7 (14)	0 (0)	(29)	5 (15)	1 (2)	1 (1)	(18)	(30)	(16)	(1)	(47)
CO-14	0 (0)	0 (0)	9 (9)	(9)	4 (12)	1 (0)	1 (0)	(12)	(12)	(0)	(9)	(21)
CO-11	0 (0)	0 (0)	0 (0)	(0)	0 (0)	0 (0)	0 (0)	(0)	(0)	(0)	(0)	(0)
CO-7	0 (0)	0 (0)	0 (0)	(0)	0 (0)	1 (2)	5 (5)	(7)	(0)	(2)	(5)	(7)
GPU-66	0 (0)	1 (2)	0 (0)	(2)	0 (0)	2 (4)	2 (2)	(6)	(0)	(6)	(2)	(8)
Total participants	12	12	12		12	12	12					

Note- Figures in parentheses are weighted scores, where 1st, 2nd and 3rd preferences were weighted with score points of 3, 2 and 1, respectively.

Results of FPA activity at Shivakumar farm at Attinattam

Name of variety	Preference score values			
	1st	2nd	3rd	Total
CO-10	0 (0)	0 (0)	0 (0)	(0)
CO-13	6 (18)	0 (0)	0 (0)	(18)
Kempu ragi	0 (0)	2 (4)	2 (2)	(6)
Bonda ragi	0 (0)	3 (6)	0 (0)	(6)
Pichagatti Ragi	0 (0)	0 (0)	1 (1)	(1)
Halukuli ragi	0 (0)	1 (2)	3 (3)	(5)
Total participants	6	6	6	

Note- Figures in parentheses are weighted scores, where 1st, 2nd and 3rd preferences were weighted with score points of 3, 2 and 1, respectively.'

Results of FPA activity at Shantmallappa farm at Attinattam

Name of variety	Preference score values			
	1st	2nd	3rd	Total
CO-7	0 (0)	0 (0)	0 (0)	(0)
CO-10	0 (0)	0 (0)	0 (0)	(0)
CO-11	1 (3)	0 (0)	0 (0)	(3)
CO-13	17 (51)	1 (2)	2 (2)	(55)
GPU-28	1 (3)	12 (24)	2 (2)	(29)
GPU-66	2 (6)	4 (8)	13 (13)	(27)
GPU-67	0 (0)	3 (6)	3 (3)	(9)
Ragalli shivali	0 (0)	1 (2)	1 (1)	(3)
Total participants	21	21	21	

Note- Figures in parentheses are weighted scores, where 1st, 2nd and 3rd preferences were weighted with score points of 3, 2 and 1, respectively.

Annexure 1b: FPA activities at Bero site

Details of locations and farmers' groups involved in FPA at Bero site, 2011

Name of the farmer	Village/ Panchayat	Number of varieties in the trial	Date of sowing	Date of trans-planting	Farmers in the group		Date of conducting FPA
					F	M	
Suresh Mahto	Chairma/ Itta	6	06.07.11	24.07.11	1	14	28.10.2011
Ranthu Bhagat	Rogo/Nehalu	6	14.07.11	25.08.11	5	19	10.11.2011

Results of FPA activities at Chairma and Rogo villages of Bero site, 2011

Name of variety	Trial-1 at Chairma village				Trial-2 at Rogo village				Overall score			
	Preference score				Preference score							
	1st	2nd	3rd	Total	1st	2nd	3rd	Total	1st	2nd	3rd	Total
A-404	7 (21)	6 (12)	0 (0)	(33)	7 (21)	5 (10)	8 (8)	(39)	14 (42)	11 (22)	8 (8)	(72)
GPU-28	6 (18)	5 (10)	2 (2)	(30)	0 (0)	5 (10)	5 (5)	(15)	6 (18)	10 (20)	7 (7)	(45)
Demba	1 (3)	1 (2)	4 (4)	(9)	4 (12)	5 (10)	5 (5)	(27)	5 (15)	6 (12)	9 (9)	(36)
JWM-1	1 (3)	3 (6)	4 (4)	(13)	10 (30)	5 (10)	0 (0)	(40)	11 (33)	8 (16)	4 (4)	(53)
BM-2	0 (0)	0 (0)	3 (3)	(3)	1 (3)	2 (4)	1 (1)	(8)	1 (3)	2 (4)	4 (4)	(11)
Gibra	0 (0)	0 (0)	2 (2)	(2)	2 (6)	2 (4)	5 (5)	(15)	2 (6)	2 (4)	7 (7)	(17)
Total participants	15	15	15		24	24	24		39	39	39	

Note- Figures in parentheses are weighted scores, where 1st, 2nd and 3rd preferences were weighted with score points of 3, 2 and 1, respectively.

Annexure 1c: FPA activities at Semiliguda site, 2011

Details of FPA activities in finger millet mother trials at Semiliguda, 2011

Name of the farmer	Village/ Panchayat	No. of varieties in trial	Date of sowing	Farmers in the group		Date of conducting FPA
				M	F	
Sadhu Ayal	Gelhaguda	10	9.07.2011	19	33	20.10.2011
Rukmani Bhoi	Lunguri	6	20.07.2011	21	32	20.10.2011
Somanatha Gumal	Gumalguda	6	29.07.2011	9	21	24.10.2011
Kadu Jani	Dekapar	5	13.07.2011	15	7	26.10.2011
Padma Majhi	Phuldhaba	14	17.07.2011	12	14	27.10.2011

Results of FPA activities at five villages at Semiliguda site, 2011

Sl No.	Name of variety	No. of farmers indicating their preference					Most preferred
		Gelhaguda	Lunguri	Gumalguda	Dekapar	Phuldhaba	
1	*Bati*	13	---	---	12	05	√
2	*Kada*	04	---	---	02	01	
3	*Kala Kerenga*	01	---	---	08	03	√
4	Champavati	18	24	10	---	13	√
5	*Dudha Kerenga*	02	0	---	---	---	
6	Bhairabi	36	28	12	---	16	√
7	Chilika	16	18	11	---	15	√
8	*Bagha Chhad*	06	---	03	---	01	
9	*Madai Maskali*	01	---	---	---	02	
10	*Bhalu*	04	05	10	---	03	√
11	*Badu*	---	01	---	---	02	
12	*Mami*	---	---	08	---	---	
13	*Mati*	---	---	---	01	07	
14	*Sunamani*	---	---	---	09	---	√
15	*San mandia*	---	---	---	---	11	√
16	*Dasrabodi*	---	---	---	---	10	√
17	*Dinda mandia*	---	---	---	---	05	

Annexure 1d: FPA activities at Jawadhu Hills site, 2011

Details of locations and farmers' groups involved in FPA in little millet at Jawadhu Hills, 2011

Name of the farmer	Village/Panchayat	No. of varieties	Date of sowing	Farmers in the group		Date of conducting FPA
				Female	Male	
Amuthavalli w/o Rajendran	Puthur/ Nammiampattu	6	1.08.2011	3	5	15.10.2011
Kuppu w/o Kasi	Nammiampattu/ Nammiampattu	7	14.08.2011	4	4	15.10.2011
Nathiya w/o Rajamanikkam	Velichanur/ Melsilambadi	7	2.08.2011	8 7	0 3	24.10.2011

Activity-1&2 - Preference analysis scores from Puthur and Nammiampattu villages, Jawadhu Hills

Name of variety	Activity-1				Activity-2				Overall score			
	Preference score				Preference score				1st	2nd	3rd	Total
	1st	2nd	3rd	Total	1st	2nd	3rd	Total				
CO-2	0 (0)	0 (0)	3 (3)	(3)	0 (0)	2 (4)	2 (2)	(6)	0 (0)	2 (4)	5 (5)	(9)
CO-3	2 (6)	1 (2)	2 (2)	(10)	0 (0)	3 (6)	4 (4)	(10)	2 (6)	4 (8)	6 (6)	(20)
CO-4	2 (6)	1 (2)	0 (0)	(8)	3 (9)	1 (2)	2 (2)	(13)	5 (15)	2 (4)	2 (2)	(21)
Koluthana samai	3 (9)	0 (0)	3 (3)	(12)	3 (9)	0 (0)	0 (0)	(9)	6 (18)	0 (0)	3 (3)	(21)
Chittan samai	1 (3)	5 (10)	0 (0)	(13)	2 (6)	2 (4)	0 (0)	(10)	3 (9)	7 (14)	0 (0)	(23)
Perun samai	0 (0)	1 (2)	0 (0)	(2)	0 (0)	0 (0)	0 (0)	(0)	0 (0)	1 (2)	0 (0)	(2)
OLM-203	-	-	-	-	0 (0)	0 (0)	0 (0)	(0)	0 (0)	0 (0)	0 (0)	(0)
Total participants	8	8	8	-	8	8	8	-	16	16	16	-

Note- Figures in parentheses are weighted scores, where 1st, 2nd and 3rd preferences were weighted with score points of 3, 2 and 1, respectively.

Activity-3 Preference analysis scores from Velichanur village, Jawadhu Hills

Name of variety	Preference score			
	1st	2nd	3rd	Total
Co-4	0 (0)	0 (0)	1 (1)	(1)
CO-3	0 (0)	0 (0)	0 (0)	(0)
CO-2	0 (0)	0 (0)	4 (4)	(4)
OLM-203	0 (0)	2 (4)	3 (3)	(7)
Koluthana samai	3 (9)	5 (10)	1 (1)	(20)
Chittan samai	5 (15)	3 (6)	0 (0)	(21)
Perun samai	2 (6)	0 (0)	1 (1)	(7)
Total Participants	10	10	10	-

Note- Figures in parentheses are weighted scores, where 1st, 2nd and 3rd preferences were weighted with score points of 3, 2 and 1, respectively.

Annexure 1e: FPA activities at Peraiyur site, 2011

Farmers' Preference score values for Barnyard millet varieties at Peraiyur, 2011

Sl. No.	Variety	Preference score value (weighted)			
		I	II	III	Total
1	*Sadai*	0	0	0	
2	*Pullu*	3	0	2	5
3	VL-29	0	0	0	0
4	VL-172	0	0	0	0
5	*M*	6	4	1	11
6	*M1*	6	0	2	8
7	M2	0	2	0	2
8	M3	0	0	0	0
9	V2	0	0	0	0
10	V3	0	0	1	1
11	V4	0	0	0	0
12	CO-2	6	8	1	15
	Total participants	7	7	7	

Annexure 2-Details of FPA activities in Indian Project sites during 2012

Project site	Location	Date of event	No. of participants		Varieties preferred	Desirable traits as the basis of preference
			Women	Men		
FINGER MILLET						
Anchetty	Shivanna, Jannamantham, Kotaiyur	29.11.2012	2	8	CO-13 GPU-28 *Karungatti* *Saratha*	Short duration, high grain and fodder yield, hard and tasty grains
Jawadhu Hills	GovindanRukku, Puthur, Nammiampattu	23.11.2012	9	10	GPU-28 *Ragalli shivalli* GPU-66 *Kempu*	High grain and fodder yield,
Semiliguda MT	Mangalu G.naik Gelhaguda	1.11.2012	10	19	GPU-67 GPU-66 Bhairabi *Kala kerenga*	Uniform crop stand maturity, big panicle with high yield, short duration, non-lodging, easy threshability, bold grain
-RCBD	CPR, Berhampur	30.10.2012	6	7	Bhairabi Chilika	High yield, uniform maturity, short duration, med-Ht
Bero – MT	Bandhna Bhagat, Khakhsitoli, Jamtoli	15.11.2012	14	47	GPU-66 GPU-67 Hybrid GPU-28	More tillers, big panicle for high yield, uniform maturity, short duration, good grain colour with taste

Project site	Location	Date of event	No. of participants		Varieties preferred	Desirable traits as the basis of preference
			Women	Men		
-RCBD	Suresh Uraon, Sijuavillage, Ghaghara	16.11.2012	13	25	GPU-67 GPU-28 GPU-66	
LITTLE MILLET						
Jawadhu Hills	Mallika Krishnan, Perungattur, Kovilur	26.10.2012	12	16	*Perungulai* JK-8 *Sittan* *Karu sittan*	Uniform crop stand, high yield, short duration, tolerance to salinity, non-shattering
Semiliguda	CPR, Berhampur	30.10.2012	6	7	*Bada* Kolab	High yield, easy threshing
BARNYARD and KODO MILLET						
Peraiyur	Karpi Papirettypatty	10.12.2012	7	7	*Sadai* *Arupukottai* *Mallanginaru*	Drought tolerance, short duration, bold grain, non – lodging
	Rangasamy, Sengapadai	11.12.2012	6	8	Siru Uppu TNAU-111	Short duration, brown seed, high grain and fodder yield

Annexure 3- Performance of finger millet varieties in baby trials at Indian sites, 2012

Project sites	Test variety	Number of trials	Average Grain Yield (kg/ac)				Local varieties tested	Remarks
			Test variety	Check variety	Increase	Decrease		
Anchetty	GPU-66	12	1028	1012	7	5	INDAF	Since the check varieties are as such improved ones, the farmers did not realize much yield advantage of the test varieties; but some of them showed keen interest for growing local varieties.
		Max	1600	1800			GPU-28	
		Min	640	680				
	Kempu	10	768	756	4	6	INDAF	
		Max	1280	1400				
		Min	360	400				
	Halukuli	10	876	896	5	5	INDAF	
		Max	1120	1200			GPU-28	
		Min	600	680				
Bero	A-404	19	1156	952	10	1	Demba	Most of the farmers preferred both varieties, but the local varieties were found to be equally good.
		Max	2000	1600			Lohardagiya	
		Min	340	240			Hybrid	
	GPU-28	18	736	610	11	5	Demba	
		Max	2400	1600			Lohardagiya	
		Min	280	260			Hybrid	
Semiliguda	Bhairabi	30	784	744	19	11	Bodi, Bada	Both varieties are improved ones and many farmers preferred these varieties. Local varieties also have
		Max	1000	980			Dinda, Badu	
		Min	680	540			Dasrabodi	

Project sites	Test variety	Number of trials	Average Grain Yield (kg/ac)				Local varieties tested	Remarks
			Test variety	Check variety	Increase	Decrease		
	Chilika	19	856	752	16	3	*Bada mandia*	potential but need purification
		Max	1040	960			Bodel	
		Min	660	480				

Annexure 4- Farmers' assessment of finger millet varieties in baby trials at Indian project sites, 2013

Farmers' assessment of performance of Saratha variety at Anchetty site, 2013

S. No	Parameters	More/better than check	Same as check	Less/poor than check	Not applicable
1	Duration	14 (41.1)	20 (58.8)	0	0
2	Tolerance to dry spell	5 (16.1)	26 (83.9)	0	3
3	Lodging	9 (36.0)	13 (52.0)	3 (12.0)	9
4	Damage by rains during maturity.	10 (83.3)	2 (16.7)	0	22
5	Grain shattering	17 (89.5)	2 (10.5)	0	15
6	Grain yield	1 (2.9)	7 (20.6)	26 (76.5)	0
7	Straw yield	9 (26.5)	20 (58.8)	5 (14.7)	0
8	Colour preference	2 (5.9)	19 (55.9)	13 (38.2)	0
9	Do you save seed?				
	Yes	11 (32.4)			
	No	23 (67.6)			

*Figures in parentheses are % values

Farmers' assessment of GPU-28 variety of finger millet at Jawadhu Hills, 2013

S. No.	Parameters	More/better than check	Same as check	Less/poor than check	Not applicable
1	Duration	5 (26.3)*	5 (26.3)	9 (47.4)	0
2	Tolerant to dry spell	5 (36.0)	7 (50.0)	2 (14.0)	5
3	Lodging	6 (43.0)	7 (50.0)	1 (7.0)	5
4	Damage by rains during Maturity.	7 (77.8)	2 (22.2)	0	10
5	Grain shattering	4 (33.3)	5 (41.7)	3 (25.0)	7
6	Resistance to blast	2 (50.0)	2 (50.0)	0	15
6	Grain yield	17 (89.5)	0	2 (10.5)	0
7	Straw yield	18 (94.7)	0	1 (5.3)	0
8	Flour recovery	1 (25.0)	3 (75.0)	0	15
9	Taste	2 (66.7)	1 (33.3)	0	16
10	Colour preference	8 (50.0)	8 (50.0)	0	3
	Do you save seed?				
	- Yes	17 (89.5)			
	- No	2 (10.5)			

* Figures in parentheses are % values

Farmers' assessment of *Ragalli shivali* variety of finger millet at Jawadhu Hills, 2013

S. No.	Parameters	More/better than check	Same as check	Less/poor than check	Not applicable
1	Duration	1	2	2	0
2	Tolerant to dry spell	2	1	2	0
3	Lodging	0	1	0	4
4	Damage by rains during Maturity	1	0	0	4
5	Grain shattering	0	0	0	5
6	Resistance to blast	1	0	0	4
6	Grain yield	2	1	2	0
7	Straw yield	2	1	2	0
8	Flour recovery	0	0	0	5
9	Taste	0	1	0	4
10	Colour preference	2	3	0	0
	Do you save seed?				
	- Yes	2			
	- No	3			

Farmers' assessment of GPU-66 variety of finger millet at Jawadhu Hills, 2013

S. No.	Parameters	More/better than check	Same as check	Less/poor than check	Not applicable
1	Duration	0	1	2	0
2	Tolerant to dry spell	0	0	2	1
3	Lodging	1	1	0	1
4	Damage by rains during Maturity	0	0	1	2
5	Grain shattering	1	1	0	1
6	Resistance to blast	1	0	0	2
6	Grain yield	1	2	0	0
7	Straw yield	2	1	0	0
8	Flour recovery	0	1	0	2
9	Taste	0	0	0	3
10	Colour preference	1	2	0	0
	Do you save seed?				
	- Yes	2			
	- No	1			

Farmers' assessment of *Kempu ragi* variety of finger millet at Jawadhu Hills, 2013

S. No.	Parameters	More/better than check	Same as check	Less/poor than check	Not applicable
1	Duration	1	3	0	0
2	Tolerant to dry spell	1	2	0	1
3	Lodging	2	0	0	2
4	Damage by rains during Maturity	2	0	0	2
5	Grain shattering	2	0	0	2
6	Resistance to blast	0	0	2	2
6	Grain yield	4	0	0	0
7	Straw yield	3	1	0	0
8	Flour recovery	0	0	0	4
9	Taste	0	0	0	4
10	Colour preference	1	3	0	0
	Do you save seed?				
	- Yes	4			
	- No	--			

Farmers' assessment of performance of GPU-67 at Bero, 2013

S. No	Parameters	More/better than check	Same as check	Less/poor than check	Not applicable	Total
1	Maturity	23 (62.16)	12 (32.43)	2 (5.41)	--	37
2	Tolerant to dry spell	7 (23.33)	18 (60)	5 (16.67)	7	37
3	Lodging	4 (40)	6 (60)	0	27	37
4	Damage by rains during maturity	15 (50)	13 (43.33)	2 (6.67)	7	37
5	Grain shattering	14 (46.67)	11 (36.67)	5 (16.67)	7	37
6	Resistance to blast (Only FM)	0	0	0	37	37
7	Grain yield	35 (94.59)	2 (5.41)		--	37
8	Straw yield	7 (18.92)	18 (48.65)	12 (32.43)	--	37
9	Color preference	28 (75.68)	8 (21.62)	1 (2.70)	--	37
10	Flour recovery(Only to FM)	12 (33.33)	24 (66.67)		--	36
11	Taste	15 (62.50)	7 (29.17)	2 (8.33)	--	24
	Saved seed for next year					
12	- Yes	33 (89)				
	- No	4 (11)				

* Figures in parentheses are % values

Farmers' assessment of performance of GPU-66 at Bero, 2013

S.	Parameters	More/better	Same as	Less/poor	Not	Total

No.		than check	check	than check	applicable	
1	Maturity	14 (38.89)	18 (50)	4 (11.11)	0	36
2	Tolerant to dry spell	9 (34.62)	13 (50)	4 (15.38)	10	36
3	Lodging	1 (5.88)	8 (47.06)	8 (47.06)	19	36
4	Damage by rains during maturity	9 (30)	17 (56.67)	4 (13.33)	6	36
5	Grain shattering	11 (35.48)	16 (51.61)	4 (12.90)	5	36
6	Resistance to blast (Only FM)	0	1	0	35	36
7	Grain yield	33 (91.67)	3 (8.33)	0	0	36
8	Straw yield	13 (36.11)	11 (30.56)	12 (33.33)	0	36
9	Color preference	23 (63.89)	13 (36.11)	0	0	36
10	Flour recovery(Only to FM)	10 (30.3)	22 (66.67)	1 (3.03)	0	33
11	Taste	13 (52)	11 (44)	1 (4)	0	25
	Saved seed for next year					
12	- Yes	29 (80.56)				36
	- No	7 (19.44)				

* Figures in parentheses are % values

Farmers' assessment of GPU-66 variety of finger millet at Semiliguda, 2013

S. No.	Parameters	More/better than check	Same as check	Less/poor than check	Not applicable
1	Duration	27	12	61	0
2	Tolerance to dry spell	23	6	9	62
3	Lodging	10	10	20	60
4	Damage by rains during Maturity.	3	3	13	80
5	Grain shattering	0	5	9	86
6	Grain yield	69	13	15	3
7	Straw yield	67	19	14	0
8	Colour preference	37	57	6	0
9	Finger blast	4	0	4	92
	Do you save seed?				
	Yes	95			
	No	5			

* Figures in parentheses are % values

Farmers' assessment of GPU-67 variety of finger millet at Semiliguda, 2013

S. No.	Parameters	More/better than check	Same as check	Less/poor than check	Not applicable

S. No.	Parameters	More/better than check	Same as check	Less/poor than check	Not applicable
1	Duration	17 (29.8)*	14 (24.6)	26 (45.6)	0
2	Tolerance to dry spell	7 (24.1)	9 (31.0)	13 (44.8)	28
3	Lodging	0	1 (2.9)	33 (97.1)	23
4	Damage by rains during Maturity	1 (14.2)	3 (42.9)	3 (42.9)	50
5	Grain shattering	0	5 (50)	5 (50)	47
6	Grain yield	37 (64.9)	15 (26.3)	5 (8.8)	0
7	Straw yield	21 (36.8)	26 45.6)	10 (17.5)	0
8	Colour preference	12 (23.5)	36 (70.6)	3 (5.9)	6
9	Finger blast	1 (4.0)	7 (28.0)	17 (68.0)	32
	Do you save seed?				
	Yes	48 (84.21)			
	No	9 (15.79)			

* Figures in parentheses are % values

Annexure 5- Farmers' assessment of little millet varieties in baby trials at Indian project sites, 2013

Farmers' assessment of *Perungulai* variety of little millet at Jawadhu Hills, 2013

S. No.	Parameters	More/better than check	Same as check	Less/poor than check	Not applicable
1	Duration	11 (57.9)	8 (42.1)	0	0
2	Tolerance to dry spell	4 (21.0)	10 (52.6)	2 (10.5)	3 (15.7)
3	Lodging	3 (15.7)	15 (78.9)	0	1 (5.2)
4	Damage by rains during Maturity	1 (5.2)	2 (10.5)	0	16 (84.2)
5	Grain shattering	0	14 (73.6)	5 (26.3)	0
6	Grain yield	16 (84.2)	2 (10.5)	1 (5.2)	0
7	Straw yield	12 (63.1)	6 (31.5)	1 (5.2)	0
8	Colour preference	13 (68.4)	6 (31.5)	O	0
	Do you save seed				
9	Yes	18 (94.7)			
	No	1 (5.2)			

* Figures in parentheses are % values

Farmers' assessment of *Koluthuna* variety of little millet at J. Hills, 2013

S. No.	Parameters	More/better than check	Same as check	Less/poor than check	Not applicable
1	Duration	5 (33.3)*	10 (66.6)	0	0
2	Tolerance to dry spell	0	11 (73.3)	3 (20.0)	1 (6.6)
3	Lodging	4 (26.6)	11 (73.3)	0	0
4	Damage by rains during Maturity	1 (6.6)	4 (26.6)	3 (20.0)	7 (46.6)
5	Grain shattering	1 (6.6)	12 (80.0)	2 (13.3)	0
6	Grain yield	11 (73.3)	2 (13.3)	2 (13.3)	0
7	Straw yield	3 (20.0)	11 (73.3)	1 (6.6)	0
8	Colour preference	2 (13.3)	13 (86.6)	0	0
	Do you save seed?				
	Yes	15 (100)			
	No	0			

*Figures in parentheses are % values

(iii) Farmers' assessment of *Kala suan* variety of little millet at Semiliguda, 2013

S. No.	Parameters	More/better than check	Same as check	Less/poor than check	Not applicable
1	Duration	0	41 (56.9)	31 (43.1)	0
2	Tolerance to dry spell	24 (50.0)	9 (18.8)	15 (31.2)	24
3	Lodging	9 (26.5)	19 (55.9)	6 (17.6)	38
4	Damage by rains during Maturity	2 (25.0)	2 (25.0)	4 (50.0)	64
5	Grain shattering	4 (21.0)	6 (31.6)	9 (47.4)	53
6	Grain yield	16 (22.2)	19 (26.4)	37 (51.4)	0
7	Straw yield	10 (16.4)	17 (27.9)	34 (55.7)	11
8	Colour preference	9 (14.5)	42 (67.7)	11 (17.7)	10
	Do you save seed				
9	Yes	28(38.89)			
	No	44(61.11)			

*Figures in parentheses are % values

Annexure 6- Farmers' assessment of barnyard and kodo millets varieties in baby trials, 2013

S. No.	Parameters	More/better than check	Same as check	Less/poor than check	Not applicable
1	Duration	0	64 (77.1)	19 (22.9)	0
2	Tolerance to dry spell	17 (22.1)	31(40.3)	29 (37.7)	6
3	Lodging	9 (30.0)	21 (70.0)	0	53
4	Damage by rains during Maturity	31(60.7)	18 (35.3)	2 (3.9)	32
5	Grain shattering	0	17 (85.0)	3 (15.0)	63
6	Grain yield	39 (47.0)	11 (13.3)	33 (39.8)	0
7	Straw yield	30 (36.1)	25 (30.1)	28 (33.7)	0
	Do you save seed				
8	Yes	19 (22.89)			
	No	(77.11)			

Farmers' assessment of *Arupukottai* variety of Barnyard millet at Peraiyur, 2013

Farmers' assessment of *Uppu varagu* variety of Kodo millet in baby trial at Peraiyur, 2013

S. No.	Parameters	More/better than check	Same as check	Less/poor than check	Not applicable
1	Duration	0	10 (58.8)	7 (41.1)	0
2	Tolerance to dry spell	4 (23.5)	3 (17.6)	10 (58.8)	0
3	Lodging	2 (40)	3 (60)	0	12
4	Damage by rains during Maturity.	3 (17.6)	11 (64.7)	3 (17.6)	0
5	Grain shattering	5 (29.4)	10 (58.8)	2 (11.7)	0
6	Grain yield	7 (41.1)	5 (29.4)	5 (29.4)	0
7	Straw yield	1 (5.8)	14 (82.3)	2 (11.7)	0
	Do you save seed				
8	Yes	5 (29.4)			
	No	12 (70.6			

(iii) Farmers' assessment of *Podi varagu* variety of kodo millet in baby trials at Peraiyur, 2013

S. No.	Parameters	More/better than check	Same as check	Less/poor than check	Not applicable
1	Duration	0	9 (56.3)	7 (43.7)	0
2	Tolerance to dry spell	2(12.5)	3 (18.8)	11(68.7)	0
3	Lodging	2(40)	2(40)	1(20)	11
4	Damage by rains during Maturity	1(6.2)	12 (75)	3(18.7)	0
5	Grain shattering	3(18.7)	9(56.2)	4(25)	0
6	Grain yield	9(56.2)	5(31.25)	2(12.5)	0
7	Straw yield	0	9(56.2)	7 (43.7)	0
	Do you save seed				
8	Yes	3(18.7)			
	No	(81.2)			

Annexure 7- Farmers' assessment of varieties of small millets in Indian sites under IRD, 2013

Farmers' assessment of *Kempu ragi* finger millet variety at Anchetty, 2013

S. No.	Parameters	More/better than check	Same as check	Less/poor than check	Not applicable
1	Duration	24 (82.7)	5 (17.2))	0	0
2	Tolerance to dry spell	6 (20.7)	15 (51.7)	2 (6.8)	6 (20.7)
3	Lodging	11 (37.9)	5 (17.2)	5 (17.2)	8 (27.6)
4	Damage by rains during maturity	12 (41.4)	4 (13.7)	1 (3.4)	12 (41.4)
5	Grain shattering	14 (48.2)	9 (23.07)	0	6 (20.7)
6	Grain yield	9 (23.7)	14 (48.3)	6 (20.7)	0
7	Straw yield	11 (37.9)	15 (51.7)	3 (10.3)	0
8	Colour preference	5 (17.2)	22 (75.8)	2 (6.8)	0
9	Resistance to blast	4 (13.7)	3 (10.3)	0	22 (75.8)
	Do you save seed?				
10	Yes	22 (75.8)			
	No	7 (24.1)			

*Figures in parentheses are % values

Farmers' assessment of *Halukuli ragi* finger millet variety at Anchetty, 2013

S. No.	Parameters	More/better than check	Same as check	Less/poor than check	Not applicable
1	Duration	20 (60.6)	12 (36.3)	0	0
2	Tolerance to dryspell	1 (3.03)	19 (57.6)	7 (21.2)	5 (15.1)
3	Lodging	3 (9.09)	8 (24.2)	15 (45.4)	5 (15.1)
4	Damage by rains during Maturity.	2 (6.06)	7 (21.2)	7 (21.2)	16 (48.4)
5	Grain shattering	8 (24.2)	9 (27.3)	13 (39.4)	2 (6.06)
6	Grain yield	4 (12.1)	15 (45.4)	13 (39.4)	0
7	Straw yield	7 (21.2)	21 (63.6)	4 (12.1)	0
8	Colour preference	2 (6.06)	26 (78.7)	4 (12.1)	0
9	Resistance to blast	1 (3.03)	1 (3.03)	2 (6.06)	28 (84.8)
	Do you save seed?				
10	Yes	14 (42.4)			
	No	18 (54.54)			

*Figures in parentheses are % values

Farmers' assessment of performance of GPU-28 variety of finger millet at Bero, 2013

S. No.	Parameters	More/better than check	Same as check	Less/poor than check	Not applicable	Total
1	Maturity	31 (36.9)	30 (35.71)	23 (27.38)	0	84
2	Tolerant to dry spell	32 (50)	27 (42.19)	5 (7.81)	20	84
3	Lodging	16 (28.07)	30 (52.63)	11 (19.3)	27	84
4	Damage by rains during maturity	32 (51.61)	28 (45.16)	2 (3.23)	22	84
5	Grain shattering	23 (37.1)	36 (58.06)	3 (4.84)	22	84
6	Resistance to blast (Only FM)	13 (100)	0	0	71	84
7	Grain yield	76 (90.48)	7 (8.33)	1 (1.19)		84
8	Straw yield	45 (53.57)	28 (33.33)	11 (13.1)		84
9	Color preference	42 (50)	42 (50)	0		84
10	Flour recovery(Only to FM)	26 (33.33)	52 (66.67)	0		78
11	Taste	43 (57.33)	30 (40)	2 (2.67)	0	75
12	Saved seed for next year - Yes - No	80 (95.24) 4 (4.76)				84

Farmers' assessment of performance of A-404 variety of finger millet at Bero, 2013

S. No.	Parameters	More/better than check	Same as check	Less/poor than check	Not applicable	Total
1	Maturity	43 (58.11)	24 (32.43)	7 (9.46)		74
2	Tolerant to dry spell	23 (48.94)	22 (46.81)	2 (4.26)	27	74
3	Lodging	14 (33.33)	16 (38.1)	12 (28.57)	32	74
4	Damage by rains during maturity	18 (36.73)	24 (48.98)	7 (14.29)	25	74
5	Grain shattering	19 (41.30)	22 (47.83)	5 (10.87)	28	74
6	Resistance to blast (Only FM)	0	0	0	74	74
7	Grain yield	63 (85.14)	9 (12.16)	2 (2.70)	0	74
8	Straw yield	35 (47.3)	25 (33.78)	14 (18.92)	0	74
9	Color preference	47 (64.38)	23 (31.51)	3 (4.11)	0	73
10	Flour recovery(Only to FM)	21 (31.34)	46 (68.66)	0	0	67
11	Taste	32 (47.76)	35 (52.24)	0	0	67
12	Saved seed for next year - Yes - No	71 (97.26) 2 (2.74)				73

Farmers' assessment of CO-4 variety of little millet in IRD trials, Jawadhu Hills, 2013

S. No.	Parameters	More/better than check	Same as check	Less/poor than check	Not applicable
1	Duration	52 (88.14)*	7 (11.86)	0	0
2	Tolerance to dry spell	10 (16.95)	35 (59.32)	7 (11.86)	7 (11.86)
3	Lodging	17 (28.81)	32 (54.24)	7 (11.86)	3 (5.08)
4	Damage by rains during Maturity	11 (18.64)	15 (25.42)	9 (15.25)	24 (40.68)
5	Grain shattering	5 (8.47)	44 (74.58)	6 (10.17)	4 (6.78)
6	Grain yield	28 (47.46)	18 (30.50)	13 (22.03)	0
7	Straw yield	44 (74.58)	10 (16.95)	5 (8.47)	0
8	Colour preference	5 (8.47)	51 (86.44)	3 (5.08)	0
	Do you save seed?				
	Yes	43 (72.88)			
	No	16 (27.12)			

*Figures in parentheses are % values

Farmers' assessment of *M* variety of Barnyard millet in IRD at Peraiyur, 2013

S. No.	Parameters	More/better than check	Same as check	Less/poor than check	Not applicable
1	Duration	9 (9.1)	89 (89.9)	1 (1.0)	0
2	Tolerance to dry spell	56 (65.9)	22 (25.9)	7 (8.2)	14
3	Lodging	23 (67.6)	7 (20.6)	4 (11.8)	65
4	Damage by rains during Maturity.	1 (9.1)	8 (72.7)	2 (18.2)	88
5	Grain shattering	11(43.3)	12 (46.2)	3 (11.5)	73
6	Grain yield	45 (45.5)	29 (29.3)	25 (25.3)	0
7	Straw yield	48(48.5)	35 (35.4)	16 (16.2)	0
	Do you save seed				
8	Yes	38 (38.38)			
	No	61 (61.61)			

Annexure 8: Farmer's assessment of small millet varieties in mother/baby trials, 2014

(i) Farmers' assessment of GPU-66 variety of finger millet at Anchetty, 2014

S. No.	Parameters	More/better than check	Same as check	Less/poor than check	Not applicable
1	Duration	0(0)*	16 (100)	0(0)	0
2	Tolerance to dry spell	0 (0)	8 (50)	8 (50)	0
3	Lodging	14 (87.5)	2 (12.5)	0(0)	0 (0)
4	Damage by rains during maturity	2 (12.5)	9(56.2)	5 (31.2)	0 (0)
5	Grain shattering	0(0)	11 (68.7)	5 (31.2)	0
6	Grain yield	0 (0)	0 (0)	16 (100)	0
7	Straw yield	0 (0)	0 (0)	16 (100)	0
8	Colour preference	3 (18.7)	12 (75)	1 (6.2)	0
	Do you save seed?				
	Yes	0 (0)			
	No	100)			

(ii) Farmers' assessment of ML- 365 variety of finger millet at Anchetty, 2014

S. No.	Parameters	More/better than check	Same as check	Less/poor than check	Not applicable
1	Duration	1(2.1)	39(84.7)	6(13)*	0
2	Tolerance to dry spell	2 (4.3)	32 (69.5)	12 (26)	0
3	Lodging	21 (45.6)	24 (52.1)	1(2.1)	0 (0)
4	Damage by rains during Maturity	11 (23.9)	29(63)	1 (2.1)	5 (0)
5	Grain shattering	7(15.2)	32(69.5)	0	7(15.2)
6	Grain yield	12 (26)	11(23.9)	23 (50)	0
7	Straw yield	10 (21.7)	10(21.7)	26 (56.5)	0
8	Colour preference	6 (13)	34 (73.9)	6 (13)	0
	Do you save seed?				
	Yes	14(30.4)			
	No	32 (69.5)			

(iii) Farmers' assessment of GPU-28 variety of finger millet in baby trial at Semiliguda, 2014

Parameters	More/Late/High Better than check	Same as check	Early/Less/ poor than check	Not applicable
Duration	17 (85.0)	0	3 (15.0)	0
Tolerance to dry spell	6 (54.6)	3 (27.3)	2 (18.1)	9
Lodging	8 (40.0)	8 (40.0)	4 (20.0)	0
Damage by rains during Maturity	5 (38.5)	1 (7.6)	7 (53.9)	7
Grain shattering	2 (12.5)	5 (31.3)	9 (56.3)	4
Blast incidence occurrence	0	1 (16.7)	5 (83.3)	14
Taste	0	0	1	19
Grain yield	18 (90.0)	0	2 (10.0)	0
Straw yield	17 (85.0)	2 (10.0)	1 (5.0)	0
Colour preference	17 (85.0)	3 (15.0)	0	0
Do you save seed				
Yes	19 (95.0)			
No	1 (5.0)			

(iv) Farmers' assessment of GPU-48 variety of finger millet in baby trial at Semiliguda, 2014

Parameters	More/Late/High Better than check	Same as check	Early/Less/ poor than check	Not applicable
Duration	12 (60.0)	3(15.0)	5 (15.0)	0
Tolerance to dry spell	3 (16.7)	12 (66.7)	3 (16.7)	2
Lodging	2 (10.0)	13 (65.0)	5 (15.0)	
Damage by rains during Maturity	1 (5.0)	10 (50.0)	9 (45.0)	0
Grain shattering	2 (10.5)	6 (31.6)	11 (57.9)	1
Blast incidence occurrence	0	5 (31.3)	11 (68.8)	4
Taste	1 (5.6)	0	17 (94.4)	2
Grain yield	17 (85.0)	3 (15.0)	0	
Straw yield	12 (60.0)	8 (40.0)	0	
Colour preference	9 (47.4)	8 (42.1)	2 (10.5)	1
Do you save seed?				
Yes	15 (75.0)			
No	5 (25.0)			

(v) Farmers' assessment of *IR 20* variety of little millet in baby trials at Jawadhu Hills, 2014

S. No.	Parameters	More/better than check	Same as check	Less/poor than check	Not applicable
1	Duration	18 (36.7)	11 (22.4)	20 (40.8)	0
2	Tolerance to dry spell	14 (28.5)	20 (40.8)	14 (28.5)	1 (2.0)
3	Lodging	11 (22.4)	28 (57.1)	10 (20.4)	0
4	Damage by rains during Maturity	7 (14.2)	22 (44.9)	17(34.7)	3 (6.1)
5	Grain shattering	6 (12.2)	23 (46.9)	19 (38.7)	1(2)
6	Grain yield	24 (49.0)	21 (42.8)	4 (8.2)	0
7	Straw yield	23 (65.0)	19 (38.7)	7 (14.2)	0
8	Colour preference	11 (22.4)	32 (65.3)	5 (10.2)	0
	Do you save seed				
9	Yes	36 (73.4)			
	No	13 (26.6)			

*Figures in parentheses are % values

(vi) Farmers' assessment of *Siru samai* variety of little millet at Jawadhu Hills, 2014

S. No.	Parameters	More/better than check	Same as check	Less/poor than check
1	Duration	10 (71.4)*	3 (21.4)	1 (7.1)
2	Tolerance to dry spell	6 (42.9)	7 (50.0)	1 (7.1)
3	Lodging	5 (35.7)	4 (28.6)	5 (35.7)
4	Damage by rains during Maturity	12 (85.7)	1 (7.1)	1 (7.1)
5	Grain shattering	14 (100)	0	0
6	Grain yield	9 (64.3)	5 (35.7)	0
7	Straw yield	11 (78.6)	3 (21.4)	0
8	Colour preference	5 (35.7)	9 (64.3)	0
	Do you save seed?			
	Yes	14 (100)		
	No	0		

*Figures in parentheses are % values

(vii) Results of FPA activities in mother trial of kodo millet at Sengapadai village, Peraiyur, 2014

Name of variety	Preference score			
	1st	2nd	3rd	Total weighted score
Uppu varagu	0 (0)	3 (6)	2 (2)	(8)*
Podi varagu	0 (0)	6 (12)	3 (3)	(15)
Karu varagu	9 (27)	0 (0)	0 (0)	(27)
Kozhikal varagu	0 (0)	1 (2)	1 (1)	(3)
Sendhal varagu	0	0	0	(0)
TNAU 86	0 (0)	0 (0)	2 (2)	2 (2)
RK 390-25	0 (0)	0 (0)	1 (1)	1 (1)
RBK 155	0	0	0	(0)
Total Participants	9	9	9	-

* values in parentheses are weighted scores.

Annexure 9: Farmers' assessment of varieties of small millets in Indian sites under IRD, 2014

(i) Farmers' assessment of *Saratha* variety of finger millet under IRD at Anchetty, 2014

S. No.	Parameters	More/better than check	Same as check	Less/poor than check
1	Duration	32 (64)*	18 (36)	0
2	Tolerance to dry spell	20 (40)	29 (58)	1 (2)
3	Lodging	0	22 (44)	28 (56)
4	Damage by rains during maturity	0	14 (28)	36 (72)
5	Grain shattering	0	14 (28)	36 (72)
6	Grain yield	1 (2)	6 (12)	43 (86)
7	Straw yield	32 (64)	15 (30)	3 (6)
8	Colour preference	9 (18)	32 (64)	9 (18)
	Do you save seed?			
	- Yes	15 (30)		
	- No	35 (70)		

*Figures in parentheses are % values

(ii) Farmers' assessment of *Kempu ragi* variety of finger millet under IRD at Anchetty, 2014

S. No.	Parameters	More/better than check	Same as check	Less/poor than check	Not applicable
1	Duration	32 (64)*	18 (36)	0	0
2	Tolerance to dry spell	16 (32)	32 (64)	2 (4)	0
3	Lodging	4 (8)	32 (64)	14 (28)	0
4	Damage by rains during Maturity	9 (18)	34 (68)	7 (14)	0
5	Grain shattering	12 (24)	31 (62)	5 (10)	2 (4)
6	Grain yield	17 (34)	13 (26)	20 (40)	0
7	Straw yield	22 (44)	16 (32)	12 (24)	0
8	Colour preference	12 (24)	37 (74)	1 (2)	0
	Do you save seed?				
	Yes	19 (38)			
	No	31 (62)			

*Figures in parentheses are % values

(iii) Farmers' assessment of GPU-28 variety of finger millet under IRD at Jawadhu Hills, 2014

S. No.	Parameters	More/better than check	Same as check	Less/poor than check
1	Duration	3 (6)*	30 (60)	17 (34)
2	Tolerance to dry spell	22 (44)	19 (38)	19 (38)
3	Lodging	20 (40)	17 (34)	13 (26)
4	Damage by rains during Maturity	36 (72)	12 (24)	12 (24)
5	Grain shattering	36 (72)	14 (28)	0
6	Grain yield	28 (56)	22 (44)	0
7	Straw yield	32 (64)	18 (36)	0
8	Colour preference	27 (54)	23 (46)	0
	Do you save seed?			
	Yes	50 (100)		
	No	0		

(iv) Farmers' assessment of *Kempu ragi* variety of finger millet under IRD at Jawadhu Hills, 2014

S. No.	Parameters	More/better than check	Same as check	Less/poor than check
1	Duration	13 (43)*	12 (40)	5 (17)
2	Tolerance to dry spell	15 (50)	14 (47)	1 (3)
3	Lodging	17 (57)	11 (36)	2 (7)
4	Damage by rains during Maturity.	23 (76)	7 (23)	0
5	Grain shattering	27 (90)	3 (10)	0
6	Grain yield	11 (36)	19 (64)	0
7	Straw yield	24 (80)	6 (20)	0
8	Colour preference	6 (20)	24 (80)	0
	Do you save seed?			
	Yes	30 (100)		
	No	0		

(v) Farmers' assessment of GPU 66 variety of finger millet under IRD at Jawadhu Hills, 2014

S. No	Parameters	More/better than check	Same as check	Less/poor than check
1	Duration	19 (63)*	11 (37)	0
2	Tolerance to dry spell	15 (50)	4 (13)	11 (37)
3	Lodging	14 (46)	10 (33)	6 (21)
4	Damage by rains during maturity	20 (66)	6 (21)	4 (13)
5	Grain shattering	21 (70)	9 (30)	0
6	Grain yield	13 (43)	10 (33)	1 (3.3)
7	Straw yield	15 (50)	14 (46)	1 (3.3)
8	Colour preference	4 (13)	26 (87)	0
	Do you save seed?			
	Yes	30 (100)		
	No	0		

*Figures in parentheses are % values.

(vi) Farmers' assessment of GPU-66 variety of finger millet in IRD at Bero (values in %), 2014

S. No.	Parameters	More/better than check	Same as check	Less/poor than check
1	Maturity	11.0	67.0	22.0
2	Tolerant to dry spell	44.0	44.0	11.0
3	Lodging	0.0	11.0	89.0
4	Damage by rains during maturity	0.0	56.0	44.0
5	Grain shattering	0.0	56.0	44.0
6	Resistance to blast (Only FM)	67.0	11.0	22.0
7	Grain yield	100.0	0.0	0.0
8	Straw yield	0.0	11.0	89.0
9	Color preference	56.0	44.0	0.0
10	Flour recovery(Only to FM)	0.0	100.0	0.0
11	Taste	67.0	33.0	0.0
12	Saved seed for next year - Yes - No	 89 11		

(vii) Farmers' assessment of GPU-67 variety of finger millet in IRD at Bero (values in %), 2014

S. No	Parameters	More/better than check	Same as check	Less/poor than check
1	Maturity	32.0	65.0	3.0
2	Tolerant to dry spell	46.0	49.0	5.0
3	Lodging	0.0	3.0	97.0
4	Damage by rains during maturity	6.0	62.0	32.0
5	Grain shattering	3.0	35.0	62.0
6	Resistance to blast (Only FM)	84.0	14.0	2.0
7	Grain yield	97.0	3.0	0.0
8	Straw yield	0.0	19.0	81.0
9	Color preference	43.0	57.0	0.0
10	Flour recovery(Only to FM)	11.0	84.0	5.0
11	Taste	70.0	30.0	0.0
12	Saved seed for next year - Yes - No	 95.0 5.0		

(viii) Farmers' assessment of A-404 variety of finer millet in IRD at Bero (values in %), 2014

S. No.	Parameters	More/better than check	Same as check	Less/poor than check
1	Maturity	64.0	36.0	0.0
2	Tolerant to dry spell	21.0	75.0	4.0
3	Lodging	0.0	7.0	93.0
4	Damage by rains during maturity	3.0	61.0	36.0
5	Grain shattering	11.0	57.0	32.0
6	Resistance to blast (Only FM)	71.0	21.0	7.0
7	Grain yield	96.0	4.0	0.0
8	Straw yield	0.0	39.0	61.0
9	Color preference	46.0	54.0	0.0
10	Flour recovery(Only to FM)	15.0	81.0	4.0
11	Taste	86.0	14.0	0.0
12	Saved seed for next year			
	- Yes	93.0		
	- No	7.0		

(ix) Farmers' assessment of GPU-28 variety of finger millet in IRD at Bero (values in %), 2014

S. No.	Parameters	More/better than check	Same as check	Less/poor than check
1	Maturity	28.0	89.0	3.0
2	Tolerant to dry spell	31.0	63.0	6.0
3	Lodging	0.0	3.0	97.0
4	Damage by rains during maturity	0.0	56.0	44.0
5	Grain shattering	3.0	50.0	47.0
6	Resistance to blast (Only FM)	72.0	16.0	12.0
7	Grain yield	88.0	12.0	0.0
8	Straw yield	0.0	38.0	63.0
9	Color preference	44.0	53.0	3.0
10	Flour recovery(Only to FM)	9.0	81.0	10.0
11	Taste	78.0	22.0	0.0
12	Saved seed for next year			
	- Yes	97.0		
	- No	3.0		

(x) Farmers' assessment of GPU-66 variety of finger millet in IRD at Semiliguda, 2014

Parameters	More/Late/High Better than check	Same as check	Early/Less/poor than check	Not applicable
Duration	11 (55)	3 (15)	6 (30)	0
Tolerance to dry spell	3 (60)	1 (20)	2 (40)	14
Lodging	3(16.66)	2 (11.11)	13 (72.22)	2
Damage by rains during Maturity	1 (5.89)	11 (64.71)	5 (29.40)	3
Grain shattering	0	3 (30)	7 (70)	10
Blast incidence occurrence	1 (20)	0	4 (80)	15
Taste	2 (28.5)	5 (71.5)	0	13
Grain yield	15 (75)	4(20)	1 (5)	0
Straw yield	12 (60)	8 (40)	0	0
Colour preference	9 (45)	11 (55)	0	0
Do you save seed?				
Yes	16 (80)			
No	4 (20)			

(xi) Farmers' assessment of GPU-67 variety of finger millet in IRD at Semiliguda, 2014

Parameters	More/Late/High Better than check	Same as check	Early/Less/poor than check	Not applicable
Duration	7(35)	5(25)	8(40)	0
Tolerance to dry spell	1(20)	2(40)	2(40)	15
Lodging	1(14.28)	2(28.58)	4(57.14)	13
Damage by rains during Maturity	1(11.12)	0	8(88.88)	11
Grain shattering	0	1(20)	5(80)	14
Blast incidence occurrence	2(11.76)	2(11.76)	13(76.48)	3
Taste	2(28.57)	4(57.14)	1(14.29)	13
Grain yield	11(64.7)	6(35.29)	0	3 (not collected)
Straw yield	15(83.4)	3(16. 6)	0	2
Colour preference	11(57.9)	8(42.1)	0	1
Do you save seed?				
Yes	18(90)			
No	2(10)			

(xii) Farmers' assessment of *Perungulai* variety of little millet under IRD at J. Hills, 2014

S. No.	Parameters	More/better than check	Same as check	Less/poor than check	Not applicable
1	Duration	17 (34)	31 (62)	2 (4)	0
2	Tolerance to dry spell	11 (22)	33 (66)	6 (12)	0
3	Lodging	9 (18)	24 (48)	17 (34)	0
4	Damage by rains during Maturity	8 (16)	32 (64)	5 (10)	5 (10)
5	Grain shattering	15 (30)	32 (64)	3 (6)	0
6	Grain yield	25 (50)	21 (42)	4 (8)	0
7	Straw yield	27 (54)	18 (36)	5 (10)	0
8	Colour preference	20 (40)	29 (58)	1 (2)	0
	Do you save seed				
9	Yes	39 (78)			
	No	11 (22)			

*Figures in parentheses are % values

(xiii) Farmers' assessment of *Koluthana* variety of little millet under IRD at Jawadhu Hills, 2014

S. No.	Parameters	More/better than check	Same as check	Less/poor than check	Not applicable
1	Duration	28 (56)*	18 (36)	4 (8)	0
2	Tolerance to dry spell	9 (18)	25 (50)	16 (32)	0
3	Lodging	5 (10)	30 (60)	13 (26)	2 (4)
4	Damage by rains during Maturity	9 (18)	27 (54)	7 (14)	7 (14)
5	Grain shattering	17 (34)	28 (56)	5 (10)	0
6	Grain yield	32 (64)	15 (30)	3 (6)	0
7	Straw yield	34 (68)	14 (28)	2 (4)	0
8	Colour preference	22 (44)	27 (54)	1 (2)	0
	Do you save seed?				
	Yes	43 (86)			
	No	7 (14)			

*Figures in parentheses are % values

(xiv) Farmers' assessment of CO 4 variety of little millet under popularisation at Jawadhu Hills, 2014

S. No.	Parameters	More/better than check	Same as check	Less/poor than check	Not applicable
1	Duration	10 (20)*	31 (62)	9 (18)	0
2	Tolerance to dry spell	9 (18)	25 (50)	16 (32)	0
3	Lodging	8 (16)	23 (46)	18 (36)	1 (2)
4	Damage by rains during Maturity	12(24)	35 (70)	1 (2)	2 (4)
5	Grain shattering	19 (38)	26 (52)	3 (6)	2 (4)
6	Grain yield	18 (36)	27 (54)	5 (10)	0
7	Straw yield	24 (48)	20 (40)	6 (12)	0
8	Colour preference	11 (22)	35 (70)	4 (8)	0
	Do you save seed?				
	Yes	39 (78)			
	No	11 (22)			

*Figures in parentheses are % values

(xv) Farmers' assessment of CO-2 variety of barnyard millet under IRD at Peraiyur, 2014

S. No.	Parameters	More/better than check	Same as check	Less/poor than check	Not applicable
1	Duration	2 (4)	48 (96)	0	0
2	Tolerance to dry spell	26 (52)	18 (36)	0	6 (12)
3	Lodging	15 (30)	9 (18)	4 (8)	22 (44)
4	Damage by rains during Maturity.	19 (38)	5 (10)	1 (2)	25 (50)
5	Grain shattering	13 (26)	4 (8)	3 (6)	30 (60)
6	Grain yield	14 (28)	16 (32)	18 (36)	0
7	Straw yield	10 (20)	25 (50)	15 (30)	0
	Do you save seed				
8	Yes	37 (74)			
	No	13 (26)			

(xvi) Farmers' assessment of *Arupukottai* variety of barnyard millet under IRD at Peraiyur, 2014

S. No.	Parameters	More/better than check	Same as check	Less/poor than check	Not applicable
1	Duration	0	27 (96)	1 (4)	0
2	Tolerance to dry spell	14 (50)	14 (50)	0	0
3	Lodging	21(75)	6 (21)	1 (4)	0
4	Damage by rains during Maturity	21 (75)	5 (18)	0	2 (7)
5	Grain shattering	20 (71)	8 (29)	0	0
6	Grain yield	7 (25)	16 (57)	5 (18)	0
7	Straw yield	12 (43)	13 (46)	3 (11)	0
	Do you save seed				
8	Yes	14 (50)			
	No	14 (50)			

Annexure 10: Organoleptic test results in small millets at project sites

(i) Score values of organoleptic tests of two recipes in finger millet at Anchetty

Recipe	Farmer Name	Gender	Age	Varieties				
				GPU-28	INDAF	ML 365	Kempu	Saratha
Ragi mudde (Kali)	Elakkiya	F	23	4	1	3	5	2
	Govindasamy	M	63	5	4	3	1	2
	Konamma	F	36	2	5	4	3	1
	Madhappan	M	43	2	3	4	5	1
	Manikkam	M	25	2	1	5	3	4
	Pachiyamma	F	29	1	4	2	5	3
	Periyasamy	M	31	2	4	5	3	1
	Reetha	F	14	2	5	3	4	1
	Venkatesh	M	67	4	5	2	1	3
	Total	--	--	**27**	**36**	**36**	**31**	**20**
Ragi rotti (bread)	Elakkiya	F	23	2	4	3	5	1
	Govindasamy	M	63	3	2	5	1	4
	Konamma	F	36	1	2	5	3	4
	Madhappan	M	43	2	3	4	1	5
	Manikkam	M	25	2	5	4	1	3
	Munilakshmi	F	23	5	1	4	2	3
	Pachiyamma	F	29	2	5	3	1	4
	Periyasamy	M	31	2	4	3	1	5
	Reetha	F	14	4	3	5	1	2
	Venkatesh	M	67	1	5	2	3	4
	Total	--	--	**24**	**34**	**38**	**19**	**35**

(ii) Score values of organoleptic tests of two recipes in little millet at Jawadhu Hills

Recipe	Evaluators	Gender	Age	Varieties						
				Siru samai	Koluthana	IR-20	Perungulai	Vella Samai	CO-4	Sittan
Samai cooked rice	Anbu	M	32	6	4	2	7	5	3	1
	Boochi	M	40	5	4	2	5	1	6	3
	Govindh	M	45	2	7	5	4	1	6	3
	Kuppu	F	60	6	4	5	1	2	7	3
	Ponnusami	M	50	7	5	4	6	3	2	1
	Rajamma	F	45	6	3	7	2	4	5	1
	Renjith	M	15	7	2	1	6	4	3	5
	Rukku	F	40	4	7	3	2	6	5	1

	Valarmathi	F	42	7	6	1	2	5	4	3
	Vijaya	F	33	6	4	1	5	3	2	7
	Total	--	--	**66**	**56**	**41**	**48**	**41**	**46**	**36**
	Average	**--**	**--**	**5.5**	**4.67**	**3.42**	**4**	**3.42**	**3.83**	**3**
Samai Uppuma	Anbu	M	32	1	5	4	6	7	3	2
	Boochi	M	40	5	2	3	6	7	4	1
	Govindh	M	45	1	5	2	6	3	7	4
	Jagatheesh	M	25	3	2	6	1	7	5	4
	Kuppu	F	60	5	4	6	2	3	7	1
	Rajeshwari	F	35	1	2	5	3	6	7	4
	Rajamma	F	45	3	5	1	4	6	7	2
	Renjith	M	15	1	3	6	7	5	2	4
	Rukku	F	40	4	3	5	6	7	2	1
	Vijaya	F	33	5	1	6	2	7	3	4
	Total	**--**	**--**	**29**	**32**	**44**	**43**	**58**	**47**	**27**
	Average	**--**	**--**	**2.9**	**3.2**	**4.4**	**4.3**	**5.8**	**4.7**	**2.7**

(iii) Score values of organoleptic tests of two recipes in barnyard millet at Peraiyur

Recipe	Evaluators	Gender	Varieties				
			CO-2	**M**	**M1**	**AK**	**Sadai**
Sadham (Cooked rice)	Karuppaiya	Male	5	3	4	1	2
	Suppuraj	Male	5	3	4	1	2
	Sivakumar	Male	5	4	3	1	2
	Kutty	Male	1	4	2	5	3
	Chinnasami	Male	4	5	3	1	2
	Krishnammal	Female	4	3	4	1	2
	Annalakshmi	Female	4	5	1	3	2
	Rajeshwari	Female	3	3	2	1	1
	Kalaiselvi	Female	5	4	3	2	1
	Patchaiyammal	Female	4	3	4	1	2
	Total		**40**	**37**	**30**	**17**	**19**
Kanchi (Gruel)	Karuppaiya	Male	4	2	3	1	4
	Suppuraj	Male	1	5	2	3	4
	Sivakumar	Male	3	5	1	2	4
	Kutty	Male	4	3	5	1	2
	Chinnasami	Male	1	5	3	4	2
	Krishnammal	Female	4	4	2	3	1
	Annalakshmi	Female	3	2	4	1	4
	Rajeshwari	Female	3	4	2	4	1
	Kalaiselvi	Female	5	1	4	3	2
	Alagupandi	Female	4	3	2	5	1
	Total		**32**	**34**	**28**	**27**	**25**