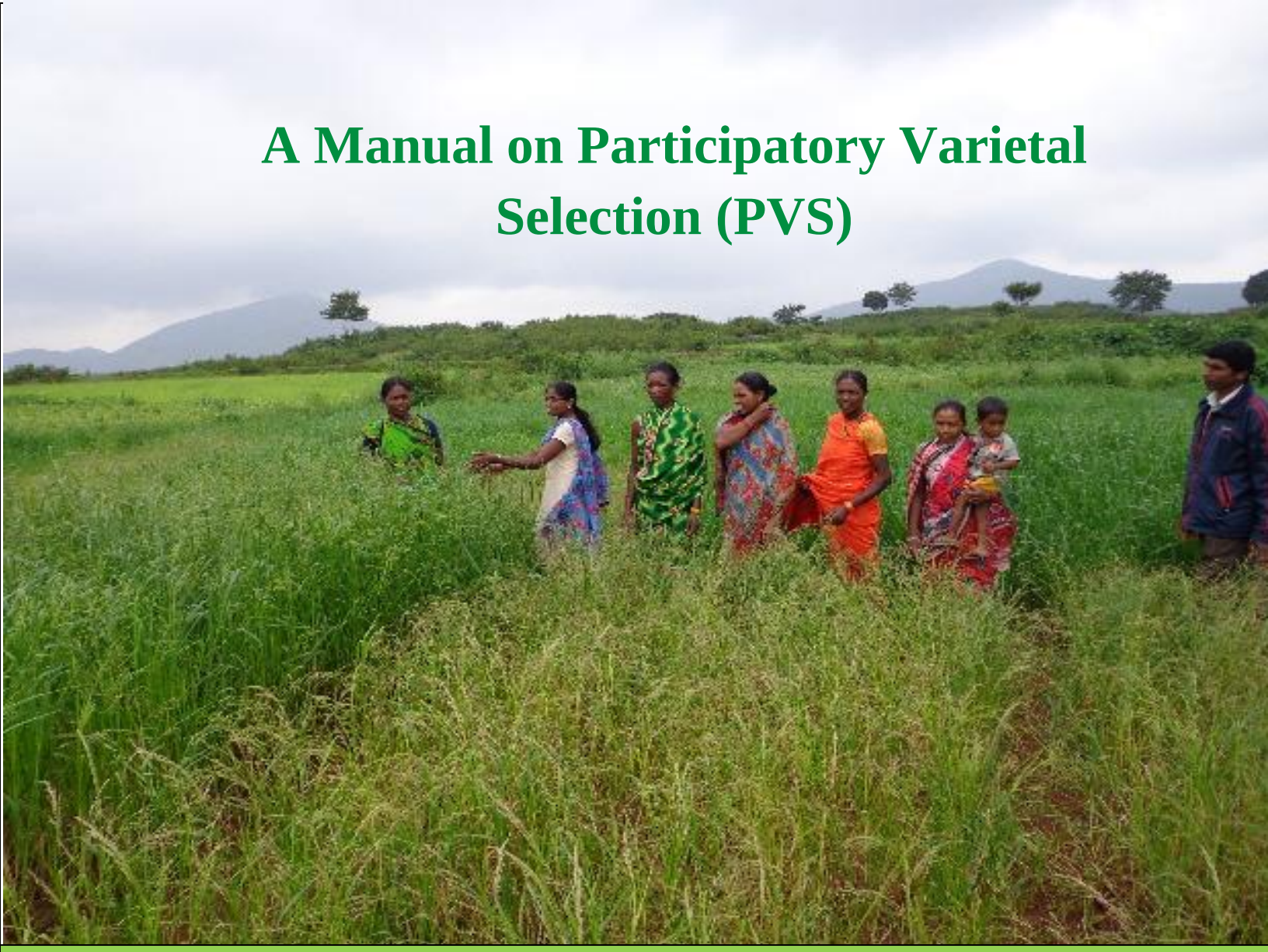
A Manual on Participatory Varietal Selection (PVS)



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DHAN Foundation
Building Institutions for Generations

Contents

Acronyms

CPB	Conventional Plant Breeding
FGD	Focus Group Discussion
FPA	Farmers Preference Analysis
FPV	Farmer-preferred variety
LI-BIRD	Local Initiatives for Biodiversity, Research and Development
PCI	Participatory Crop Improvement
PVS	Participatory Varietal Selection
RESMISA	Revalorizing Small Millets in Rainfed Regions of South Asia
MAS	Marker Assisted Selection
ART	Adaptive Research Trials
IRD	Informal Research and Development
CBSP	Community Based Seed Production
RCBD	Randomised Complete Block Design
ANOVA	Analysis of Variance
Sem	Standard error of mean
CIKS	Centre for Indian Knowledge Systems

Preface

This manual is an outcome of learning from 'Revalorizing Small Millets in Rainfed Regions of South Asia' (RESMISA) project implemented between 2011-14 by DHAN Foundation and Canadian Mennonite University as leading partners. In this project Participatory Varietal Selection (PVS) activities were taken up in four small millet crops in India, Nepal and Sri Lanka. Small millets, known for their rich nutritional attributes and more resilience to climatic vagaries of rainfed agro-climatic ecosystems, are losing their original status in many countries as indicated by the declining trend in area under cultivation and consumption status. Considering the heterogeneous situations of rainfed farming areas of sites, the project adopted PVS as an ideal approach for enhancing varietal diversity and crop improvement of small millets. The project viewed PVS as a strategic way for bringing back the role of local farmers in identifying and developing suitable varieties for their location. Though the principles and design of PVS are accessible in literature, handling of on-farm activities is a massive task, for which a systematic scientific approach is needed. A set of well-designed activities were formulated for implementing PVS concept more effectively and efficiently, taking into consideration the local situations in the sites comprising farming system, soil type, moisture regimes, etc. This manual shares the specific learning of the project team in terms of various PVS research activities that need to be taken in a period of three years for identifying additional potential varieties with systematic involvement of community in each step. It includes research designs of different on-farm trials, data collection, data processing and statistical analysis for producing reliable useful results. Further, guidelines for quality seed production and dissemination of identified varieties locally through community organizations for realizing the objectives of PVS are also given.

Though the manual shares the experience of PVS in small millet crops, the principles and methods shared can also be used for other crops with necessary improvising and contextualization. We hope that any organization or individuals, who may show interest in adopting PVS approach to help farmers to increase their control over their livelihoods will find this manual useful. The manual is prepared mainly for the benefit of field staffs (also called as field research staff) who are involved in varietal improvement, keeping their basic educational background in mind. This manual can be used for offering structured training to both technical and non-technical staff implementing the PVS. The manual content can also be used as a resource material for training the trial farmers. We hope that this manual will be useful for practitioners in the field. We are glad to receive from you any comments on the process and methods shared in this manual and any suggestions for improving the manual content and presentation.

We thank all the colleagues and trial farmers in the five sites, who were my co-learners and whose glad involvement made this manual possible. We profusely thank DFATD and IDRC for their generous financial support for the RESMISA project, which resulted in this book.

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Module 1

Introduction to Participatory Varietal Selection (PVS)

Module objectives

- Introduces the reader to crop improvement approaches and the need for participatory methods like PVS
- Describes the what and why of PVS
- Describes various stages of PVS

Introduction to Participatory Varietal Selection

Approaches to crop improvement

Crop improvement or plant breeding is the art and science of changing the traits of plants to produce desired characteristics. The basic methods of crop improvement are domestication, introduction, hybridization and selection. Plant breeding is an applied, multidisciplinary science based on the application of genetic principles and practices for the development of cultivars more suited to the needs of people. It uses knowledge from agronomy, botany, genetics, cytogenetic, molecular genetics, physiology, pathology, entomology, biochemistry, bio-informatics and statistics (Schlegel, 2003). In the beginning, plant breeding was more of art than science; now it is not just science, but technology too. As a science, plant breeding started soon after the rediscovery of Mendel's Laws at the beginning of the 20th century. Before that, farmers had done plant improvement for several thousand years. After domesticating the crops, which give the food, feed, medicines, textiles, etc., of today, they have continued to modify them, and move them from continent to continent, adapting them to new climates, new cultural practices and new uses. There is evidence that hybridization also started before 1900 (Strampelli, 1944).

So earlier, crop improvement was in the domain of the enlightened farmers. They were responsible for creating rich crop and varietal diversity. Their selection process was unique as it involved both farmers' perspective as well as natural forces, which operated over a long period in their habitat. The varieties so evolved adapted to the specific sites resulting in increased varietal diversity. The traditional knowledge and skills of the local farmers in maintaining crop and varietal diversity also enriched over the years. One can assume the genetic makeup of such varieties was never fixed in 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.

Later, with the advent of crop improvement as a science by public and private research organisations in the last two centuries, large-scale changes happened related to plant breeding. Besides natural variation, it was possible to create new variation artificially through hybridisation and mutation. These mechanisms helped to hasten crop improvement processes. With the advancement of scientific knowledge in molecular genetics, now scientists can manipulate genetic systems through biotechnology tools in any manner they could think. Similarly, sophisticated selection procedures and tools were also developed. Thus, plant breeding has remained a vibrant science, with continued success in developing and deploying new cultivars across the world. This conventional plant breeding (CPB) approach was successful in increasing productivity and production of major food and commercial crops, heralding 'green revolution'. On average, around 50% of productivity increases can be attributed to genetic improvement (Fehr, 1984).With these changes crop improvement moved from the domain of farmers to the domain of public and private organisations.

But, over time the cracks in the conventional approach of plant breeding became visible. It failed to make significant impact in vast farming areas characterised by diversity in soil, weather, 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. Most of the modern varieties are bred under controlled conditions (on research farms) to suit favourable growing situations.The varieties developed may not be suitable for target production areas, because of the existence of large Genotype X Environment interactions (i.e. differences) among the performances of the breeding materials. This led to large difference in the performance of these materials between research stations (the selection environment) and the field of poor farmers or the marginal areas (the target environment). Further, the improved varieties are developed 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 early phases of selection process. The varieties 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 to ensure large scale cultivation. Such a move replaces gradually the existing traditional as well as popular varieties of that region, making it 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 seed replacement on a regular basis. So, in the absence of inbuilt mechanisms to adjust with the changing surroundings, most of the introduced varieties lose their existence after some years.

The main deficiencies of conventional plant breeding according to Ceccarelli, 2012 are,

1. Plant breeding has not been successful in marginal environments and for poor farmers.
2. It still takes a longtime (about 15 years) to develop and release a new variety in developing countries.
3. Farmers adopt only few of the officially released varieties.
4. Even when new varieties are acceptable to farmers, their seeds are either not available or too expensive.
5. There is a widespread perception of a decrease of biodiversity associated with conventional plant breeding programmes.

In spite of these issues, the conventional approach remains as the main domain of public and private research organisations at national, regional and global levels.

These issues gave impetus to think about participatory approach for crop improvement. The term 'participatory crop improvement' (PCI) became established in the 1990s, as several projects were undertaken under this banner (Vernooy, 2003). PCI emerged especially as a response to alarming loss of traditional varieties in farmers' fields and growing marginalisation of farmers in crop improvement and agriculture development (SEARICE, 2007). By involving the farmers in the various stages of selection process through 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). PCI need not be considered as the alternate method to the conventional approach of crop improvement. Both could complement each other to reach the benefits of scientific and indigenous knowledge to the farmers of diverse farming situations in shortest possible period. Among the various crop improvement activities

Box 1: Stages in plant breeding programme

In all breeding programmes, it is possible to identify three main stages (Schnell, 1982; Ceccarelli, 2009):

1. Generating genetic variability: This includes making crosses (selection of parents, crossing techniques and type of crosses), inducing mutation, and introducing exotic germplasm.

2. Selection: This involves selection of the best genetic material within the genetic variability created in the first stage. In self-pollinated crops, this includes primarily implementing various methods, such as classical pedigree, bulk pedigree, backcross, hybridization, recurrent selection, or the F2 progeny method. In self-pollinated tree crops, this includes progressive evaluation of individual plants. In cross-pollinated crops, synthetic varieties, open pollinated varieties and hybrids are used, and in vegetatively propagated crops, there are clones and hybrids. Marker assisted selection could be used in this stage.

3. Testing of breeding lines: This includes comparisons between existing cultivars and the breeding lines emerging from Stage 2, and the appropriate methodologies to conduct such comparisons. These comparisons take place partly on-station (on-station trials) and partly in farmers' fields (on-farm trials).

taken up under the broad umbrella of PCI, participatory varietal selection (PVS) was one among them (Joshi and Witcombe, 1996).

What is Participatory Varietal Selection?

Participatory Varietal (or Variety) Selection is a selection among fixed lines by farmers under target environment. Fixed lines are varieties that do not segregate in the next generation and have stable characteristics (i.e.) finished or nearly finished varieties. Target environment here means the farmer's fields. It is a simple way for breeders and agronomists to learn which varieties perform well on-farm and preferred by farmers. It is both a research and extension method. Different practitioners view the role of PVS in crop improvement differently (see the box on stages in plant breeding programme). Ceccarelli (2012) stated that PVS is always an integral part of Participatory Plant Breeding (PPB), representing its final stages; but it can also be a standalone intervention in an otherwise non-participatory breeding programme. Abay and Bjornstad (2008) and DeBoef et al (2010) opined that PVS could even be used to identify local varieties that perform well in the target environment. In this manual, PVS is considered as a starting point for crop improvement in a site and involves selection among the promising traditional, released and pre-release varieties by the farmers in the site.

Box 2: Difference between Adaptive research trials (ART) done before release of varieties and PVS

PVS differs from ART in several ways such as

a) Only farmer management is used (no package),
b) Farmers' opinions about varieties, being tested are systematically collected,
c) Environmental replication is extensive,
d) Released, pre-release and proven local varieties are included and
e) Trials are taken up in three stages.

Why Participatory Varietal Selection?

- The basic premise behind PVS is that there are heterogeneous crop environments that require specific efforts for varietal selection than centralized breeding efforts. Further, breeders may not be aware of some of the important traits that are needed or preferred by farmers and varieties selected on research stations may not perform well under farmer management. PVS helps in overcoming these issues.
- PVS is 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).
- Involving farmers in varietal selection process increases the chances of adoption of these varieties. So PVS can be considered as a step in formal breeding process.
- 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.
- Many of the traditional varieties, evolved over a long period as a response to local environment, have vanished in the last two decades and the process is still going on. Farmers are losing various cultivars,

which are of value to them. For many contemporary issues and needs faced by the farmers, including climate change related issues, the solution could be adoption of well adapted well performing traditional varieties. Therefore, it is important to evaluate the traditional varieties for their suitability for the current and emerging problems. PVS offers such possibility.

In essence, PVS helps in identifying additional farmer-preferred varieties (FPVs) in each site, which in turn increases the varietal diversity and productivity realised. This is important in the context of fast decline of varietal diversity, deskilling of farmers, increasing vulnerability due to climate change and increasing nutrition insecurity. PVS in combination with on-farm conservation and seed system development at the local level is expected to increase resilience of small and marginal farmers in the long run.

Different stages in PVS

A successful participatory varietal selection programme has four phases:

1. Participatory evaluation to identify farmers' needs in a cultivar
2. A search for suitable material to test with farmers
3. Experimentation on acceptability of suitable material in farmers' fields and
4. 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 site related to the varieties of a particular crop for initiating varietal selection and to set breeding goals. This is done through various participatory methods like i) focus group discussion (FGD), ii) voting for preferred traits separately by each gender and iii) matrix ranking. Consumer/market survey can also be taken up. The traits preferred by the farmers identified through these methods need to be considered at different phases of PVS cycle for varietal selection process.

Set of data collected will vary depending on the familiarity of the research team with cropping situation in the site. If it is a new area and crop situation is not familiar, then all the themes given in Table 1 are studied using the methods suggested. If the research team is familiar with the crop situation, then themes 4 and 5 are studied for setting breeding goals. The field research team should equip themselves for conducting these methods of inquiry and prepare necessary checklist or guidance sheet beforehand. Detailed suggestions to conduct Key informant surveys, FGD, seasonal calendars, semi-structured interview, time line and Venn diagram are given in **Guide to Participatory Varietal Selection for Submergence-tolerant Rice by IRRI.**

Table 1 Methods that for understanding local cropping system and for identifying farmers' needs in a cultivar

Sl. No.	Themes studied	Methods

1	List of crops grown and their cropping pattern	Focus group discussion, seasonal calendar, transect walk, plant sample collection and photo documentation
2	Changes in cropping pattern over the years	Trend analysis, and timeline
3	Identification of important focus crops and their varieties; details of the focus crops like productivity, cost of cultivation, institutions involved in those crops, including value chain actors, source of seed, etc.	Focus group discussion, transect walk, plant sample collection, photo documentation, Venn diagram and semi-structured interview
4	Selection of focus crops for which PVS is needed and their feasibility	Focus group discussion
5	For the selected crops: Status of the existing varieties, their pros and cons, the requirements for a suitable variety	Matrix analysis and key informant interview

The Table 2 illustrates the desirable traits identified for finger millet at three village development committees in Nepal by farmers and the Table 3 illustrates the pairwise ranking by farmers for finger millet. The traits getting more score are considered to be more preferred by the farmers (in the illustration they are disease resistance and synchronous maturity).

Table 2 Illustration of traits preferred and used by farmers to evaluate finger millet varieties in Nepal

Traits	Kaskikot	Dhikurpokhari	Jogimara
Maturity	Late	Late	Late
Plant stature	Tall, short internode length	Tall, short internode length	Tall, short internode length
Straw	Good straw yield, stay green trait	Good straw yield, stay green trait	Good straw yield, stay green trait
Finger/head type	Closed fingers (Closed fingers are less affected by hail compared to open type)	Closed fingers (Closed fingers are less affected by hail compared to open type)	Long fingers irrespective of head type
Adaptation	Adaptive to relay cropping with maize	Adaptive to relay cropping with maize	Adaptive to relay cropping with maize
Intercropping	Adaptive to mix cropping with grain legumes like blackgram, ricebean, soyabean, cowpea, beans and horsegram	Adaptive to mix cropping with grain legumes like blackgram, ricebean, soyabean, cowpea, beans and horsegram	Adaptive to mix cropping with grain legumes like blackgram, ricebean, cowpea, beans and horsegram

Source: LI-BIRD, Nepal

Table 3 Illustration of pair wise ranking of traits of finger millet in Nepal

Traits	Disease resistance	Size of head	Stay green character	Non-lodging	Synchronous maturity	Size of grain	Firmness of head	Devoid of branching in head
Disease resistance	X	Disease resistance	Disease resistance	Disease resistance	Disease resistance	Disease resistance	Disease resistance	Disease resistance
Size of head		X	Size of head	Size of head	Synchronous maturity	Size of head	Firmness of head	Size of head
Stay green character			X	Stay green character	Synchronous maturity	Stay green character	Stay green character	Stay green character
Non-lodging				X	Synchronous maturity	Size of grain	Firmness of head	Non lodging
Synchronous maturity					X	Synchronous maturity	Synchronous maturity	Synchronous maturity
Size of grain						x	Firmness of head	Size of grain
Firmness of head							X	Firmness of head
Devoid of branching in head								x
Count	7	4	4	1	6	2	4	0

Source: LI-BIRD, Nepal

Box 3: Participatory evaluation to identify farmers' needs in a cultivar at Jawadhu Hills

At Jawadhu Hills, little millet is the major crop covering about 70 % of the cultivated area. It is both a commercial and food crop. Almost all the farmers also grow finger millet for home consumption. All other crops are grown only to a limited extent. Given this, little millet and finger millet were selected as focus crops for PVS. In little millet, only traditional varieties are prevalent. While in most part of the Jawadhu Hills only short duration (3 to 4 months) varieties are grown, only in Nammiyampattu area long duration (5 to 6 months) varieties are grown besides short duration varieties. Therefore, varietal improvement of short duration varieties was given more importance. The research team identified 10 short duration little millet varieties and two long duration varieties. Among short duration varieties, *Sittan* was most commonly grown variety. There were variations in varieties across the working villages.

Focus group discussion on the varietal features preferred by the farmers indicated that they give more importance for the following traits: 1) higher grain yield, 2) higher straw yield (little millet straw is considered as a good quality fodder), 3) ability to withstand moisture stress like long dryspell, 4) ability to withstand heavy/excessive rains mainly to avoid grain shattering, 5) less chaffy grains and 6) tasty grains.

2. A search for suitable material to test with farmers

Once the requirements of farmers in the particular site are understood, then search for suitable varieties from various sources need to be taken up. The possible sources are,

- National list of released varieties
- District/ agro-climatic zone level recommended varieties

- Biodiversity fair
- Community seed bank
- Varieties documented by Community biodiversity register
- Local varieties performing well in the nearby areas falling in the similar agro-climatic situations
- Seed available at markets
- Network of breeders
- International/national gene bank

Box 4: Selection of suitable little millet varieties to test with farmers at Jawadhu Hills

As there was difference in presence of little millet varieties across the working villages, all the local varieties for which seed could be acquired were included for testing under mother trials. Further, released varieties namely CO-2, CO-3, CO-4, OLM-203, JK-8, JK-36, Kolab and Paiyur-2 were included for testing in PVS based on seed availability. Out of these, CO-2, CO-3, CO-4 and Paiyur-2 were sourced from Tamil Nadu Agricultural University and OLM-203, JK-8 and Kolab were sourced from All India Coordinated Small Millets Improvement Project. Promising traditional varieties from Pudur Nadu (nearby area in Jawadhu Hills range), Dumbriguda (Andhra Pradesh) and Semiliguda (Odisha), which fall in the Eastern Ghats as that of Jawadhu Hills, were also included for testing.

3. Experimentation on acceptability of suitable material in farmers' fields

Once potential cultivars that meet the requirements of farmers in a particular site are chosen from various sources, they need to be tested in the farmer's fields for their suitability to meet the requirements of farmers and to understand their acceptability by the farmers. For this purpose, three kinds of PVS trials are conducted. They are,

1. Mother trials
2. Baby trials
3. Informal research and development (IRD)

The differences in the research design of three PVS trials, however, are summarized in Table 4.

Table 4 Summary of differences between mother, baby and IRD trials

Mother trial	Baby trial	IRD
Growth parameters, yield and farmers' perception data to be collected	Yield and farmer's perception data to be collected	Only farmer's perception data to be collected
Few trials	Many trials	More trials than baby trials
Researcher designed and Supervised	Simple design by the researcher; supervised by the researcher	No design
All entries, single-replicate block design, small plots	Two or three entries, simple design, large plots	One entry – the identified variety
Farmers' perceptions usually measured by matrix ranking/ preference analysis as a group of farmers and simple ranking at individual trial farmer level	Farmers' perceptions measured by administering Household Level Questionnaire to the section of trial farmers.	Farmers' perceptions measured by administering Household Level Questionnaire to the section of trial farmers.
Farmers' management and, if needed, ensuring cultural operations in time	Farmers' management and, if needed, ensuring cultural operations in time	Farmers' management
Farmer can be compensated for growing the trial	Farmer bears the cost and risk (but has free seed)	Farmer has free seed and benefit, but bears the cost

Further, post-harvest studies can also be conducted as part of PVS and they include,

1. Organoleptic tests for food crops
2. Analysis of other quality traits like nutrition analysis

More details and illustrations of the different trials carried out for testing the short listed varieties in the farmer's fields are furnished in Module 2 & 3.

4. Wider dissemination of farmer-preferred cultivars

After identifying farmer-preferred varieties the earlier steps, they need to be disseminated to large number of farmers in the selected site. Seed pockets are distributed and Community-based seed production (CBSP) are done for further dissemination of the most preferred varieties.

More details about various activities taken for wider dissemination of farmer-preferred varieties are shared in the module 4.

Module 2

Mother trial

Module objectives

- Describe the different steps in planning and execution of mother trial (both unreplicated and replicated)
- Share step-by-step procedure for conducting of farmers preference analysis and organoleptic test
- Provide guidelines for data collection on growth and yield parameters, preferences of farmers and sensory evaluation
- Provide guidelines for processing data from mother trial and deriving inferences

Mother trial

Mother trial is an on-farm trial in which a set of new lines, either released, pre-release or successful farmers' varieties from elsewhere is compared with local checks under farmers' crop management practices. The experimental design followed is similar to 'randomized complete block design', in which each individual trial on farmers' field is considered as a replication or a block. In this step, scientists/ site researchers measure yield and other important traits. Opinion of the trial farmer is collected. Further, group of farmers are invited to visit one or two trials for rating the varieties using some simple techniques like matrix ranking and preference analysis (PA). Based on the data and information collected, the varieties suitable for the experimented area are identified and taken forward to the baby trial.

Mother trial -unreplicated

1. Planning of mother trial- unreplicated

a) Deciding on the number of trials

There need to be minimum of 25 mother trials in each testing site, to get at least 15 trials meeting the expected standards to get reliable data. This number is applicable for trials taken up in rainfed conditions where the control over the crop performance is limited and where the heterogeneity of site villages in terms of slope, soil, altitude, etc. is more. If the heterogeneity is less and if the crops are growing in an assured situation, reduce the number of trials to 15.

Box 1: Minimum number of quality trials needed for statistical analysis

The number of trials is determined based on two criteria. One is the extent of diversity in the experimentation site in terms of soil, microclimate, socio-economic classes, etc. If the diversity is more, then the number of trials will be more to cover all the diverse environments. The other is 'error degrees of freedom', which is the product of 'number of replications/ trials minus one' and 'number of treatments/ varieties minus one'. The minimum error degrees of freedom should be 12 and above for statistical precision. For example, if there are five varieties to be tested and if the number of trials are 10, then the error degrees of freedom is equal to (5-1)X(10-1) = 36. However, there has to be minimum two replications even if the varieties are 13 and more.

b) Deciding on the number of varieties to be tested

1. Only eight to ten varieties need to be included in one mother trial for effectively undertaking the trial. One of them will be the common variety of the locality/usually grown by the farmers (standard check).
2. The variety grown by the mother trial farmer will be one of the 10 entries in the mother trial and it will act as the local check variety.
3. The variety usually grown by the specific mother trial farmer may match with the standard check or may not; if it does not match, the concerned mother trial will have both standard check and local check.

c) Selection of hamlets

1. It is important to capture the performance of the tested varieties under various agro-ecological situations (like soil type, land quality and altitude) and socio-economic conditions (like caste) in the research site. Therefore, it is essential to distribute the trials based on diversity of agro-ecological and socio-economic conditions within the village. For making this possible *the number of hamlets selected in one bigger village (revenue village/ Panchayat in India), has to be two and above. These hamlets need to be located faraway and different from one another in terms of soil type, land quality, altitude and social group (caste).*
2. Give preference for the hamlets, where the implementing agency has good quality farmers' organisations and the site staff has considerable influence.
3. Minimum of two and maximum of three trials need to be planned in one hamlet *to avoid complete collapse of PVS in one hamlet due to uncontrollable factors like poor rainfall and to optimize human resources.* If there is difference across the hamlet in terms of soil type, altitude and social group (caste), representative farms that are different from one another need to be selected.
4. Use the format given below for proper planning of distribution of trials.

Format 1 **Format for hamlet wise planning of mother trial in a site**

Sl. No	Name of the village/ *Panchayat*	Name of the hamlet	Why this hamlet? (Share how this hamlet is different from other selected hamlets in terms of soil type, land quality, altitude, social group (caste), presence of research agency, etc.)	No. of farmers to be covered		
				M	F	Total

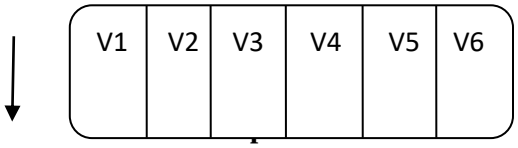
d) Selection of farmers

1. *Select farmers who are willing to take up experimentation in their farm.*
2. Select equal number of men and women farmers or *ensure that at least 33 percent of the farmers selected are women. Take extra efforts to get the viewpoints of women in all the stages of mother trial.*
3. Select farmers from all landholding size categories, with more of them from small and marginal farmers.
4. Give preference for members of the farmers groups/ organisations and SHGs.
5. Give preference for farmers with whom the site staff has good relationship and influence.

6. List the potential farmers and visit them to know their interest and to motivate. Add their names after getting their consent in the final list.
7. *Give orientation to the selected farmers onthe purpose of mother trial, its various steps, and the role of trial farmer and the research agency. Share the details about cost sharing arrangements or incentive, if any, in advance.*
8. There is no need to change the farmers and hamlets over years. Continuing the trials with the same farmers will make the trials easier to run, as the trial farmers involved would have gained clarity and skills.

e) Selection of plots

1. *Do not select plots with shade.*
2. *Do not select plots that can be affected by soil erosion.*
3. *Select plots that can be accessible with moderate efforts.*
4. The plot size of each variety tested need to be one cent (40 sq. m) and minimum area required for the trial would be around 320-400 sq. m. If only smaller plot have to be selected, reduce the plot size accordingly.
5. There should be clear demarcation between the plots of different varieties. At least half meter gap between adjacent plots need to be ensured. If possible, grow intercrop between two plots.
6. *The field layout for the trial should be in such a way that all the tested varieties receive uniform soil and fertility conditions. In a sloppy land, the alignment of plots has to be across the slope (See the figures below).*



Direction of slope

Figure 1 (Sloppy land)
Acceptable

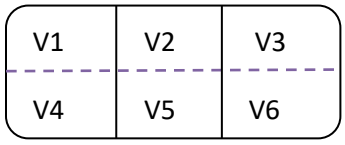


Figure 2 (Sloppy land)
Not Acceptable

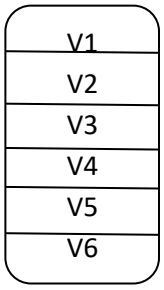


Figure 3 (Sloppy land)
Not Acceptable

If the land is not sloppy and if not all the plots could be accommodated in a row, plots can be arranged as shown in Fig. 2.

7. Leveled lands need to be selected at least for some of the trials. For the rest representative land types can be selected.

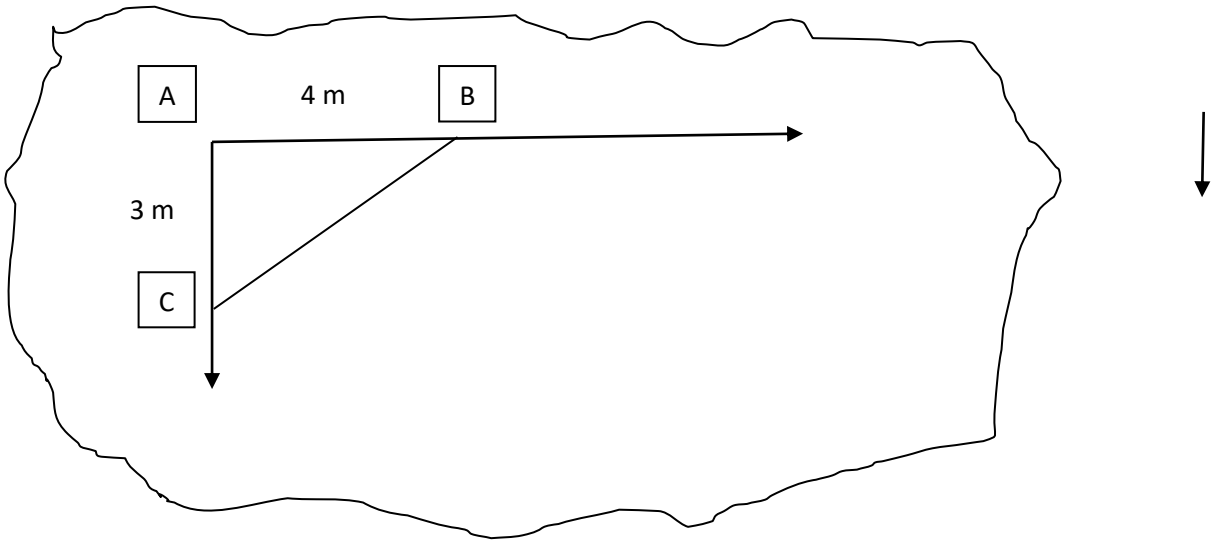
8. Select the experimental plot with the help of the experimenting farmer.

Box 2: Guidelines for layout of field experiments

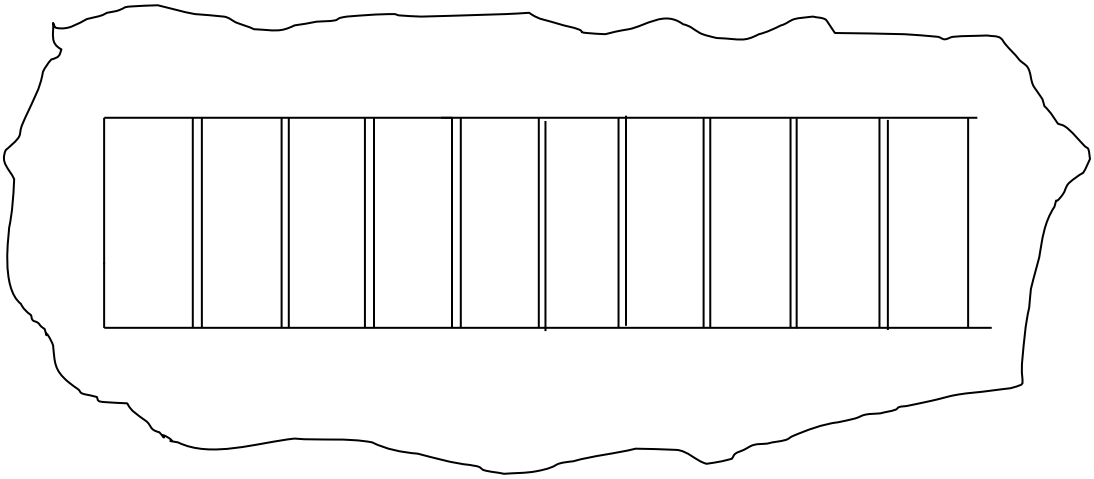
In most of the cases, farmers' field poses different kinds of hurdles for systematic layout of field experiments. Finding an ideal field with proper levelling, free from shade from border trees, having definite shape and with easy accessibility is not that simple. Since the object of on-farm trial is to have the experiments in farmers' fields, some guidelines are necessary to meet minimum requirements of field experiment principles. Uniform conditions need to be maintained in all experimental plots to avoid the effects of other possible sources, except the effect of the treatment. This includes slope, shade, variation in soil depth and hardpans beneath the soil surface, which affect the treatments differently contributing too much to the total effect of unknown causes. Follow the steps given below to ensure near uniform conditions in all the plots.

Step 1: Survey the field; check its boundaries and direction of slope; decide the appropriate location for the trial within the field, which is free from border and shade effects. The experimental field as for as possible need to be located at one end of the field, so the farmer can utilise the rest of the area without any hindrance.

Step 2: Let us take one example as shown in the following diagram, which shows the shape of a field and its slope (along the breadth as shown by the arrow). Fix the line rope along the length of the field as shown in the figure and this line is considered as baseline. Then fix adjacent borderline perpendicular to the baseline using measuring tape as described in the next step.



Step 3: Three people are needed to hold the tape at three points (A, B and C). Out of three points, one is fixed at the start of the baseline, say A, and another at 4m length on the baseline, say B, with pegs. First person will join the starting point of the tape with 12th metre point at point A. The second person at point B will hold the same tape at 4th metre point and the third person will hold the tape at 9th m point (4m+5m=9m) in the shape of a triangle as depicted in the diagram. The remaining tape length between the third and first persons has to be 3 m. By holding the tape stretching tightly on the baseline from A to B, fix the point C with a peg by the third person. Then the adjacent line is marked with another line rope touching the two points A and C, which will be perpendicular to the baseline. This simple step uses Pythagoras theorem to ensure right angle at juncture A.



Step 4: Mark with a peg at 10m length on the perpendicular line. Fix another line rope from this point parallel to the baseline. Ensure the distance between two parallel lines at far end is also 10m breadth.

Step 5: Mark at 4m length with pegs on the baseline and parallel line. Then mark the first plot by drawing lines on the soil surface with the help of line rope and pickaxe. Then mark at 4.5 m on the baseline and parallel line. Then mark the space between first plot and second plot (0.5m breadth) by drawing lines on the soil surface with the help of line rope and pickaxe. Then mark at 8.5m length with pegs on the baseline and parallel line for marking the second plot. Repeat the same, until the necessary number of plots is marked in the experimental field. The experimental plot looks as shown in the following diagram.

Take layout work after land preparation and levelling on the day of sowing or one day earlier. Keep the pegs fixed at all the corners until the crop is harvested, for easy demarcation of each plot. The plot size in the above example is 4m x 10m (i.e.40 sq. m or 1 cent). If the length and breadth of the selected field varies, then layout should be done accordingly(e.g. 5m x 8m). In case of biodiversity blocks, the field layout will be similar but plot size happens to be smaller (3m x 4m = 12sq.m). If the varieties to be tested are more, say 15 and above, go for more than one band of blocks like the one shown above, leaving a space of 0.5m between adjacent bands.

Experiment layout in the farmer's field after land preparation, Semiliguda, Odisha

f) Procurement and pocketing of seeds

1. Calculate the seed quantity required for one cent based on the seed rate in vogue in the site. For example, if the prevailing seed rate for finger millet is 15 kg per acre, then the seed rate for one cent is 150 g (=15 x 1000g/100).
2. Take necessary care to procure good quality seeds of the selected varieties in time and label and store it properly in the site office.
3. Do pocketing and labelling of the seeds in advance.
4. Do procuring the pegs and labelling them in advance.

g) Varietal sequence

1. The sequence of varieties should not be the same in all the mother trials, as that will result in certain varieties occupying always similar positions, say border. Those varieties will have favourable or unfavourable conditions when compared with the varieties in the middle of the plot. To avoid this, follow different sequences based on randomisation as shown in Fig. 4.

Figure 4 Illustration of sequencing of test varieties in the mother trial

	Incorrect					Correct				
Farmer	A		B		C	A		B		C
Varieties	1		1		1	1		6		7
	2		2		2	2		1		6
	3		3		3	3		7		1
	4		4		4	4		3		8
	5		5		5	5		2		5
	6		6		6	6		5		4
	7		7		7	7		8		2
	8		8		8	8		4		3

Table 1 Example of random sets of varieties tested in mother trial

Set I		Set II		Set III		Set IV		Set V	
Plot No.	Variety	Plot No.	Variety	Plot No.	Variety	Plot No.	Variety	Plot No.	Variety
1	*Sittan*	1	*Siruvellai*	1	*IR-8*	1	*Karunsittan*	1	*IR-20*
2	*Karunsittan*	2	L-Check	2	JK-8	2	JK-36	2	*IR-8*
3	CO-4	3	*IR-8*	3	*Sittan*	3	*IR-20*	3	JK-8
4	*IR-20*	4	*Karunsittan*	4	*Siruvellai*	4	*IR-8*	4	CO-4
5	*Perungulai*	5	JK-8	5	JK-36	5	L-Check	5	*Karunsittan*
6	*IR-8*	6	*IR-20*	6	L-Check	6	*Perungulai*	6	JK-36
7	*Siruvellai*	7	*Sittan*	7	*Karunsittan*	7	CO-4	7	*Sittan*
8	JK-8	8	JK-36	8	CO-4	8	*Sittan*	8	L-Check
9	JK-36	9	*Perungulai*	9	*IR-20*	9	*Siruvellai*	9	*Perungulai*
10	L-Check	10	CO-4	10	*Perungulai*	10	JK-8	10	*Siruvellai*

L-Check – Local check variety

Table 2 **List of little millet mother trial farmers at Jawadhu Hills in 2012**

Village/ *Panchayat* Sl. No	Hamlet Sl. No	Site Sl. No	Village/ *Panchayat*	Village Name	Farmer/Spouse	Gender Male/Female	Allotted set
1	1	1	Kovilur	Keelpankottai	Govindammal/Srinivasan	F	I
	2	2	Kovilur	Keelpankottai	Chinnathai/Govindan	F	II
	3	3	Kovilur	Keelpankottai	Govindan/Lalitha	M	III
	4	4	Kovilur	Kovilur	Rukku/Nadarajan	F	IV
	5	5	Kovilur	Kovilur	Raman/Kuppu	M	V
	6	6	Kovilur	Melnellimarathur	Rajeshwari/Manikkam	F	I
	7	7	Kovilur	Melnellimarathur	Sivagami/Devan	F	II
2	1	8	Nammiyampattu	Puthur	Amuthavalli/Rajenthiran	F	III
	2	9	Nammiyampattu	Puthur	Govindan/Rukku	M	IV
	3	10	Nammiyampattu	Puthur	Papathi/Mani	F	V
	4	11	Nammiyampattu	Nammiyampattu	Selvi/Murugan	F	I
	5	12	Nammiyampattu	Nammiyampattu	Manjan/Chinnapponnu	M	II
	6	13	Nammiyampattu	Periyaveerapattu	Gantha/Muthaiyan	F	III
	7	14	Nammiyampattu	Periyaveerapattu	Raji/Santha	M	IV

Village/ *Panchayat* Sl. No	Hamlet Sl. No	Site Sl. No	Village/ *Panchayat*	Village Name	Farmer/Spouse	Gender Male/Female	Allotted set
3	1	15	Kuttakkarai	Pattaraikadu	Manikam/Ambiga	M	V
	2	16	Kuttakkarai	Pattaraikadu	Chinnababu/ Kamala	M	I
	3	17	Kuttakkarai	Pattaraikadu	Jaya/Murugan	F	II
	4	18	Kuttakkarai	Kuttakkarai	Santhi/Manikam	F	III
	5	19	Kuttakkarai	Kuttakkarai	Papathi/Chinnapaiyan	F	IV
	6	20	Kuttakkarai	Pathri	Alagesan/Chinnakanni	M	V
	7	21	Kuttakkarai	Pathri	Kuppu/Vaddu	F	I
4	1	22	Melsilambadi	Kuttathur	Kullu/Jaya	F	II
	2	23	Melsilambadi	Kuttathur	Ramadas/Jaya	M	III
	3	24	Melsilambadi	Athukanoor	Selvarani/Thamodhiran	F	IV
	4	25	Melsilambadi	Athukanoor	Gopal/Chinnakanne	M	V

2. First, generate at least five random sets of test varieties (see Table 1). Then list the selected farmers in the order of hamlets in each village/ *Panchayat*. The varietal sets are allocated to the listed farmers villagewise. The design should be such that the farmers from the same village get different sets. See the Table 2. Do not change the allotted set for any reason. Even if one farmer is replaced with another, follow the same set allotted to the earlier farmer.

h) Preparing seed packets and name pegs

Pack the needed quantity of seed of each variety in small plastic covers with name labels inside. Arrange the seed packets of the varieties of each set in the order specified in the set. Then number each packet in such a way that the name of the variety, the set number and the variety sequence number [E.g. *Sittan samai*, I (for set), 3 (for variety sequence number in the set I)] are clearly visible. Then, place the seed packets of one complete set in a bigger bag, with the name of the set labelled on it. Distribute such a pack with pegs to farmers well before the sowing season (at least 10-15 days before expected sowing date). Write the variety sequence number in the pegs.

A set of varieties ready for delivery to farmer

i) Orienting the farmers

During seed distribution, orient the trial farmer on the mother trial modalities and finalise the layout of the trial plot. This is important for two reasons:

1. To make the trial farmer understand about mother trial, to get willingness to offer particular part of his or her land and to gain confidence through handing over seeds and pegs, and
2. To avoid last-minute confusion during sowing-Keep in mind that the farmer's priority would be different during sowing season; they will be in a hurry to complete sowing of their primary crop before the soil moisture dries up.

2. Execution of mother trial- unreplicated

a) Sowing of experiments

Repeatedly advise trial farmers to inform the sowing date at least before 3-5 days to the research agency staff, so they can fulfil their important role of guiding the trial farmer during sowing. Ensure that the allotted set of varieties is sown in the specified sequence. Complete sowing of all the varieties tested in mother trial on the same day- there should not be any difference in the sowing date across the varieties tested in a trial.

It takes more time to demarcate the plot followed by sowing on the same day. Further, on receiving rains, almost all the farmers will go for sowing simultaneously. Therefore, it is better to layout the field 2-3 days before probable date of sowing and keep the land ready for sowing.

b) Monitoring and observation of the trials

The following visits by the research staff are necessary for proper monitoring and observation

a) To monitor crop growth and ensure intercultural operation (*may be twice)*
b) To measure growth parameters
c) To do preharvest evaluation
d) To measure yield and get feedback of the trial farmer

Involve experts and a group of interested farmers during the visit related to preharvest evaluation. Observe incidence of any insect pest or disease in each variety and note the extent of damage. In case of any prolonged dry spell or water logging situation, record the response of each variety to moisture related stress.

Mother trial at Anchetty, Tamil Nadu

Scientists and community members interacting at mother trial, Bero, Jharkhand

C) Data collection

Collect the data on the trial need in the specified format given in the attachment 1. The data collected for each trial has two components namely, i) General information about the farmer and trial land, and ii) Experimental details – quantitative and qualitative data on performance of varieties in the trial.

The experimental details in mother trial can be divided into five groups:

1. Details on entries (varieties tested), field layout and allotment of entries to the plots.
2. Details of cultural operations starting from land preparation to harvesting and threshing.
3. Observations of the crop stand and performance of crop at various stages, including pest and disease incidence and stress tolerance.
4. Growth parameters and
5. Yield data and feedback of the trial farmer.

Data collection on growth parameters

Growth parameters are collected in mother trial to understand the morphological and duration differences between the varieties. Some of these parameters may also help in interpreting the yield data and the preferred traits of the farmers. In small millets, the growth parameters collected are: i) plant population, ii) date of 50 % flowering, iii) plant height, iv) number of productive tillers and v) earhead size (number of fingers in finger millet). These

Measuring growth parameters in Anchetty, Tamil Nadu

parameters may vary from crop to crop. Some guidelines for collecting growth parameters are mentioned below.

1. Date of 50% flowering – Record the date when about 50% of plants in a plot show emergence of panicle.
2. Measure all the other growth parameters during physiological maturity or just before harvesting.
3. Plant population – Count the individual plants (not tillers) in a sample plot of 1m x 1m size (in case of finger, barnyard and kodo millets) or 30cm x 30cm size (in case of little millet). Collect data from two such sample plots for each variety, that is in each experimental plot and record the figures in the format. Calculate the average value later in the office.
4. Plant height (cm), Number of productive tillers per plant, and Earhead size – Collect data from five randomly selected plants or earheads, as the case may be, and record the figures in the format. Calculate the average value later in the office.
5. Measure earhead size from the node of the peduncle and not just from base of the panicle.

Preharvest participatory evaluation

A group of interested farmers evaluates performance of the varieties when the varieties are near to maturity or at ma**t**urity. Employ any one of the following two methods - Matrix ranking and Farmers' Preference Analysis (FPA). Details of preference analysis (Box 3) and matrix ranking methods are given below.

Different colored tokens for indicating farmers preference

A farmer explaining his choice of varieties after voting in FPA at Anchetty

Ballot being set up in mother trial field for FPA at Anchetty

Awomen farmer expressing her preference in FPA at Anchetty

Box 3: Farmers' Preference Analysis (FPA) in mother trial

FPA is a method to assess rapidly the opinion of a group of farmers on a set of varieties in a trial in a simple way. This is done by allowing a group of farmers to "vote" for their preferred varieties during a field day conducted in one of the good mother trials just before harvesting. Conduct at least one FPA for each village or Panchayat, as the preferences varies across Panchayats. Orient the participating farmers about the background of the project/ programme, about mother trial, the purpose of the FPA and the steps to be followed. Keep a bag/ box in front of each plot. Give each farmer three tokens of different colour to show their first, second and third preferences. Ask each farmer to visit all the plots in the trial individually and observe the varieties and express their preference by depositing the token in a bag or box. Do not ask farmers asked to rank all varieties, a process they find tedious. Only ask them to identify the first three varieties. Later separately, ask each one of them about their preference and the reasons for the same. Then the votes are counted and the most preferred variety is identified based on the weighted scores. Weighted score systems is followed for easy comparison among the tested varieties -the weightage for first rank is 3, second rank is 2 and third rank is 1. After the results are known, ask the participating farmers to share the reasons for their preference as a group in terms of different varietal traits. The preference analysis thus generates two kinds of data:

1. Quantitative preference scores for each variety in terms of first, second and third ranks and the total weighted score value.
2. A list of characteristics of the preferred varieties liked by the farmers

The method of analysing the data generated is shared in another section.

Farmers enjoy the FPA process. It can be described to them as an "election" or a "beauty contest". It is simple to use, requiring no survey forms, and produces a quantitative score for each variety that is easy to analyse statistically. Importantly, this method works well with illiterate farmers, since they do not have to be able to read or write to take part.

Preference analysis is a snapshot of preference of participating farmers at the harvesting stage, rather than a completely reliable estimate of what farmers think about the varieties tested in the trail. However, preference analysis can reveal important information about traits valued by farmers as well as their first impressions of new varieties. Thus, FPA is only a tool for preliminary identification of varieties, which need to be followed with more extensive farmer-managed evaluation.

Useful tips for conducting FPA

1. It is easy to conduct voting procedure in FPA with large numbers of farmers. However, the focus group discussion to clarify the voting results is best done with a group size no more than 10-12 farmers at a time. If a large group of farmers participates in the voting procedure, break them into smaller groups for the focus group discussion.

2. Conduct separate events for men and women farmers. If a mixed group is engaged, then in the ballot/ token mention 'F' and 'M' to indicate the gender. Take extra care needs to elicit information from women in the mixed group.
3. At least two researchers are needed, one to guide farmers, and another to tabulate and record.
4. Bags or boxes and ballots should be prepared in advance.
5. The ballots/ token need to be in different colour and shape for first, second and third ranks.
6. Place grain samples in front of the plot, so that farmers can also judge based on grain size and shape.
7. Ensure that each participant observes and ranks individually and not influenced by a dominating person in the group.
8. Similarly, collect the reasons behind ranking of varieties from each individual separately, so to avoid other's influence on that individual.

Matrix ranking in mother trial

Matrix ranking is a tool to compare and characterize a set of varieties in qualitative and quantitative manner. Like other ranking tools, it is often used in PVS and PPB. The procedure includes the following steps.

Step 1: Make a matrix with the traits in the first column (Table 3). For this, use the traits identified earlier through brainstorming or FGD. Mention the names of varieties in the first row or for convenience use cards or symbols to represent the varieties.

Step 2: Supply the participants a fixed number of seeds (like beans) or other local materials to express their ranking of traits. Ranking can be done individually or as a group.

Step 3: Let participants rank the varieties for each trait by placing the seeds/ local materials in the inter section of column and row as per ranking- 1=low/bad and 5=high/good. Variety with most desirable trait (like highest yield and tolerance to moisture stress) need to be given score value of 5, while the one with lowest / least desirable trait (like low yield, grain shattering and lodging) need to be given score of 1. The varieties falling between these two extreme situations need to be given corresponding intermediate values.

Step 4: farming community do not give equal importance to all the traits. To reflect this, calculate a weighted ranking of varieties as the product of 'the value for the trait' and 'the ranking score for that trait' for each specific variety. The weighted ranking helps in comparing all varieties. Illustration: Let us assume that in brainstorming exercise, 'yield'was identified as the most important criteria out of 7

Table 3 An illustration of matrix ranking of varieties

Criteria	V1	V2	V3	V4	V5	V6	V7	V8
Grain yield	5	1	5	4	3	2	3	5
Straw yield	5	3	5	4	3	4	5	5
Tillering ability	1	3	1	1	2	4	3	2
Grain colour	1	5	2	3	4	1	2	2
Tolerance to moisture stress	3	1	3	4	5	5	4	4
Maturity	1	4	2	5	4	3	2	3
Resistance to P&D	5	3	3	4	3	4	3	3
Total	21	20	21	25	24	23	22	24

Note: 1=low/bad, 5=high/good

criteria and on 5 point scale gets score of 5 and 'colour of grain' was considered the least important and gets score of 1. Similarly, each of remaining criteria will have a particular score value depending on its relative importance. Applying this weight age in Table 4, for v4, the weighted score value for yield would be 20 (= 4x5) and for colour would be 3 (= 3x1). Following the same procedure, weighted score value could be estimated for the 7 criteria for each variety. The variety with the highest total weighted score value is adjudged as the most preferred variety and the one with lowest total score value as the least preferred variety.

Data collection during harvesting of the trial

Measuring grain yield in Anchetty, Tamil Nadu

Harvest the trial fields once the crops attain physiological maturity. Advise trial farmers repeatedly to inform the harvesting date to the research agency staff at least before 5-7 days, so that they can guide the trial farmer during harvesting. Observe the following points during yield data collection:

1. Harvest whole plants (straw with earhead) from one sample plot of 10 sq. m in the plot of each variety and keep for sun drying (1 or 2 days) and then bundle it for recording 'total weight' of harvested plants. After proper threshing and cleaning, record the weight of grain. The 'straw weight' need to be estimated by subtracting the value of 'grain weight' from 'total weight' value.

2. Thresh harvested produce of different varieties threshed separately, so mix of varieties is avoided. Keep threshed and cleaned produce of each variety in separate gunny bags or containers. If needed, gunny bags need to be given to the trial farmers.
3. Harvest the varieties, which mature early at right time to avoid grain shattering or other kinds of loss. So, in mother trials involving varieties with varied duration, the research agency staff needs to visit more than once to collect harvest data.

Measuring straw yield in Anchetty, Tamil Nadu

Other data to be collected

a) Visit the plot with the concerned trial farmer and his or her spouse just before harvesting. Facilitate them to rank the tested varieties and to share the specific reasons behind their preferences. Record the varieties selected by trial farmers for next year cultivation.

b) Synthesise the observations of the research agency staff for each mother trial and record it in the data format.

Mother trial- replicated

Replicated mother trial under recommended package of practices is taken upto understand the potential of varieties tested in the site environment.

1. Research design of replicated mother trial

Follow Randomised Complete Block Design (RCBD),the common experimental design used for field layout of the experiments. The field data collected on growth and yield parameters of each variety is analysed statistically using 'analysis of variance' (ANOVA) technique. The results obtained from RCBD happen to be more reliable, because the treatment effect is not biased by the environmental factors. To strengthen the results of mother trials (unreplicated trials), one or two replicated trials comprising the same set of varieties might be essential on farmer's fields. An example of replicated mother trial followed for testing little millet varieties is given below.

Number of varieties: 10

Design: RCBD (Randomised Complete Block Design)

Plot size: 4m x 3m (12 sq. m)

Replications: 3

Number of trials: One each for short duration and long duration varieties

Field layout plan: An example of RCBD for little millet in Jawadhu hills

Figure 5 Field layout plan for little millet (short duration) replicated trials

Sl. No.	Varieties of little millet (short duration)
1	*Sittan*
2	*Karunsittan*
3	CO-4
4	*IR-20*
5	*Perungulai*
6	*IR-8*
7	*Siruvellai*
8	JK-8
9	JK-36
10	Local Check

Replication		
I	II	III
1	8	5
2	6	7
3	9	10
4	2	8
5	4	9
6	1	3
7	5	4
8	10	1
9	3	6
10	7	2

2. Execution of mother trial- replicated

a) Arrangement of blocks and plots

Select a farmer who is willing to take up replicated trial. As far as possible, select a levelled field without shade. If land has slope, arrange plots across the slope (as suggested for mother trials) and let the blocks be along the slope. It can be observed in Fig. 5 that the replication I has the same order of varieties as listed (1 to 10) and replications II and III have the different arrangements i.e. varieties are allotted randomly to each plot as shown in the field plan.

Figure 6 Allotment of seed packets as per the field plan of replicated mother trial

Replication I

Number on seed packet	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Arrangement as per plan	1	2	3	4	5	6	7	8	9	10

Replication II

Number on seed packet	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Arrangement as per plan	8	6	9	2	4	1	5	10	3	7

Replication III

Number on seed packet	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Arrangement as per plan	5	7	10	8	9	3	4	1	6	2

Follow the recommended seed rate. Ensure the quantity of seeds in each pocket based on the plot size. Arrange seed packets for each replication (also known as Blocks) separately in the office itself as indicated in Figure 6, as per the field layout plan. In the field, place the seed packets according to serial numbers in each replication. This exercise helps to avoid any mistakes in allotting seed packets to each plot in the field.

b) Seed sowing and crop management

- After proper land preparation, apply recommended dose of fertilizer uniformly. For this, workout the quantity of fertilizer needed for the experimental area. Do not apply farmyard manure, as it is difficult to maintain uniform fertility level among the different plots.
- Using field layout plan, mark blocks and plots as suggested above. Keep 0.5 m space between each block for easy demarcation and for easy movement while collecting data from each plot.
- Follow line sowing to have uniform plant population in each plot. Open shallow furrows lengthwise, about 2 inches deep, using marker or pickaxe manually, with 25 cm spacing between rows. Provide 30-35 cm gap between the plots within each block (replication) for demarcation.

Laying out of replicated mother trial at Semiliguda

- Place the seed pockets in each plot by referring the field plan mentioned above. Sow the seeds in furrows uniformly in such a way that the recommended quantity of seeds covers the whole plot. As the quantum of seeds sown in each plot is meagre, one need to be careful in sowing. Initially use minimum quantity in each row; if excess seeds are there, then distribute the same uniformly in all the rows. Cover the furrows with soil by hand.
- Complete sowing of all the plots on the same day; otherwise it leads to variation due to unknown causes.
- Follow regular weeding and top-dressing, maintaining uniform treatment for all plots. For this, workout the quantity of fertilizer required for top dressing for each block of the experimental area from the recommended quantity per acre/ha.
- Avoid any plant protection measures (spraying pesticides) against insect pests and diseases to know the reactions of the varieties to different pest and diseases.

c) Data collection

Follow the same procedure suggested for mother trial; but record the data for each replication separately. To avoid confusion in the field in locating the particular variety while taking measurements, just follow the serial number of plots in each replication instead of serial number of varieties. Later while processing, the data can be rearranged for each variety according to replications.

Box 4: Need to have a replicated mother trial in a study site

Based on the experience it is suggested to have one well organised replicated mother trial following recommended package of practices along with many unreplicated mother trials under prevailing farmers' practices spread across the working villages in a site. While the replicated mother trial will help in understanding the potential of varieties tested in the site environment, the unreplicated mother trials will help in understanding the performance of varieties under varied environments that exist in the site under farmers' management conditions.

Data processing

The field data collected from different trials (raw data) needs to be processed in order to carry out statistical analysis. Data processing involves compiling, cleaning (verification), assorting and preparing final data sheet. Consider the two types of field data sheets mentioned above (General information and Field performance of varieties under testing) and then follow the steps given below.

Box 5: Sharing of responsibilities in mother trial

The list of various responsibilities of different people participating in the mother trial person is given below and the detailed notes on few of the responsibilities are shared the following pages. Technical aspects of mother trial like plot layout, data collection, etc. are taken care of by field research staff.

Responsibilities	Who is responsible?
1. Layout of the trial	Field research staff
2. Randomisation of the treatments	Field research staff
3. Sowing of the trial	Farmer and supervised by field research staff
4. Crop and trial management	Farmer
5. Trial monitoring and data collection	Field research staff
6. Farmers preference analysis	Field research staff & assisted by farmer
7. Harvesting and threshing	Farmer &supervised by field research staff
8. Recording grain and straw yield of varieties and getting feed back	Field research staff & assisted by farmer

Arrange the data of the trials, hamlet wise within each village/ *Panchayat* and villagewise/*Panchayatwise* within the site. Check once again the data collected thoroughly; fill the gaps, if any and correct the inadvertent values caused by wrong entries.

- Use two different master excel sheet formats for entering the individual trials information - one for general experimental information and another for experimental data (See attachments 3&4). Fill the two types of data from each trial in these two master sheets. These master sheets will have consolidated data of all the trials.
- For working out values for days to flowering, find the difference between the ‘date of sowing’ and the date by which 50% of plants in the plot of a particular variety started flowering. Count the number of days from ‘date of sowing’ to ‘date of 50 % flowering’ and enter the same in the column ‘Days to 50% flowering’ in the master sheet.
- The processed data needs to be presented in a particular format (in Excel sheet) depending on the software used for statistical analysis. The format widely used for unreplicated mother trials is given in Attachment 5 and for replicated trials in Attachment 6.

Box 6: Steps for data cleaning

- Check for missing data; do not consider trials with missing data for analysing a particular parameter.
- If there are no data, do not put '0' in the corresponding row or column in the excel sheet; otherwise it will lead to inaccurate estimation of the average value.
- Check for typing errors
- Check the values in each column of a particular parameter (e.g. growth and yield) for odd figures (e.g. Presence of 3 digit figure where only 2 digit figures are expected) and verify their correctness.
- Mark the trials which have many missing data and consider only those trials having complete data for all the parameters for data analysis.

Data analysis

In this section, the method of statistical analysis of quantitative and qualitative data gathered from mother trials and the ways of deriving the inferences/ results is mentioned briefly.

Different types of data available from mother trials are:

1. Data on growth parameters of varieties included in the trials
2. Data on yield parameters of varieties (grain and straw yield)
3. Data from Farmers' Preference Analysis
4. Specific observations recorded by the research team and experts

Box 7: Experimental design and statistical techniques used for the mother trials

The mother trials follow unreplicated Randomised Complete Block Design (RCBD), in which a set of varieties (treatments) tested in one block on individual farmer's field is considered as one replication. Hence number of replications is equal to number of mother trials in a site. Using the 'analysis of variance' technique (ANOVA), the field data of growth parameters and yield parameters will be analysed. This technique helps to compare statistically the overall performance of individual varieties across a geographical unit. For example, the data of mother trails located in one hamlet or in one village *Panchayat* or from the whole site can be analysed separately to understand the suitability of a particular variety for the pertaining geographical unit. The planned allotment of mother trials within individual hamlets, among hamlets within village *Panchayat* and finally covering all the *Panchayats* within the site, makes it possible to get such relevant information from the study. The general ANOVA table for each of the parameters studied will be as follows.

ANOVA Table for a particular parameter (for example, Plant height)

Source of variation	Degrees of freedom	Sum of squares	Mean sum of squares	Calculated F-value	F-Test P=0.05	F-Test P=0.01
Replication	(r-1)	S1	M1=S1/(r-1)	M1/M3		
Varieties	(t-1)	S2	M2=S2/(t-1)	M2/M3		
Error	(r-1)(t-1)	S3	M3=S3/(r-1)(t-1)			
Total	(rt-1)					

Where r = number of replications (number of mother trials whose data used for analysis), t = number of varieties tested

The above analysis will be carried out using suitable software tool. After running this analysis for each of the parameters, a table containing average values of parameters for each of the varieties will be prepared, based on which relevant inferences will be drawn. The same procedure will be followed for analysis of the data from the replicated trials also. The statistical analysis of field data from these mother trials using ANOVA technique provides other information like experimental mean, standard error of mean values (Sem), critical difference at 5% probability (CD at 5%) and experimental coefficient of variation (CV%) for each of the parameter. Each of these statistical measures will be used in interpreting the results critically. In brief, let us look what they mean exactly.

Experimental mean – It indicates overall performance of varieties in the mother trail for different parameters. It is used to know which of the varieties are above or below the average performance for a particular parameter. For example, in Table 4, the grain yield of *Siruvellai* and JK-8 was below the experimental mean (455.8 kg/acre), while that of other six varieties were above the mean.

Standard error of mean (Sem) – It indicates the efficiency of the experiment. In other words, it indicates the extent of influence of error component (uncontrolled factors) to the total variation among the individual unit values. So the mean value of a each parameter for particular variety is within probable range of plus or minus of its Sem. For example, in Table 4, mean plant height of *Sittan* variety is 91.3±2.4 cm.

Critical Difference (CD) at 5% - ANOVA of RCBD data involves using of two statistical tests of significance, namely, 'F-test' and 't-test', which are known as statistical tests of significance. In simple words, whether the observed differences in mean values of different varieties in the trial for a particular trait is because of real cause effect or just by chance is revealed by these tests. If F-test is found significant, then t-test is followed. The CD values shown in the Table 4 are nothing but t-test only. If the difference between mean values of two varieties for particular trait is more than the corresponding CD value, then the difference between the varieties is considered as statistically significant.

Coefficient of Variation (CV %) - It also measures the extent of influence of uncontrolled factors on total variation of values in the trial and used as a measure of reliability of the data collected. The reliability level fixed for field trials is usually 20%. If the CV values are too high, the experiment is considered as failure, as it is not able to identify the real difference among the tested varieties. CV value of trials cannot be too low also, as some variation due to uncontrolled factors is bound to exist in an experiment. In Table 4, it can be observed that CV % was less than 20 % in all parameters studied except for 'number of productive tillers per plant' and 'grain yield'.

Table 4 Growth and yield parameters of little millet varieties in mother trials at Jawadhu Hills, 2012

Varieties	Growth and yield parameters				
	Plant population per square metre	Plant height (cm)	No. of productive tillers per plant	Panicle length (cm)	Grain yield (kg/acre)
Koluthana	250.6	95.7	3.0	37.2	467.4
Siruvellai	223.5	88.0	3.2	34.7	411.8
Karunsittan	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**

An illustration of interpreting mother trial results is shown with the data in Table 4.The Table 4 shows mean values for growth and yield parameters of eight varieties of little millet evaluated in 20 mother trials during 2012 at Jawadhu Hills site. Experimental mean values shown in the table for each trait are used to understand the performance of the tested varieties. F – test revealed that the mean values for plant population, plant height and grain yield varied significantly, while the variation observed among mean values for number of productive tillers/ plant and panicle length was not statistically significant (NS). Hence, only the three traits were subjected to t – test and the estimated critical difference values at 5% probability are shown for these traits in the table. It is possible to find out whether difference between two values of a particular trait is statistically significant or not using t values. For example, the minimum yield value is 359.4 kg/acre for JK – 8. The grain yields of all the varieties except that of *Siruvellai* (411.8 kg/acre) are more than 422.1 kg/acre (359.4 of JK.8 + 62.7 (CD for yield) = 422.1 kg/acre), indicating they are statistically superior to JK.8. If the differences of any two of these 6 varieties is less than C.D value (62.7 kg/acre), their yield performance is considered on par with each other. Similarly, the difference in mean values of any two varieties for other traits are statistically significant or not could be decided based on the corresponding CD values.

The performance of test varieties can also be compared with that of check varieties in terms of numerical values, as shown in the following table.

Table 5 Comparison of short duration varieties of little millet in mother trials, Jawadhu Hills, 2013

Sl. No.	Test variety	Yield parameters	Performance of varieties	Percent 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 results shown in Table 5 indicate that *IR-20* and Paiyur-2 produced slightly higher grain yield (about 6 % increase) over *Sittan*. *Kadari-1* was found better than *Sittan* with respect to straw yield (38.8 % increase) but its grain yield was too low (-15.4 %). Considering yield advantage in most of the cases (more than 10 out of 14 trials) *IR-20* and Paiyur-2 could be considered for further promotion in the site to enhance varietal diversity in little millet.

The rankings given by 14 participating farmers for the varieties included in mother trials need to be presented as follows.

Table 6 **Farmers' preference ranking for little millet varieties (short duration) at Jawadhu Hills, 2013**

Preference ranking	*Sittan*	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 percentage values

Analysis of data generated through Farmers' Preference Analysis (FPA)

The cumulative preference score for each of the varieties tested have to be determined by counting the ranking given by the participating farmers (1st, 2nd or 3rd) and listing against corresponding variety as shown in the Table 7. If sufficient number of both men and women farmers are available among the participants, the results could be presented gender wise as well as pooled one as shown in the Table 7. The scores so listed need to be converted into weighted scores by multiplying 1st, 2nd and 3rd rank scores by 3, 2 and 1, respectively, for easy comparison. The data from FPA need to be presented after processing as shown in the table below. It can be seen that *Perungulai* variety was the most preferred variety by the male farmers (score 16), female farmers (score 12) and together (score 25). JK-8 was the second most preferred variety by the male farmers (score 15) and together (score 20). However, in the case of female farmers the score given for JK-8 was on par with *Sittan*, the ruling variety.

The reasons given by each participant for his/her preference for a particular variety need to be listed in the order of importance. The trait mentioned by maximum number of farmers for preferring a particular variety need to be identified; second and third most frequently mentioned traits should also be identified. The list of traits considered by the farmers needs to be exhaustive, as it helps in understanding farmers' perception regarding a particular variety.

Table 7 Results of FPA activity in mother trial of little millet at Jawadhu Hills site, 2012

Sl. No.	Name of variety	Women group				Men group				Total score values			
		1st	2nd	3rd	Total	1st	2nd	3rd	Total	1st	2nd	3rd	Total
1	*Sittansamai*	2	0	1		1	3	2		3	3	3	
		(6)	(0)	(1)	**(7)**	(3)	(6)	(2)	**(11)**	(9)	(6)	(3)	**(18)**
2	*Karunsittansamai*	0	3	0		0	3	1		0	6	1	
		(0)	(6)	(0)	**(6)**	(0)	(6)	(1)	**(7)**	(0)	(12)	(1)	**(13)**
3	**CO-4**	1	1	1		2	0	2		3	1	3	
		(3)	(2)	(1)	**(6)**	(6)	(0)	(2)	**(8)**	(9)	(2)	(3)	**(14)**
4	*IR-20*	0	0	0		0	0	2		0	0	2	
		(0)	(0)	(0)	**(0)**	(0)	(0)	(2)	**(2)**	(0)	(0)	(2)	**(2)**
5	*Koluthana*	0	0	0		0	2	1		0	2	1	
		(0)	(0)	(0)	**(0)**	(0)	(4)	(1)	**(5)**	(0)	(4)	(1)	**(5)**
6	*IR-8*	1	0	1		1	1	0		2	1	1	
		(3)	(0)	(1)	**(4)**	(3)	(2)	(0)	**(5)**	(6)	(2)	(1)	**(9)**
7	*Siruvellai*	0	2	2		0	0	2		0	2	4	
		(0)	(4)	(2)	**(6)**	(0)	(0)	(2)	**(2)**	(0)	(4)	(4)	**(8)**
8	**JK-8**	0	2	3		3	2	0		3	4	3	
		(0)	(4)	(3)	**(7)**	(9)	(4)	(0)	**(15)**	(9)	(8)	(3)	**(20)**
9	*Perungulai*	4	0	0		4	0	1		8	0	1	
		(12)	(0)	(0)	**(12)**	(12)	(0)	(1)	**(16)**	(24)	(0)	(1)	**(25)**
Total participants		8	8	8		12	12	12		20	20	20	

Note- Values in parentheses are weighted scores.

Conducting organoleptic test

Acceptance of a particular variety by the local farmers does not depend only on its field performance. It also depends on its desirable attributes related to consumption such as taste, colour, dough consistency, flouring percentage, keeping quality, etc. Hence, in order to collect systematic and reliable information on the consumption aspects, organoleptic test is carried out. The results of organoleptic test need to be used in conjunction with results obtained from quantitative analysis of mother trial data discussed above for selection of most suitable varieties for the site. The procedure of organoleptic test is described below.

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

Steps:

1. Collect 1 kg of cleaned grains of identified and popular local varieties of the crop subjected to PVS.
2. Process the 1 kg grain for getting flour (in the case of finger millet) or rice (in other small millets); take extra precaution to avoid mixtures while processing the grains in the mill.
3. Measure the volume of flour of each variety separately (uniform handling is necessary while measuring volume) and record it for estimating flour recovery.
4. Prepare two different locally popular recipes for each variety using flour or rice minimum of 500 grams for each variety; ensure following the same procedure while preparing recipes for each variety.
5. Invite 5 men and 5 women knowledgeable local farmers/ persons to evaluate the prepared food from different varieties.
6. Serve 50 grams of the first recipe of each variety in 10 different paper plates (or paper cups for gruel) with marking as 'A'; for the other varieties mark as 'B', 'C', etc. (any other letter can be used; but use different letter for each variety; do not mention the name of the variety). Arrange the plates in 10 different groups, each group containing the same recipe prepared from all the tested varieties. Place them at distant places to avoid cross-discussing among the evaluators.
7. Before starting the evaluation, share the purpose of the activity and the instructions to be followed for evaluation with the participants (evaluators). The instructions include tasting the recipe by taking a small quantity (by chewing or drinking), feeling its consistency (stickiness, soft or hard), colour (dark, medium or light), and arranging them in the order of their preference, among many. Most desirable need to be placed at the top and least one at the bottom; in case it is

difficult to distinguish the recipes and some of them appear more or less same, then they can be placed side by side.

8. Record all the scorings in the data sheet (format given below) with the remarks for each variety given by the evaluators. After completing the evaluation, fill the decoding column with the name of the varieties tested. From individual data sheets, prepare the final table of results as shown in Table 15.
9. Repeat the same procedure for the second recipe.
10. The final table of results can also be prepared with separate scores for each parameter like appearance, colour, consistency, taste, aroma, flour/ rice recovery, shelf life, etc., along with scores of overall preference. Pairwise ranking might be helpful for scoring in case of certain parameters like taste and aroma, as it would be difficult to find differences among items of 8-10 samples.
11. It is to be noted that parameters of organoleptic test vary from crop to crop and even for recipes within the crop. Standard protocols are available for certain crops like rice and vegetable crops. In the absence of standard protocol, develop ad-hoc procedures based on common parameters. The procedure mentioned above is one such type developed for small millets.

Format 2 Data sheet for collecting information from organoleptic test

Name of the participant:		Age:	Gender:
Recipe:			No. of varieties:

Sample Code	Ranking	Remarks by the evaluator	Decoding

Signature of the participant: Scorer:

Date: Signature:

Box 8: Organoleptic test for little millet varieties in Jawadhu Hills

Organoleptic test at Jawadhu Hills included seven varieties of little millet (5 identified from PVS and two popular local varieties). Grains of these varieties (1 Kg each) were dehulled to get rice and two recipes were prepared- rice and *uppuma*. Rice recovery percentage for each variety was recorded. The highest rice recovery, percentage was noticed in IR-20 (65%), followed by CO-4 (64%) and *Sittan* (62%). It was 58% in *Vellasamai*, 57% in *Perungulai*, 55% in *Koluthana* and 54% in *Sirusamai*. The score values given by the evaluators for each of the two recipes are furnished in Table 8. *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 other varieties, appearing similar to the normal rice, the predominantly consumed cereal. IR-20 and *Vellasamai* were ranked next best for cooked rice recipe, while *Sirusamai* and *Koluthana* for *samai uppuma*. A few observations made by the participants on other attributes deserve attention. CO-4 grains took more time than the grains of other varieties for cooking rice. In the case of *Koluthana*, cooking of rice grains was not uniform, as some grains remained uncooked. The cooked rice of CO-4, *Vellasamai* and *Sittan* was non-sticky, while that of *Perungulai* was stickier.

Table 8 Score values of organoleptic tests of two recipes in little millet at Jawadhu Hills, 2014

Recipe	Evaluators	Gender	Age	Varieties *Sirusamai*	*Koluthana*	*IR-20*	*Perungulai*	*VellaSamai*	CO-4	*Sittan*
	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
	Jagatheesh	M	25	3	6	4	7	2	1	5
	Kuppu	F	60	6	4	5	1	2	7	3
***Samai* cooked rice**	Muthu	F	48	7	4	6	1	5	2	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**
	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
SamaiUppuma	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**

Nutrient analysis of the selected local/ indigenous varieties

The indigenous varieties identified as farmer preferred varieties through PVS in a site need to be tested for their nutrient content to understand their advantages over the other varieties. Some of the indigenous varieties may be on par with the prevailing varieties in yield, but they may be more nutritious. Reverse can also be the case. Therefore, nutrient analysis may help in fine-tuning the recommendations from PVS. *Kempu ragi* and *Halukuli*, landraces of finger millet, have not only performed better in terms of grain yield, productive tillers per unit area and panicle size; they are also on par in nutritional profile with that of GPU-28, a ruling improved variety. *Gatti ragi*, another landrace, recorded higher content of Zinc (3.73 mg/100 g) and Calcium (326.8 mg/100 g) than that of GPU-28 (3.2 and 283.1 mg/100 g, respectively).

Box 9: Tips for ensuring effective participation of farmers

Process of participation of farmers in PVS is as important as that of product of PVS and is a non-negotiable aspect in PVS. The tips for ensuring effective participation of farmers are,

1) Involve the existing well functioning community organisations at the site level like federation of farmers group/ women group and farmers' cooperative, and at hamlet level like farmers group/ women group from the beginning in the PVS intervention.
2) Form a farmers' committee at the site level with the representatives from various communities and both gender to support and guide the PVS activities. Enroll the interested farmers and accomplished office-bearers of the community organisations in the committee. Consult with this committee for all the PVS steps, starting from 'participatory evaluation to identify farmers' needs in a cultivar', on a periodic basis.
3) Select trial farmers among the members of community organisations. Facilitate the sharing of the learning by the trial farmers to other members in various ways such as physically visiting the plot and sharing during regular meeting of the community organisation.
4) Give special attention to ensure effective participation of women farmers. Involve women Self Help Groups and women federations as it helps a lot in effective participation of women farmers.
5) Take all efforts to recruit women field staff.
6) Train all the staff on 'gender analysis and gender perspective' and undertake gender analysis of farming in the first year.
7) If possible, give incentives to participating farmers to compensate the loss of yield from the trial plot or to meet the expenses of cultural operations.
8) The field research staff need to be sensitive about the power equation between the 'farmers and scientists', 'farmers and themselves', 'men and women', different castes and different income classes in the site. They need to ensure effective participation of all the vulnerable sections such as small and marginal farmers, tribals, scheduled caste and women, by addressing the issues arising from the various power equations. They need to follow 'New Plant Genetic Resources Professionalism' as described by De Boef et al. (2013) while working with farmers.

Deriving inferences from mother trial results

The inferences drawn from analysis of i) growth and yield parameters, ii) opinion of the participating farmers and iii) preference expressed by group of farmers through FPA and the specific insights, if any, recorded by the research team and experts will be considered to work out the following outputs:

1. The most suitable variety or varieties for individual site
2. The traits of the tested varieties most preferred by the farmers
3. The varieties with special characteristics such as adaptability to particular soil types, tolerance to moisture stress, taste and short duration.

Shortlist the suitable varieties identified in the mother trials for testing in the baby trials.

Box 10: Selection of suitable short duration little millet varieties in Jawadhu Hills through mother trials in 2012

During 2012, mother trials (unreplicated) as well as replicated trials were conducted with nine varieties of little millet. However, because of miss identification of seed source of one variety (IR-20), the data of only eight varieties were considered for the analysis. Significant differences were noticed for plant population, plant height and grain yield among the varieties (Table 4). Even the values for grain yield of all the varieties, except *Siruvellai* and JK-8, were found to be statistically on par, indicating six out eight varieties have equal potential for the site. However, the maximum grain yield was recorded in *Perungulai* (506.3 kg/acre), followed by IR-8, CO-4, *Karunsittan* and *Sittan*. In replicated trials, significant differences among varieties were noticed only for plant height and panicle length (Table 9). *Perungulai* again recorded the highest yield (405.3 kg/acre) along with *Karunsittan*. Plant population was less in replicated trials when compared to mother trials as recommended seed rate was followed in the former and farmers' seed rate was followed in the latter.

The results of FPA also suggested almost same pattern of varietal preference (Table 7). In the opinion of farmers, *Perungulai*, JK-8, *Sittan*, CO-4 and *Karunsittan* were the preferred varieties, in the order of preference. JK-8 was preferred for early duration, uniform maturity and semi-compact panicle. CO-4 was already included in baby trials in 2012 based on the results of trials in 2011.

Table 9 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
Karunsittan	203.3	85.7	3.7	42.3	405.0	1530
Perungulai	111.1	103.7	3.3	43.7	405.3	1500
Sittan	174.1	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

Table 10 Synthesis of mother trials at Jawadhu Hills in 2011 & 2012

Sl. No.	Varieties selected	Year	Preferred traits
1	CO 4	2011	Similar in duration as that of *Sittan,* the local popular variety.
2	Koluthana	2011	Attractive semi-compact panicle, higher grain yield, more grain weight, duration same as that of *Sittan*
3	Perungulai	2012	Visually attractive long semi-compact panicle, higher plant height, higher grain and straw yield, bigger grain size and while coloured grains

Note:The 3 varieties included in the table above were included for further testing and validation through baby trials; JK 8, though preferred by farmers, was not selected in mother trial due to its poor grain and straw yield.

Attachment 1

MOTHER TRIAL INFORMATION SHEET

I. Trial farmer's family details

1	Name of the farmer	_____	2	Gender	_____
3	Husband/father	_____	4	Panchayat	_____
5	Village	_____	6	Group name	_____
7	Family members no.	_____	8	Literacy status	_____
9	Year of involvement	_____			

II. Land details

1	Farm size (acres)	Own	Leased in	Leased out	Total
	a. Rain-fed				
	b. Irrigated				
2	Irrigation facilities	Open well/ Bore well/ Other source			
3	Live stock (number)	Cows : Local ___ Crossbred _____ Bullocks: ___ Sheep/goat: _____			

III. Crop cultivation details of last year

a. All crops			
Rainfed		Irrigated	
Crop	Area (acre)	Crop	Area(acre)
1.		1.	
2.		2.	
3.		3.	
4.		4.	

b. Small millet and associated crops				
Crop	Variety	Seed source(Own/Purchased)	Area(acre)	Yield (Qtl)
1.				

2.				
3.				
4.				

b) Experience of cultivating SMAC: _____ Years

IV. Mother trial details

1. Crop: _____

2. Plot details:
   a. Area dimension: _____

   b. Land condition (Plot) Plain (slope < 3%) With slope > 3%

   c. Soil type (Indicate below the specific features by circling it)

   1. Color — Red/ Light brown/ Black/ Any other
   2. Texture — Clayey/ Sandy/ Loamy/ Sandy loam/ Others……
   3. Depth — Deep(>70 cm)/ Medium (20 – 70 cm)/ Shallow(<20cm)
   4. Fertility status — Very good/ Moderate/ Poor

   d. Last year crop: _____

   e. Whether fertilizer applied last year? Yes / No

   f. Whether manure applied last year? Yes / No

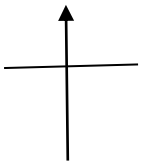
   g. Possibilities of protective irrigation: Possible/ Not possible

3. Local check variety:_____
4. List of test varieties

Sl. No.	Name of the variety	Seed quantity (g)	Sl. No.	Name of the variety	Seed quantity (g)
1			6		
2			7		
3			8		

4			9		
5			10		

5. Experiment field location with direction



6. Field layout plan

North											
West	Plot No.	1	2	3	4	5	6	7	8	9	10	East
	Varieties											
	South											

7. Plot size: _____ Sq. metre Plot dimensions:_____
8. Cultural operation details:

Date	Operations	Detail information, if any
	Land preparation including summer ploughing	
	Manure application	
	Fertiliser application	
	Sowing - Method of sowing	
	Transplanting, if applicable	

	Inter-cultivation like thinning, earthing up, etc.	
	Weeding	
	Top dressing, if applicable	
	Harvesting	
	Threshing	

9. Observations made during field visit:

Date	Visited by	Observations*	Instructions given	Signature of visitor	Signature of farmer

*Observations include, stage of the crop, germination, establishment, plant type (vigorous/ not vigorous), disease and pest incidence - its impact, dryspell and its impact, difference of impact over varieties, intercultural operations taken up like weeding, top dressing of fertilizers, earthing up, pesticide and fungicide application, damage to crop by wild animals, shade effect, erosion, farmers opinion about crop performance and other relevant factors.

10. Data collected during flowering and physiological maturity.

(- - - - - -) given for filling regional language terms so that farmer and local staff can collect the data. The parameters for which data is collected pertaining for items 10 & 12 may change from crop to crop. In Attachment 2, data sheets for groundnut crop and pulses are provided.

Plot No.	Variety name (- - - - - -)	Date of 50% Flowering (- - - - - -)	Plant population/ Sq. m (- - - - - -)	Plant height (cm) (- - - - - -)	Productive tillers/ plant (- - - - - -)	Earhead size (- - - - - -)		Grain colour
						Length (cm)	Fingers	
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

11. General remarks on crop condition:

12. Data collected during harvest (in 5*2 sq. m area) (- - - - - -)

Plot No.	Variety (- - - - - -)	Weight in kg (- - - - - - - -)			Pest and disease incidence (- - - - - -)	Moisture stress (- - - - - -)
		Total	Grain	Straw		
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

13. Mother trial farmers opinion on the tested varieties

Plot No.	Variety (- - - - - -)	Rating (- - - - - -)	Reasons (- - - - - -)	Like to grow next time?(- - - - - -)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

14. Specific comments on the tested varieties by the research team including the experts

Plot No.	Variety (- - - - - -)	Comments (- - - - - -)
1		
2		
3		

4		
5		
6		
7		
8		
9		
10		

15. Other observations and information:

Attachment 2

Data sheet for collecting data on growth parameters and yield parameters for crops other than cereals and millets

(i) Groundnut

a) Growth parameters

Sl. No.	Varieties	Plant population/m^2	Days to 50% flowering	Growth habit	No. of branches	Days to maturity	Disease incidence (%)	Pest incidence (%)
1		**			*****			
.								
N								

b) Yield parameters

Sl. No.	Varieties	Number of pods/ plant	No. of kernels /pod	Wt. of dry pods /plant	Yield of dry pod /10 sq. m	Yield of dry pod /ac	Shelling %	Kernel colour
1		*****	*****	*****			**	
.								
N								

(ii) Pulse crops- Red gram, Field bean, Black gram, Green gram & Horse gram

a) Growth parameters

Sl. No.	Varieties	Plant population /5m row	Days to 50% flowering	Plant height (cm)	No. of branches	Days to maturity	Disease incidence (%)	Pest incidence (%)
1		**		*****	*****			
.								
N								

b) Yield parameters

Sl. No.	Varieties	Number of pods/ plant	No. of seeds /pod	Grain yield /plant	Grain yield /5 m row	Grain yield (Kg /ac)	1000-grain weight	Seed colour
1		*****	*****	*****			**	
.								
N								

*indicate more than one values, as in case of sample plots or individual plant values; in excel sheet separate columns could be provided with additional column for average value.

Attachment 3

Format for processing general experimental information of mother trials

Sl. No.	I. Trail, farmer's family details									
	Trail farmer name	Father/Husband name	Gender	Village	Panchayat	Group name	Family size	Literacy status	Age	Participation year
1										
2										
3										
.										
n										

Format for processing general experimental information of mother trials (continued...)

II. Land details							III. Livestock (No.)			
			Ownership				Cows			
Farm size (acres)	Rainfed	Irrigated	Own	Leased in	Leased out	Irrigation facilities (Open well/ Bore well/ Other source)	Local	Crossbred	Bullocks	Sheep /goat

Format for processing general experimental information of mother trials (continued...)

IV. Crop cultivation area (previous year)										
	Rainfed			Irrigated			Crop selected for PVS			
a. All crops (area in ac)	Crop 1	Crop 2	Crop 3	Crop 1	Crop 2	Crop 3	Variety	Seed source	Yield	Years of experience

Format for processing general experimental information of mother trials (continued...)

V. Mother trial details (information of the experimental plot)														
Crop	Plot area (sq. m)	Land slope (Plain/ with slope)	Soil colour (Red/ Light brown/ Black/ Any other)	Soil texture (Clayey/ Sandy/ Loamy/ Sandy loam/ Others)	Soil depth (Deep/ Medium/ Shallow)	Fertility status (Very good/ Moderate/ Poor)	Previous crop	Last year fertilizer application(Yes/No)	Last year manure application (Yes/No)	Protective irrigation facility (Possible/ not possible)	Number of test varieties	Local check variety	Plot size (sq. m)	Any special cultural operations

Attachment 4

Format for processing field data of mother trials before sending it for compilation and statistical analysis

SITE: CROP:

Days to 50% flowering *

Sl. No.	Name of the trail farmer	Village/*Panchayat*	Date of sowing	V 1	V 2	V 3	V 4	V 5	V 6	V 7	V 8	V 9	V1 0
1													
2													
.													
.													
25													

*(Use *same format for other growth and yield parameters*)

Plant height (cm) of randomly selected five plants (same format for panicle length (cm), productive tillers per plant and other parameters where 5 readings are taken)

Sl. No.	Name of the trail farmer	Village/ *Panchayat*	Village	Date of sowing	V1						V2						…Vn					
					1	2	3	4	5	Avg	1	2	3	4	5	Avg	1	2	3	4	5	Avg
1																						
2										###						###						###
.										###						###						###
.										###						###						###
25										###						###						###

Avg- Average

Plant population per square meter (Square feet in the case of little millet & other densely populated crops) from two places

Sl. No.	Name of the farmer	Village/ *Panchayat*	Hamlet	Date of sowing	V1			V2			V3			Vn		
					1	2	Avg	1	2	Avg	1	2	Avg	1	2	Avg
1							###			####			###			####
2							###			####			###			####
.							###			####			###			####
.							###			####			###			####
25							###			####			###			####

Grain yield/ Straw yield

Sl. No.	Name of the trail farmer	Village/ *Panchayat*	Hamlet	Date of sowing	V1		V2		V3		V4		…Vn	
					kg /10m^2	kg/ acre	kg/10 m^2	kg/ acre	kg/10 m^2	kg/ acre	kg/10 m^2	kg/ acre	kg/10 m^2	kg/ acre
1						0		0		0		0		0
2						0		0		0		0		0
.						0		0		0		0		0
.						0		0		0		0		0
25						0		0		0		0		0

Attachment 5

Processed mother trial data of short duration varieties of little millet at Jawadhu Hills, 2013 for statistical analysis

Varieties	On-farm trials	Days to 50% Flowering	Plant population/ m^2	Plant height (cm)	Prod. Tillers /plant	Panicle length (cm)	Grain yield (kg/ac)	Straw yield (kg/ac)
Sittan	1	56	29.5	76.4	1.6	41.4	780	3020
	2	50	18.5	90.2	3.4	42.2	552	3648
	3	55	24.5	87.0	1.8	39.6	600	3000
	4	59	20.5	87.2	1.8	38.4	536	2464
	5	53	26.0	87.6	1.6	40.6	796	2604
	6	57	40.0	97.4	2.6	35.8	564	3036
	7	45	26.5	98.0	2.8	35.8	580	2420
	8	56	36.0	92.0	2.4	34.4	520	2880
	9	46	39.5	87.2	2.0	37.6	596	3004
	10	60	41.5	99.8	3.2	35.6	800	5000
	11	52	16.5	97.2	3.4	38.8	700	1700
	12	54	37.0	92.0	2.8	36.0	696	3504
	13	54	21.0	113.4	4.0	32.8	720	3880
	14	44	42.0	104.8	2.2	40.2	960	3240
IR-20	1	51	20.5	90.8	3.6	47.0	796	2840
	2	42	15.0	89.4	3.4	42.4	628	3772
	3	46	21.0	83.8	3.8	37.2	620	2580
	4	53	13.5	86.4	5.0	34.0	556	1844
	5	45	15.5	93.4	2.4	42.6	800	2800
	6	51	23.5	83.0	4.4	39.0	556	2244
	7	42	29.0	94.8	5.2	35.6	536	2064
	8	51	34.0	89.2	5.0	34.4	648	3152
	9	42	34.0	105.6	6.0	38.2	644	3756
	10	52	32.0	99.0	4.8	33.6	816	4640
	11	42	25.0	96.6	5.4	41.4	800	2000
	12	50	24.5	98.8	4.4	39.0	724	3676
	13	49	15.0	117.6	5.4	41.0	680	3720
	14	44	22.0	109.6	3.4	30.5	1120	3520
Paiyur-2	1	62	11.0	87.2	7.8	48.4	800	2600
	2	56	30.5	122.0	4.0	43.6	704	3096

Varieties	On-farm trials	Days to 50% Flowering	Plant population/ m^2	Plant height (cm)	Prod. Tillers /plant	Panicle length (cm)	Grain yield (kg/ac)	Straw yield (kg/ac)
	3	66	12.0	88.0	5.2	43.4	596	2204
	4	64	6.0	114.6	10.6	50.4	756	2244
	5	72	19.5	93.4	4.8	51.2	712	2088
	6	68	32.5	98.2	4.6	41.4	620	3780
	7	60	17.0	305.0	10.6	38.8	668	2532
	8	64	22.0	80.0	4.2	37.6	480	2520
	9	60	32.0	109.4	2.8	43.8	664	2736
	10	65	33.5	107.2	4.2	46.0	812	4080
	11	71	6.0	114.4	10.4	37.8	752	2248
	12	62	13.5	111.6	6.2	43.6	744	3856
	13	52	21.0	115.0	4.0	37.8	792	3408
	14	63	19.0	115.8	3.0	36.4	900	3500
Kadari-1	1	77	11.0	140.2	7.4	52.0	760	2840
	2	85	15.0	131.2	5.4	50.0	388	5012
	3	80	13.0	129.0	5.8	49.0	480	4120
	4	89	6.5	147.2	11.2	48.2	668	4332
	5	88	10.0	149.6	6.0	52.4	280	4720
	6	73	20.0	132.6	5.8	46.6	800	5400
	7	73	11.0	140.8	7.2	46.6	280	5520
	8	73	25.5	98.8	7.6	41.4	520	4480
	9	67	20.0	145.2	7.6	46.8	720	4480
	10	74	17.0	139.8	7.6	44.2	588	5320
	11	76	17.0	131.6	9.2	48.2	700	2820
	12	79	16.0	136.8	5.0	50.2	660	3112
	13	86	13.0	148.4	8.8	40.0	508	5092
	14	89	20.0	143.6	4.4	46.0	600	3000

Attachment 6

Data sheet for mother trial in RCBD

Variety and replication	Days to 50% flowering	Plant population per m^2	Plant height(cm)	Productive tillers per plant	Panicle length(cm)	Number of fingers per panicle	Grain yield(kg/ac)	Straw yield(kg/ac)
V1 I								
II								
III								
V2 I								
II								
III								
V3 I								
II								
III								
Vn I								
II								
III								

Module 3

Baby trial and Informal research and development (IRD)

Module objectives

- Describe the different steps in planning and execution of baby trial
- Describe the different steps in planning and execution of informal research and development
- Provide guidelines for data collection on yield parameters and preferences of farmers
- Provide guidelines for processing data from baby trial and IRD and deriving inferences
- Illustrate how to present the results of one cycle of PVS

Baby trial and Informal research and development (IRD)

Baby trial

Baby trials are conducted to validate the performance of identified varieties from mother trials by comparing performance of each one of them with the prevailing farmers' variety across the site. It is the second cycle in the PVS process. The varieties validated in baby trials are recommended for Informal Research and Development (IRD).

1. Planning and execution of baby trials

1) Conduct minimum of 25 baby trials for each variety. Increase the number of trials based on the seed availability.
2) Include one or two of the promising varieties identified from mother trials as test varieties.
3) Farmer's own variety will be the check variety.
4) The experimental design involves growing the check and test varieties in the same field adjacent to one another (Figure 1). If the experimental field is sloppy, arrange the plots across the slope (not along the slope). Ensure that except for the variety, there should not be any difference in land preparation, manure application, seed rate, sowing date, intercultural operations and other practices between the test variety plot and the check variety plot.
5) Ensure the plot size for each tested variety is minimum of 10 cents.
6) Distribute the trials across the villages in the site.
7) Enroll both men and women farmers for the trials.
8) Enroll farmers from all kinds of land holding size categories, with more of them from small and marginal farmers.
9) Supply seeds to farmers well in advance with poles/ nameplates for display.
10) Select levelled lands at least for some of the trials. While for the rest, select representative land types in the site.
11) Ensure regular observation of crop performance in the trials by the trial farmer and the field research staff.

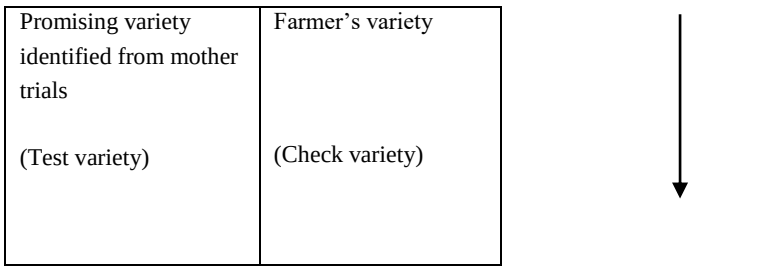


Figure 1 Field layout plan for baby trial

2. Data collection

In the case of baby trials, only opinion of the farmer on the varietal performance and yield of the tested varieties are considered for deriving the results. Collect data for baby trials in the formats given in attachments 1 & 2. For collecting data on yield, mark two random sample plots of 10 m^2 area (5m X 2m) each in plots of both test variety (ies) and check variety. Harvest the crops from these plots after they attain physiological maturity and keep the harvested produce of each variety separately. Ensure sun drying, weighing and threshing of produce from each trial plot separately. Record the grain yield and straw yield. Estimate the straw yield by deducting weight of grain yield from the weight of harvested crop of sample plots. Collect feedback from trial farmer on the performance of the test variety in comparison with check variety on various parameters in the format given in Attachment 2.

Baby trial plots of finger millet at Bero, Jharkhand

3. Data processing and analysis

The various steps involved in data processing and analysis for baby trials are shared below.

Step 1 – Preparing the consolidated yield data sheet

The model for consolidated data sheet is given in Attachment 3. Preparation of consolidated data sheet is illustrated using data of baby trials with 10 farmers involving *Perungulai* as test variety (Table 1). Average values of yield data of two sample plots (of size 10 sq. m each) for each variety was calculated and then converted into estimated values per acre. Mean grain yield and straw yield per acre of the test variety is calculated from the values of all the trials and entered in the cells marked with ****.

Table 1 Performance of *Perungulai* against farmer's variety in baby trial at Jawadhu Hills, 2013

Sl. No.	Farmer name	Date of sowing	Yield of introduced variety									
			Variety	Area in Sq. m	Grain yield in kg				Weight of straw in kg			
					1	2	Avg	kg/ ac	1	2	Avg	kg/ ac
1	Jayappal/ Unnamala	19.8.13	*Perungulai*	506	1.75	1.17	**1.46**	**584**	8.75	6.88	**7.82**	**3126**
2	Magi	19.8.13	*Perungulai*	594	1.2	1.45	**1.33**	**530**	5.8	6.55	**6.18**	**2470**
3	Kuppan	18.7.13	*Perungulai*	323	1.67	1.6	**1.64**	**654**	5.33	4.90	**5.12**	**2046**
4	Kppusamy/ Mangai	14.8.13	*Perungulai*	600	1.65	1.38	**1.52**	**606**	7.85	7.12	**7.49**	**2994**
5	Masilamani	23.7.13	*Perungulai*	546	1.11	1.21	**1.16**	**464**	7.89	8.29	**8.09**	**3236**
6	Mani	18.6.13	*Perungulai*	200	1.81	1.98	**1.90**	**758**	6.19	7.02	**6.61**	**2642**
7	Govinthan/ Thathi	20.7.13	*Perungulai*	418	1.11	1.85	**1.48**	**592**	7.39	6.15	**6.77**	**2708**
8	Vasantha/ Kasi	22.7.13	*Perungulai*	476	1.8	1.78	**1.79**	**716**	7.7	7.25	**7.48**	**2990**
9	Chinnapayan	24.6.13	*Perungulai*	560	1.45	1.25	**1.35**	**540**	10.55	9.75	**10.15**	**4060**
10	Ilayaraja/ Janaki	13.7.13	*Perungulai*	230	0.45	1.38	**0.92**	**366**	3.55	5.62	**4.59**	**1834**

MEAN VALUE= ***** **= ******

Table 1 Continued…

Sl. No.	Farmer name	Date of sowing	Yield of farmer variety									
			Variety	Area in Sq. m	Grain yield in kg				Weight of straw in kg			
					1	2	Avg	kg/ ac	1	2	Avg	kg/ ac
1	Jayappal/ Unnamala	19.08.2013	*Sittan*	152	1.17	1.2	**1.19**	**474**	6.33	6.30	**6.32**	**2526**
2	Magi	19.08.2013	*Sittan*	288	0.9	1.27	**1.09**	**434**	5.60	6.23	**5.92**	**2366**
3	Kuppan	18.07.2013	*Sittan*	432	0.63	0.05	**0.34**	**136**	3.87	4.45	**4.16**	**1664**
4	Kppusamy/ Mangai	14.08.2013	*Sittan*	612	1.45	1.60	**1.53**	**610**	8.55	7.12	**7.84**	**3134**
5	Masilamani	23.07.2013	*Sittan*	234	0.9	1.01	**0.96**	**382**	7.60	6.99	**7.30**	**2918**
6	Chinnapayan	24.06.2013	*Sittan*	391	1.21	1.55	**1.38**	**552**	8.29	8.45	**8.37**	**3348**
7	Mani	18.06.2013	*IR-20*	220	1.65	1.81	**1.73**	**692**	6.85	9.19	**8.02**	**3208**
8	Govinthan/ Thathi	20.07.2013	*IR-20*	351	0.98	0.78	**0.88**	**352**	7.20	7.22	**7.21**	**2884**
9	Vasantha/kasi	22.07.2013	*IR-20*	504	1.95	1.50	**1.73**	**690**	6.55	6.50	**6.53**	**2610**
10	Ilayaraja/Janaki	13.07.2013	*IR-20*	250	0.89	1.00	**0.95**	**378**	7.11	7.50	**7.31**	**2922**

MEAN VALUE= ***** **= ******

(Note – There were 10 trials with Sittan and 9 trials with IR-20 as checks)

Same procedures are followed for another test variety (if it is there) and for the check (farmer's) variety.

Step 2 –Preparing yield table

From the consolidated data sheet, construct the final yield table as shown in Table 2. For calculating the difference in yield between the test variety and check variety use the following formula:

$$\text{Percent increase in yield} = \frac{(\text{Yield of test variety} - \text{Yield of check variety}) \times 100}{\text{Yield of check variety}}$$

If value is positive it indicates the percentage increase in yield of test variety over the check variety and if it is negative, it indicates the percentage decrease.

Table 2 Performance of *Perungulai* variety of little millet in baby trials, Jawadhu Hills, 2013

Sl. No	Yield parameters	No of trials	Performance of		Per cent 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; Inc = with increased and Dec = decreased values**

Step 3 – Processing data on trial farmers' assessment of test variety

The trial farmer's feedback format captures opinion of the trial farmer on the test variety pertaining to different traits in comparison with his or her own variety. It is expressed as more, same or less and the corresponding score is 1, 2 and 3. Compile the opinion data in the excel sheet given as Attachment 5. Count the each score value (1's, 2's and 3's) in each column, that is for each trait and enter the same in Table 3. Calculate percent values from these number values. For seed saving column, count number of 'Yes' and 'No' and calculate their percent values. Use the percent values for deriving the inferences, which are used in the text of the report with comments. The completed table looks like the one given below.

Table 3 Farmers' assessment of *Perungulai* variety of little millet at Jawadhu Hills, 2013

Sl. 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 dryspell	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
9	Do you like to save seed				
	- Yes	18 (94.7)			
	- No	1 (5.2)			

*Figures in parentheses are % values

Step 4 – Interpret the results furnished in the tables

Infer the performance of test variety on yield from percent of trials with increase in or decrease in yields and the farmers' opinion on this trait. Infer whether the trial farmers prefer the tested variety from the feedback table, based on the specific traits for which they have answered in favour of the test variety. The traits not liked by the farmers can also be derived from the feedback table. Use these information and the opinion of the research team and experts on the performance of test variety (ies), if any (consolidated in the format given in Attachment 4), to derive the following outputs:

1. The most suitable variety or varieties for individual site
2. The traits of the selected varieties most preferred by the farmers

The suitable varieties identified in the baby trials are shortlisted for IRD trials for further validation and wider dissemination (see Box 1).

Box 1: Validation of *Perungulai* little millet variety in Jawadhu Hills through baby trials in 2013

The performance of *Perungulai* against *Sittan* and *IR-20* is given in Table 2. The results suggested that grain and straw yield of *Perungulai* was higher in majority of the trials when compared to *Sittan*. The grain yield of *Perungulai* was higher in most of the trials in the case of *IR-20* while the straw yield was lower. *Perungulai* recorded grain yield advantage of 20.5% over *Sittan* and 15.4% over *IR-20*, indicating its high yielding ability. The fodder yield was 17.6% more 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 attracted the attention of participating farmers. The results in Table 3 suggested that *Perungulai* was similar or slightly longer in duration than the check varieties. Its performance was similar to 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. 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* preferred by the baby trial farmers were higher yielding ability (grain and fodder yield), long compact panicle, less chaffy grains, more grain weight, bigger grain size, and white color of the grains. So, it was recommended for IRD.

Informal research and development (IRD)

IRD is the third cycle in the PVS process. Its specific objective is to validate the suitability of a variety identified in baby trial through getting opinion from large number of farmers based its performance in their fields. The second important objective is to introduce the identified suitable varieties to as many farmers as possible in the particular site. It also serves the purpose of production of quality seeds of the identified variety for further dissemination in the next year. The varieties validated by IRD are disseminated widely for large scale adoption.

The IRD farmers may or may not grow their own variety (ies) as checks along with the test variety, as in case of baby trials. To understand the comparative performance of the identified varieties for another season, it is better to study 25 IRD fields having farmers' varieties as checks, besides the other IRD trials without checks. Since the research design for IRD is same as that of baby trials, follow the same procedures for field operations, data collection, data processing and analysis. The trials having checks (farmer's varieties also) need to be treated same as baby trials and the data collected is processed and analysed following the steps as given above. For rest of the trials (without checks) only the feedback of trial farmers need to be collected in the specified format (Attachment 2), which need to be compiled in excel sheet as in Attachment 5.

Table 4 Farmers' assessment of *Perungulai* 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	17 (34)	31 (62)	2 (4)	0
2	Tolerance to dryspell	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
9	Do you like to save seed				
	Yes	39 (78)			
	No	11 (22)			

*Figures in parentheses are % values

Box 2: Validation of *Perungulai* little millet variety in Jawadhu Hills through IRD in 2014

Seeds were distributed to 87 farmers from 20 villages in four *Panchayats*. Most of the participating farmers found that *Perungulai* was almost same as that of their local variety in respect to duration, tolerance to dry spell, lodging, grain shattering and grain colour (Table 4). 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 expressed willingness to save seeds for the next year, indicating their positive orientation towards *Perungulai* variety. Given the consistent better performance of *Perungulai* for the past 3 years across the site villages, it was considered as highly suitable for the site. Necessary initiatives need to be taken for its wider dissemination in and beyond the working villages.

Synthesis of research results of PVS

The results of one cycle of PVS over a period of three crop seasons/ years can be synthesised as given in Table 5 for effective presentation and for preparing action plan. The action plan indicates the farmer preferred varieties identified for wider dissemination and potential varieties to be tested in the next cropping season for validating their suitability for the site. It is to be noted that lot of uncertainties exist while experimenting under rainfed farming conditions, especially with respect to adequate and timely availability of rainfall. Therefore, it is better to test each promising variety at least for two years. This will help in better assessment of the variety for its suitability to the site. A case in point is GPU-28 performance in Jawadhu Hills. When GPU-28 variety of finger millet was introduced in Jawadhu Hills in 2011, it did not perform well, but in the subsequent three years, it performed well. The PVS cycle (process) has to be continued when new promising varieties are identified for the site. If promising materials are not available for testing, participatory plant breeding can be planned to create additional varietal options for the site.

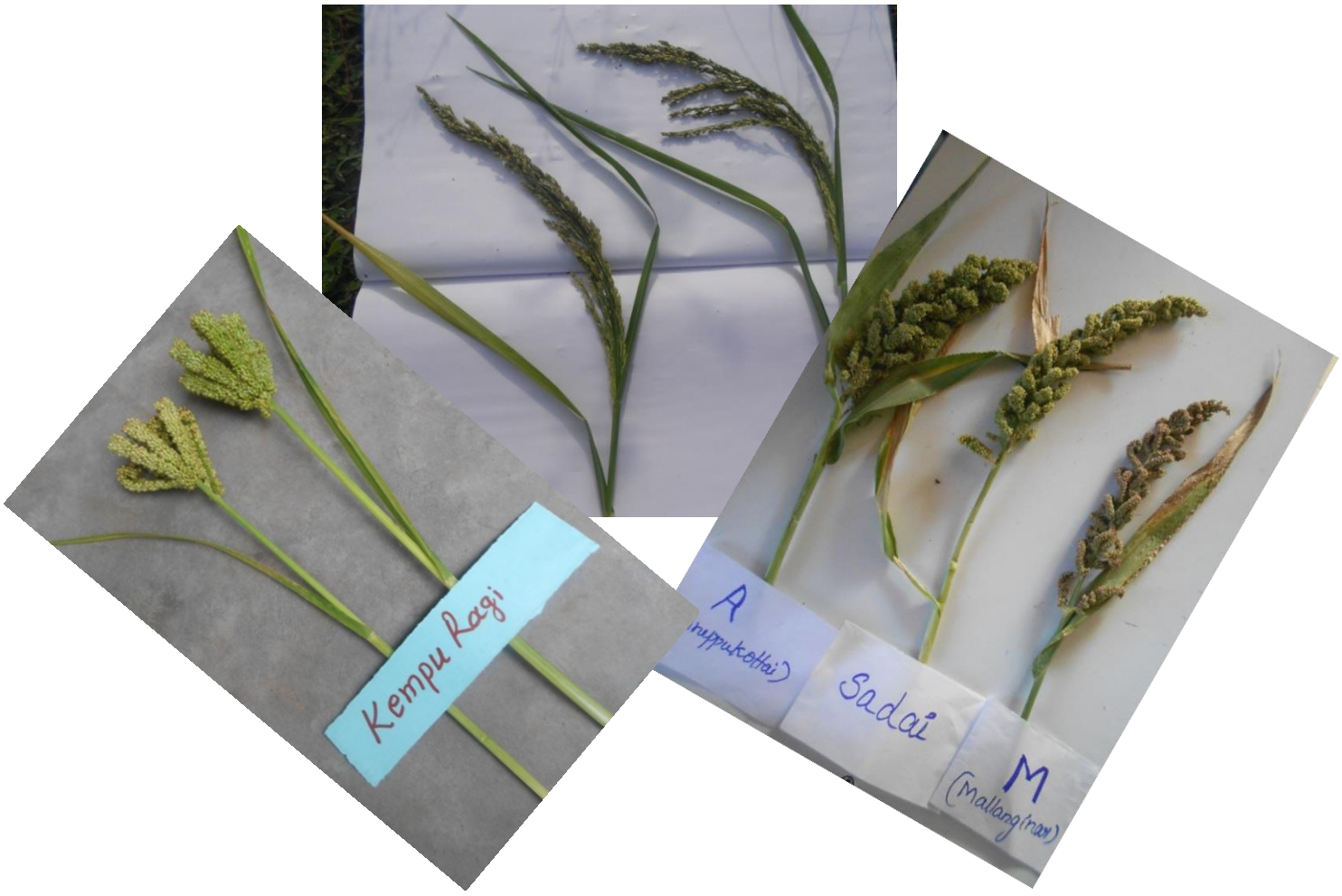
Table 5 **Synthesis of little millet PVS trials in Jawadhu Hills, 2011-2014**

Type of variety	2011	2012		2013		
	Mother trial	Mother trial	Baby trial	Mother trial	Baby trial	IRD
Traditional-Short duration	*Sittansamai, Karunsittan, Koluthana*	*Sittansamai, Karun sittan, Koluthana, Siruvellai, Perungulai, IR-8*		*Sittansamai, Kadari-1, IR-20*	*Perungulai, Koluthana*	--
Traditional-Long duration	*Vellasamai*			*Kallumannu, Vellasamai, Kala suan, Badasuan, Sirusamai*		
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 5 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	*Sittansamai, Vellasamai from Pudur Nadu and IR 8 from Pudur Nadu*	*IR 20*	*Perungulai, Koluthana*	*Perungulai, Koluthana*	*Vellasamai from PN, IR-20*
Traditional-Long duration	*Vellasamai, Kothusamai, Karun samai*	*Sirusamai*			*Sirusamai, Kothusamai and Karun samai*
Released		--	CO-4	CO-4	Paiyur 2
Total	**6**	**2**	**3**	**3**	**6**

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


Kempu Ragi
A
Sadai
M

Attachment1

BABY TRIAL INFORMATION SHEET

I. Trial farmer's identification details

1	Name of the farmer	_____	2	Gender	_____
3	Husband/father	_____	4	Village/*Panchayat*	_____
5	Village	_____	6	Group name	_____
7	Family members involved in farming	_____	8	Literacy status	_____
9	Year of involvement	I year/ II year/ III Year			

II. Land details

1. Farm size (acres)

Land type	Own	Leased in	Leased out	Total
c. Rainfed				
d. Irrigated				

2 Irrigation source Open well/ Bore well/ Other sources

3 Experience of cultivating SMAC: _____ Years

III. Baby trial details

16. Crop: _____

17. Experimental Plot details:
    a. Area _____ Dimension: Length___ m X Breadth ____ m

    b. Land condition (Plot) Plain (slope < 3%) With slope > 3%

    c. Soil type (Indicate below the specific features by circling it)

    5. Color Red/ Light brown/ Black/ Any other

    6. Texture Clayey/ Sandy/ Loamy/ Sandy loam/ Others……

    7. Depth Deep(>70 cm)/ Medium (20 – 70 cm)/ Shallow(<20cm)

    8. Fertility status Very good/ Moderate/ Poor

d. Last year crop: _____

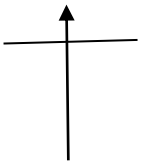
e. Whether fertilizer applied last year? Yes / No

f. Whether manure applied last year? Yes / No

g. Possibilities of protective irrigation: Possible/ Not possible

18. Field layout plan

…….m …….m …….m …….m



Treatment 1:	Treatment 2	Treatment 3	Treatment 4

……m ……m

19. Plot size:

Treatment 1:……..……: _____Sq. m Length____ m X Breadth ____ m

Treatment 2:……..……: _____Sq. m Length____ m X Breadth ____ m

Treatment 3:……..……: _____Sq. m Length____ m X Breadth ____ m

Treatment 4:……..……..……: _____Sq. m Length____ m X Breadth ____ m

20. Cultural operation details:

Date	Operations	Details, if any
	Land preparation including summer ploughing	
	Manure application	
	Fertiliser application	
	Sowing - Method of sowing	
	Transplanting, if applicable	
	Inter-cultivation like thinning, earthing up, etc.	
	Weeding	
	Top dressing, if applicable	
	Harvesting	
	Threshing	

21. Observations made during field visit:

Date	Visited by	Observations*	Instructions given	Signature of visitor	Signature of farmer

*Observations include, stage of the crop, germination, establishment, plant type (vigorous/ not vigorous), disease and pest incidence - its impact, dry spell and its impact, difference of impact over varieties/treatments, intercultural operations taken up like weeding, top dressing of fertilizers, earthing up, pesticide and fungicide application, damage to crop by wild animals, shade effect, erosion, farmers opinion about crop performance and other relevant factors.

22. General remarks on crop condition: (a. Mention pest and disease incidence, moisture stress and anything that has implication on yield; b. Mention about yield)

23. Data collected on parameters (Yield in the case of baby trials in 5*2 sq. m area in 2 spots in one plot)
The parameters for which data is collected pertaining for item 23 may change from crop to crop.

Plot No.	Treatment	Spot No. 1			Spot No. 2		
		Weight in kg			Weight in kg		
		Total	Grain	Straw	Total	Grain	Straw
1							
2							
3							
4							

24. Baby trial farmers opinion on the treatments

Plot No.	Varieties	Rating	Reasons
1			
2			
3			
4			

25. Specific comments on the treatments by the research team including the experts

Plot No.	Treatment	Comments
1		
2		
3		
4		

Attachment 2

Trial farmer's feedback format

Baby/IRD trials (in the case of small millets)#

A. Compare test variety with your own variety

B.

1.	Maturity	1)Earlier	2) Same	3) Late
2.	Tolerant to dryspell	1) More	2) Same	3) Less
3.	Tolerant to heavy rainfall	1) More	2) Same	3) less
4.	Lodging	1) High	2) Same	3) Less
5.	Damage by rains during maturity	1) High	2) Same	3) Less
6.	Grain shattering	1) More	2) Same	3) Less
7.	***Resistance to blast*** (Only in the case of finger millet)	1) More	2) Same	3) Less
8.	Grain yield	1) High	2) Same	3) Less
9.	Straw yield	1)High	2) Same	3) Poor
10.	***Colour preference***	1)Better	2) Same	3) Poor
11.	***Flour recovery*** (Only in the case of finger millet)	1) More	2) Same	3) Less
12.	*Taste*	1)Better	2) Same	3) Poor

(Traits in ***Italics*** optional)

C. Do you like to save the seed of test variety?

Yes ☐ No ☐

The parameters on which farmer's feedback is collected may change from crop to crop.

Attachment 3

Yield of grain &straw of randomly selected two 5*2 m plots in each treatment

Sl. No.	Name of the farmer	Village/ *Panchayat*	Hamlet	Date of sowing	Yield of introduced variety										Yield of farmer variety									
					Variety	Area in Sq. M	Grain yield (kg)				Weight of straw (kg)				Variety	Area in Sq. m.	Grain yield (kg)				Weight of straw (kg)			
							1	2	Avg	kg/acre	1	2	Avg	kg/acre			1	2	Avg	kg/acre	1	2	Avg	kg/acre

Attachment 4

Opinion of the research team

Sl. No.	Name of the farmer	Village/ *Panchayat*	Hamlet	Date of sowing	Test variety	Check variety	Comments on the performance of test variety with respect to check variety
1							
2							
.							
.							
25							

Attachment 5

Consolidated feedback information from baby/ IRD of variety .....

Farmers' name	DOS	MAT	TDS	THR	RBL	LDG	DRN	GYD	SYD	COL	FLR	GSH	TST	SSAVE
1		1	2	3	1	2	3	1	2	2		1		Y
2		2	3	3	1	2	2	1	1	2		1		Y
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
100		1	3	1	1	2	3	2	1	2		2		N

Date of sowing (DOS),Tolerant to dryspell (TDS), Tolerant to heavy rainfall (THR), Resistance to blast (RBL), Lodging (LDG),Maturity (MAT), Damage by rains during maturity (DRN), Grain yield (GYD), Straw yield (SYD), Colour preference (COL),Flour recovery(FLR), Grain shattering (GSH), Taste (TST), Saving seeds of test variety (SSAVE).

Module 4

Wider dissemination of farmer-preferred cultivars

Module objectives

- Describe the different steps in familiarizing the farmer preferred varieties to the local farming community and generating demand

- Describe the different steps in production of seeds of farmer-preferred varieties to ensure adequate supply

Wider dissemination of farmer-preferred cultivars

The first 3 phases of PVS helps in generating site specific farmer-preferred varieties (FPVs). The varieties so generated need to be widely disseminated for their adoption by the target community. As mother trials, baby trials and IRD are conducted in the farmers' fields and as trial farmers have access to seeds of their preferred varieties, horizontal spread of the FPVs can be expected to an extent. However, specific efforts have to be taken to ensure large-scale dissemination. This step is crucial to spread the results of PVS to a large number of farmers. Two sets of key activities needed for wider dissemination of the identified FPVs are: 1) Familiarising the FPVs to the local farming community and generating demand and 2) Production of seeds of FPVs to ensure timely supply of quality seeds in the next season.

Familiarising the FPVs to the local farming community and generating demand

These activities need to be started by the end of IRD stage itself, as by that time the site specific FPVs are already identified. The key activities for familiarising and generating demand for the FPVs can be classified as follows:

a) Dissemination activities to be taken by the end of IRD

1. **Arranging exposure visit to large number of local farmers to successful IRD trials:** As IRD trials are taken up under varied land quality and management practices, there will be variations in the expression of identified FPVs. Select one IRD plot which has visually appealing crop stand and easily accessible for each identified variety for each cluster of hamlets. Organise the interested farmers in the particular cluster, preferably members of farmers group, for an exposure visit of one to two hours duration to these few IRD plots. Seek the opinion of the visiting farmers/ members on the varieties observed and their willingness to grow in the next season. Systematically record these opinions and give necessary support to the willing farmers before the next crop season for trying their preferred variety in their farm.
2. **Identification of interested farmers:** Among the IRD farmers, identify those farmers who are highly enthused by the performance of a particular FPV, eager to integrate them in their cropping system and share their positive experience with other farmers. Encourage them to share their experience to other farmers individually and in the meetings organised for this purpose.

b) Dissemination activities to be taken before the next cropping season

1. Display of panicles, grain and other crop samples of the identified FPVs in the local weekly market.

2. **Sharing relevant communication materials to large number of farmers:** Prepare communication materials (pamphlets, posters and wall paintings) on the identified FPVs covering their salient features from the perspective of the farmers/ users. Ensure reaching of these materials to large number of farmers in the site.
3. **Raising demand in the meeting of local organisations:** Give an orientation to the office bearers of farmers' federations and cooperatives, so that they understand the advantages of the identified FPVs and share the same with their members. Give orientation and raise demand for the identified FPVs in the regular/monthly meetings of SHGs, farmers groups, etc. Do it in a systematic way using a format, which captures member wise and variety wise demand. Based on the demand raised, take necessary efforts for supplying seeds in time.
4. **Distribution of the seed kits:** Distribute seed kits to farmers who have expressed demand for the FPVs with the information on the particular varieties. Distribute seed as a 'kind loan', which need to be returned twice/ thrice in quantity by the end of the season.

c) Dissemination activities to be taken during the next cropping season

1. Demonstrate the FPVs in major hamlets throughout the site. If possible, demonstrate FPVs along with site-specific suitable production practices such as optimum seed rate and thinning. This helps in demonstrating the full production potential of the variety. Choose motivated and vocal farmers who are impressed by the performance of the FPV for demonstration.
2. Arrange exposure visit to large number of local farmers to successful demonstration plots.

Production of seeds of FPVs to ensure timely supply of quality seeds in the next season

Parallel to raising demand for the seeds of farmer-preferred varieties (FPVs) identified through PVS, take necessary efforts for production of seeds of those varieties to meet the demand created. The following section shares briefly about community based seed production (CBSP) to meet this purpose. The practices related to CBSP for FPVs are not much different from seed production for proven varieties.

Community based seed production

CBSP is the most feasible option for production of quality seeds of identified FPVs, if the selected varieties are not part of the formal seed chain (as in the case of local varieties) and if farmers in the site do not have adequate access to formal seed chain. Further, if the local varieties identified as FPV have mixtures, systematic seed production will help in purification to an extent. The two options for CBSP are shared below.

1. **Identification of fields for seed procurement from existing IRD plots**
   A number of farmers participating in baby/IRD trials are using the seeds of selected promising varieties. Taking the advantage of regular visits to these fields from initial stages of crop growth, Identify two to five IRD trial fields for each FPV having good crop stand with uniform plant population. Regularly visit these fields and select two among them based on the crop performance and varietal purity. Keep record of selected fields such as address of farmer, name of variety, date of sowing, crop condition and instructions given to the farmers.
2. **Establishing exclusive seed production plots**
   Seed production plots of large size, say 1-2 acres, for each identified traditional variety could also be established in the fields of interested farmers by using seeds purified during previous season. Similarly, seed production of identified released varieties can also be planned using foundation or breeder seeds from research centres, if necessary.

For both of these options follow the standard procedures for seed production mentioned briefly in the Box 1 to ensure quality of seeds. The seeds so produced will meet all the minimum requirements of good quality seeds and can be considered as truthful seeds. The genetic purity of the seeds produced is not very high, but their extent of purity is much higher than the seeds used by the farmers. Hence, one can expect better yields by using these seeds. Repeating production of seeds of local variety without mixtures could help in preserving its identity.

Above mentioned procedure can only help to meet immediate need for quality seeds of FPVs of certain crops. It is a short term mechanism, which is manageable with little effort. To have a sustainable seed production and distribution system at community level, a well organised unit dealing with all the existing rules and regulations of quality seed production and marketing need to be established. The design features of such a unit such as organizational and management setup, infrastructure facilities, internal quality control system and marketing can be on the lines of ‘Seed Village Concept’ followed in India (See Box 2 and 3).

Box 1: Standard procedures for seed production

Ensure minimum seed standards specified for each crop related to genetic purity, physical purity, germination percentage and free from pest and disease incidence by following the steps given below.

1. Select interested farmers and train them on seed production.
2. Select fertile and levelled land with possibilities of irrigation for seed production. If already planted field is considered, then choose field with uniform and good crop stand.
3. Maintain required isolation distance between the seed production field and neighbouring fields of same crop to avoid contamination through undesirable pollens. The isolation distance will depend on the pollination mechanism of the crop grown (self/ cross/ often cross pollinated).
4. Ensure good crop management such as optimum seed rate, application of sufficient manures, optimum plant population, weed management and plant protection measures for healthy and vigorous crop growth.
5. Follow purification through roguing of off-plants at flowering and maturity stages.
6. Harvest at right stage of maturity.
7. Thresh, clean and grade the harvested produce separately with necessary precautions to avoid mechanical mixtures.
8. Dry the seeds to optimum moisture level and store in proper containers.
9. Keep record of selected fields such as address of farmer, name of variety, date of sowing, crop condition and instructions given to the farmers.

More details are given in 'Seed Production Techniques for Cereals and Millets' by Centre for Indian Knowledge Systems, India.

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Seed production of Sadai variety of barnyard millet at Peraiyur

Box 2: Basic requirements for establishing decentralised community based seed business unit

Size and scale of the unit
The seed unit needs to produce seeds for as many crops as possible and not restrict only to the identified FPVs, to reach economic viability. Volume of sales needs to be adequate to cover all costs and to gain some profit.

Planning for quality seed production
Planning for seed production needs to be done meticulously. The plan should include aspects such as number and types of crops (self-pollinated, often cross-pollinated and cross-pollinated), number of varieties in each crop, cropping season, the quantity of seeds, sourcing foundation seeds and training to seed producers. Regular visits of seed certification team to the seed production fields at proper stage of crop growth for assessing genetic purity also need to be planned.

Seed processing, testing and packaging centre
Quality of seeds is determined by optimum physical and physiological conditions such as physical purity and moisture content, besides genetic purity. To meet these requirements, establishing a mini seed processing centre is needed, which will take care of proper processing, germination testing and bagging/ packaging of the seed lots. Each seed processing centre need to have the following infrastructure.

1. Seed grader cum cleaner
2. Bag closer, trolleys, scales and furniture
3. Building to house the equipments
4. Seed storage structure
5. Seed threshing cum drying yard
6. Seed testing laboratory

Mini seed processing unit is a business venture by the community organisation for the benefit of local farming community. Sufficient investment and building space need to be arranged, either from concerned government departments/ funding agencies/ financial institutions or from own sources, for establishing such a unit.

Internal quality control system
Success of community seed production venture mainly depends on the supply of quality seeds in sufficient quantity at right time for crops, which are in demand. The brand under which the seeds are sold should create confidence among the farmers and should be the symbol of assured quality. Hence, the internal quality control system is an essential aspect. Quality of seed production need to be monitored by a team constituted with representatives from community organization (like farmers' federation), technical staff and qualified technical personnel from research institutes.

Registration of the Unit
The decentralized seed production and distribution is a business venture and hence, needs to adhere to the existing rules and regulations of seed industry. It needs to register, get license and comply with all the stipulated norms.

Uniform crop standin seed production plots of Kempu ragi variety of finger millet at Anchetty

Kala suan variety of little millet at Semiliguda

Box 3: Useful tips from Seed Village Project of JSS Mahavidyapeetha, Karnataka

- The infrastructure for seed village cluster was built in lands belonging to Government and the farmers' federation at the cluster level owned it.
- Business plan was prepared in a way that the Seed Production Centre runs on a marginal profit after meeting the operational costs.
- The processed seeds after seed testing were packed in bags carrying the brand name given under the project. The seeds were labelled as 'truthful seeds' by seed certifying agency of the area.
- The sale of seeds was done directly by the farmers themselves. Seed Production Centre may also procure and sell the seeds, which would be decided by the cluster level federation.
- A storage unit was built along with the seed processing infrastructure. The services of this unit were made available on a cost basis to the nearby farmers for optimising its use.
- Initial investment on building and machinery was provided under the project and working capital was provided as loan from financial institutions. Further, the Seed Production Centre generated the needed working capital through its own activities.
- The marginal profits accrued in Seed Production Centre were used by the federation for capacity building programmes for seed producers and other welfare activities.

Module 5

Post-PVS activities

Module objectives

- Describe the different activities to be taken for understanding the immediate effects of PVS

Post-PVS activities

In general, an in-depth assessment of a technological intervention will be done three to five years after its completion. This is the case with PVS also. However, in the case of PVS, it is important to take up structured efforts for two years after the PVS cycle to understand the immediate effects of the identified FPVs in the site. This will help in addressing any constraints in their adoption and in providing feedback to improve the PVS process elsewhere. The following activities are suggested for understanding the immediate effects of PVS:

- Take survey in each village/ *Panchayat* during cropping season to collect information on spread of identified varieties- i) number of farmers cultivating the identified FPVs, ii) varieties under cultivation and area iii) under each of such varieties (approximate estimation).
- Select randomly at least ten fields having crops of identified FPV variety in each *Panchayat* to collect individual farmer's feedback on the performance of the variety. Use the format shared in Attachment 3 of Module 3.
- Collect yield data from three to five random fields from the selected farmers mentioned above in each village/ *Panchayat* for each variety, for verifying the farmers' perception on its yielding ability.
- Select 20 PVS trial farmers across the site per each FPV and try to understand the following: a) continuation of cultivation of the identified FPV by the trial farmer, b) if continued, whether that year's experience with the variety reinforced their earlier understanding about the FPV on its advantages and problems and c) the spread of varieties from him/ her to the neighbouring and distance area.
- Arrange one FGD in each village/ *Panchayat*, preferably immediately after the harvesting season. Ensure the participation of both men and women farmers, and farmers cultivating newly identified varieties as well as the farmers using other varieties. Elicit the following information on the introduced FPV - availability of seeds, source of seeds, method of sowing, quantity of seeds used per acre, plant population and crop stand, incidence of pest and diseases, response of the FPVs to dryspell or heavy rains, if any, crop duration, plant height, tillering ability, panicle size, grain size and color, grain and straw yield and willingness to grow in future with specific reasons.
- After collecting all the information as listed above, it needs to be analysed to understand the effect of PVS in the target area in terms of: a) Area under newly identified varieties, b) Number of introduced FPVs cultivated, c) Number of farmers cultivating each of these varieties, d) Increase in yield and other benefits realised by the farmers, e) Self spread effects observed, f) General opinion of the local farming community and g) The factors constraining the spread of the variety.
- The results need to be shared with the committee of community members formed in the site to validate and get additional comments and suggestions for increasing the spread of the variety. An

action plan to be prepared for facilitating the spread of the variety with the support of the community.

Additional inputs for technology tracking and assessment of the immediate effects of PVS process and technologies is given in “Guide to participatory varietal selection for submergence- tolerance rice”.

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Resources for further learning

Plant Breeding With Farmers: A Technical Manual

Author: Salvatore Ceccarelli

This manual on Participatory Plant Breeding (PPB) is based primarily on the direct experience derived from several years of implementing PPB programmes in a number of countries and on a number of crops, and secondly, from a number of training courses (China, Ethiopia, Jordan, Australia, South Africa) and when necessary, on relevant scientific literature, as part of the ICARDA research programme. The methods presented here have been used by in rural communities over the course of several years particularly in North Africa (Tunisia, Morocco, Egypt and Algeria), the Horn of Africa (Eritrea and Ethiopia), the Arabian Peninsula (Yemen), the Near East (Syria, Jordan and Iran) and by others (NGOs, Universities, IARCs, etc.) in other countries. Most probably, the methods described will not suit every situation that researchers and partners are likely to encounter; therefore, the manual will attempt to give some general principles that may help in adjusting the methodologies to new situations.

Guide to Participatory Varietal Selection for Submergence-tolerant Rice

Authors: T.R. Paris, D. Manzanilla, G. Tatlonghari, R. Labios, A. Cueno, and D. Villanueva, IRRI, 2011

The Green Revolution averted the threat of famine through the rapid adoption of improved rice varieties. However, despite this huge success, hundreds of millions of poor rice-farming families in rainfed areas still live in poverty and suffer from food (rice) insecurity. Despite many released improved rice varieties for rainfed conditions, farmers still use local varieties that can withstand drought and floods but have low yields or they use the same varieties for many years because of a lack of better varieties. Rainfed rice farmers are slow to adopt improved varieties because of several problems. One problem is more of extension than breeding - many farmers, particularly those living in remote rainfed areas, may not have access to or information about the seed of new varieties. Another problem is that variety testing programmes are often conducted on-station, which does not represent farmers' fields. Moreover, conventional rice breeding programmes usually seek farmers' input only at the very end of the process, when newly released varieties, usually one or two per year, are evaluated in on-farm demonstration trials. Often, in remote and unfavourable areas, subsistence farmers, who comprise the majority of the rural farming population in Asia, give importance to social and cultural dimensions aside from the agronomic performance of the new rice varieties. The complexities of developing acceptable varieties for variable and stressful rainfed environments require that breeders become deeply familiar with men and women farmers' needs and preferences. Since 1977, IRRI has been making efforts to improve communication among farmers, breeders, and extension workers so that men and women farmers' concerns and preferences are considered in plant breeding objectives. Participatory varietal selection (PVS) is a simple way for breeders and agronomists to learn which varieties perform well on-station and on-farm and to obtain feedback from the potential end users in the early phases of the breeding cycle. It is a means for social scientists to identify the varieties that most men and women farmers prefer, including the reasons for their preference and constraints to adoption. Based on IRRI's experience in collaboration with national agricultural research and extension system partners and farmers, PVS, which includes "researcher-

managed" and "farmer-managed" trials, is an effective strategy for accelerating the dissemination of stress-tolerant varieties. PVS has also been instrumental in the fast release of stress-tolerant varieties through the formal varietal release system. This guide on PVS will complement the various training programmes given by IRRI for plant breeders, agronomists, and extension workers engaged in rice varietal development and dissemination.

Participatory tools working with crops, varieties and seeds: A guide for professionals applying participatory approaches in agrobiodiversity management, crop improvement and seed sector development

Authors: Boef, W.S. de; Thijssen, M.H.

Outline to the guide Within our training programmes on local management of agrobiodiversity, participatory crop improvement and the support of local seed supply participatory tools get ample attention. Tools are dealt with theoretically, are practised in class situations, but are also applied in field study assignments. The objectives of practising participatory tools in training on local agrobiodiversity management and related to that the objectives of this guide are many. However, the current guide book has the following key objective being to provide professionals working in a genetic resources management, crop improvement and seed sector development context a kit with a diversity of tools developed for participatory learning and action that have been adapted to their specific context. In addition to this main goal, we aim to enhance those professionals creativity and flexibility in conducting group oriented, participatory learning and action types of diagnosis, research planning and implementation, and monitoring and evaluation with agrobiodiversity, plant breeding and seed projects. We used the handbook as developed by Frans Geilfus, which covers 80 tools for participatory development as an important base for this tools guide. A selection of tools from Geilfus and others have been adapted in a series of participatory instruments that can support agrobiodiversity management, crop improvement and seed sector development. The structure is basically derived from this book. The examples and selection of tools have been inspired on actual experiences during courses on participatory crop improvement, seed sector development, and local management of agrobiodiversity as organised by Wageningen International over the last 10 years. Some other tools are derived from other sources. The tools have been tested in local projects in various countries in South America (Brazil, Colombia, Ecuador, Peru and Venezuela), West Africa (Ghana, Nigeria, Cameroon and Côte dIvoire), Ethiopia, Nepal and India. The guide has been designed is such a way that it is easy to use as a reference in the field. The sequence of the tools is similar to that often used in participatory analysis, starting with general tools, moving to tools providing more details on specific topics, and going up to more analytical tools that can be applied with communities, but also can assist the facilitation team in analysing (after the diagnosis) the information gathered. However, which tools to apply, what type with whom, in what sequence, depends very much on the setting and the objectives of the exercise. Please, consider this no recipe book, but rather a kit with tools you can or may use. We consider the guide an inspiration to encourage you in adapting, merging and thereby designing your own tools.

Quantitative Analysis of Data from Participatory Methods in Plant Breeding

Editors: Mauricio R. Bellonand Jane Reeves

Although Participatory Plant Breeding (PPB) is gaining greater acceptance worldwide, the techniques needed to analyse the data from participatory methodologies in the context of plant breeding are still not well known or understood Scientists from different disciplines and cropping backgrounds, working in international research centres and universities, discussed and exchanged methods and ideas at a workshop on "The Quantitative Analysis of Data from Participatory methods in Plant Breeding". The papers in this volume address the three themes of the workshop: designing and analyzing joint experiments involving variety evaluation by farmers; identifying and analyzing farmers' evaluations of crop characteristics and varieties; and dealing with social heterogeneity and other research issues. Topics covered included different statistical methodologies for analyzing data from on-farm trials; the mother-baby trial system, which is designed to incorporate farmer participation into research; the identification and evaluation of maize landraces by small-scale farmers; and a PPB process that aims to address the difficulties of setting breeding goals and choosing parents in diversity research studies. Summaries of the discussion, as well as the participatory breeding work currently conducted by the participants, are provided.

Seed Production Techniques for Vegetables

Publisher: Centre for Indian Knowledge Systems (CIKS), Chennai; Publishing date : 2013

This manual is part of a series of booklets published by Centre for Indian Knowledge Systems (CIKS), the RRA Network's thematic node for seeds, to build the capacity of the Comprehensive Pilots as well as various field groups who are involved in the efforts to build community managed seed systems. This publication describes the procedures involved in the production of quality seeds of 15 vegetables.

Glossary

ANOVA – It is a statistical tool for partitioning the total variation among the treatments in an experiment due to various sources and for finding statistical significance of the outcome of the experiment.

Baby trial – The location specific 1 or 2 promising varieties identified among the tested varieties in mother trials are again evaluated in baby trials for validating their field performance by more number of farmers in comparison with their own varieties.

Biodiversity fair – Biodiversity fair is a participatory tool for raising public awareness on the value of conserving local landraces, bringing the farmers from different communities together to exhibit the range of landraces so that traditional systems of seed and knowledge transmission continue to conserve.

Check variety – The popular or standard variety against which the identified or developed new varieties are tested for their performance.

Community seed bank – These are community organisations involved in conservation and promotion of local varieties. Community Seed Banks provide farmers with free and easy access to seed of local varieties under the condition that a farmer returns twice the amount of seeds he or she borrowed.

Crop improvement/ Plant breeding – It is the art and science of changing the traits of plants/ crops in order to produce desired characteristics.

Cross pollination – When pollen is exchanged between different flowers from the same or different plants.

Cultivar – A plant variety that has been produced in cultivation by selective breeding. Cultivars are usually designated in the style Taxusbaccata 'Variegata'

Entries – Treatments or varieties under test in an experiment

Experimental design – These are statistical designs developed for testing accurately the treatment effects.

Farmer-preferred variety – The variety developed or identified through participatory crop improvement approach for a specific area.

Farmers Preference Analysis (FPA) –It is a participatory method in which the local farmers assess the varieties included in the mother trial and share their preferences, and observations and opinions about the varieties.

FGD – Focus group discussion is a rapid assessment and semi-structured data collection method in which a purposively selected set of participants gather to discuss issues and concerns based on a list of key themes the researcher/facilitator has earlier drawn up. It is a cost-effective technique for eliciting views and opinions of farmers—the clients of prospective innovations Seasonal calendars- A seasonal

calendar is a visual participatory research method of showing the distribution of seasonally varying phenomena (such as economic activities, resources, production activities, problems, illness/disease, migration, and natural. events/ phenomena) over time.

Fixed lines – The lines (varieties) selected from segregating populations, which are mostly homozygous, homogeneous, and stable.

Genetic purity – It is one of the criteria for determining the quality of the seeds where the crop raised from such seeds show uniformity in most of the traits.

Gene bank – Gene banks are a type of biorepository, which preserve genetic material. For plants, this could be by freezing cuttings from the plant, or stocking the seeds (e.g. in a seed bank). For animals, this is the freezing of sperm and eggs in zoological freezers until further need.

Growth parameters – The parameters related to plant growth performance such as maturity, plant height, colour, etc.

Informal Research and Development (IRD) – In IRD, the varieties selected through mother and baby trials are given to a large number of farmers for dissemination and further validation of their suitability to the location.

Isolation distance – The minimum distance suggested between two varieties of the same crop to avoid genetic contamination of the variety under seed production.

Key informant surveys – These are interviews with selected key individuals who have extensive experience in a certain community or specialized knowledge or skills on a particular topic (Box 1). One disadvantage here may be the possible biases of the individuals being interviewed. Thus, it is important to validate or ask probing questions that will verify the given information.

Matrix ranking – It is a tool to compare and characterise in qualitative and quantitative manner a range of varieties. It is used to compare local varieties, or to compare local varieties with introduced or tested varieties. It shows how farmers evaluate varieties. Matrix ranking is also helpful in comparing and evaluating other resources, issues and ideas.

Mother trial – It is on-farm experimental trial conducted for evaluating a set of promising varieties, which may comprise genetically improved lines or traditional cultivars or combination of both, under prevailing cultural practices followed by the participating farmer for the purpose of participatory varietal selection. The experimental design usually followed is un-replicated trial but it could also be replicated trial similar to the ones conducted on research farms.

Often cross pollinated varieties – In many self pollinating species, cross pollination may occur up to 5% or even reach to 30%; such species are referred as often cross pollinating species

Open pollinated varieties – Open-pollinated varieties are stable varieties resulting from the pollination between the same or genetically similar parents. Not hybrid.

Organoleptic test – The analysis of the properties of products and materials-mainly foodstuffs- by means of the sense organs.

Pairwise ranking –It is a tool to compare varieties and know how farmers evaluate varieties. During probing, it is important that the facilitators record the reasons for choosing a variety when comparing them.

Participatory crop improvement – Development and identification of suitable varieties through participation of farmers.

Physiological maturity – For most seed-producing crops, it is that stage of growth in which the plant has completed all of its development, including seeds which, when planted, can survive on their own. In non-seeding crops such as potatoes, it is the stage when all plant development has completed and the desirable part of the plant (in this case, the tuber) can be harvested.

PVS – Participatory varietal selection is a system for identifying location specific most suitable varieties for enhancing productivity as well as varietal diversity in a particular location. It involves evaluating performance of a set of varieties on farmers' fields by the local farmers, scientists and other stakeholders.

PVS cycle – It is the period in which farmers and scientists evaluate the base materials (potential varieties) for their suitability for a particular location together.

Quality seeds – The seeds showing expected levels of physiological viability, physical purity and genetic purity with optimum level of moisture content.

Released variety – Variety developed and evaluated by professional plant breeders in research organisations like agricultural universities and recommended for release by State or Central Variety Release Committee.

Replicated trial – It is an experimental design where particular treatment or variety is repeated more than once for reliability of its performance.

Roguing– Removal of off type plants of the same crop in the seed production plot in order to avoid mechanical and genetic contamination. Off-types should be removed before their flowering stage. Off-types should also be removed after harvest, during drying, processing and storage. Timely rouging is critical for the conservation of the genetic purity of the seeds.

Self pollination – When pollination takes place within a single flower, usually before it opens.

Semi-structured interview – It is a method of research used in the social sciences. While a structured interview has a rigorous set of questions, which does not allow one to divert, a semi-structured interview is open, allowing new ideas to be brought up during the interview as a result of what the interviewee says. This is a simple process of talking with individuals (men and women), families, or groups to discuss a specific topic in an informal setting, in which all present are encouraged to offer ideas and opinions.

Stay green character – The trait of crop varieties to remain green even after physiological maturity.

Synchronous maturity – Attainment of physiological maturity by the majority of the plants in the field at the same time.

Test variety – The identified or developed new variety, which is being tested for its superiority over the check variety.

Time line – It is a participatory research method and it involves a graphical representation of a period of time, on which important events are marked. Time lines visualize significant changes in key issues in the community over time. Topics for time lines often reflect themes that people consider important, for example, the number of times flooding/submergence occurred in the last 10 years.

Traits – Characters of plants determined by their genetic factors.

Traditional variety – Variety identified and cultivated by the local farmers over a long period. While most of the traditional varieties are well suited to the place of origin, some of them may show wider adaptability.

Unreplicated trial – It is an experimental design where particular treatment or variety is not repeated more than once. Such a research design is followed when replicated trials are not feasible for various reasons. Unreplicated trials are repeated many times within a geographical area in such a way that each trial is considered as a single replication.

Venn diagram – Venn diagramming is a process of listing, ranking, and connecting institutions, groups, or individuals to communication systems and information sources that influence development. This tool is also useful in identifying men's and women's access to productive resources and services.

Yield parameters – The parameters related to yield components like grain yield and straw yield per unit area and grain size.

About RESMISA Project

The action research project 'Revalorising Small millets in Rainfed Regions of South Asia (RESMISA)' was implemented to increase production and consumption of nutritious small millets and associated pulse and oilseed crops in rainfed regions of India, Nepal and Sri Lanka. 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 research sites included six in backward and tribal dominated pockets of Tamil Nadu, Andhra Pradesh, Odisha and Jharkhand states of India and one site each in Sri Lanka and Nepal. DHAN Foundation and Canadian Mennonite University anchored the project. In India, it was implemented by DHAN Foundation, in Sri Lanka by Arthacharya Foundation and in Nepal by LI-BIRD. The other Indian partners are Tamil Nadu Agriculture University, All India Coordinated Small Millets Improvement Project of ICAR and WASSAN. 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.

About Small Millet Foundation

Realizing the importance of small millets for addressing triple burden of malnutrition and the prevalence of non-communicable diseases such as diabetes and for ensuring health of the planet and the economy, DHAN Foundation has started working on small millets since 2011. It has led two South Asian consortium research projects on small millets in India, Nepal and Sri Lanka, supported by IDRC and Global Affairs Canada under Canadian International Food Security Research Fund (CIFSRF). These projects resulted in a set of technologies and working models developed on production, processing, value chain development and consumption of small millets. There is considerable need and scope for scaling up the learning across India. Towards this, DHAN Foundation has initiated an exclusive organisation, **Small Millet Foundation (SMF)** by 2018. More details on SMF can be seen at https://www.dhan.org/smallmilletfoundation/

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