

Enhancing the Resilience of Livelihoods of Small Millet Farmers through Participatory Varietal Selection in India

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Abstract

Small millets are nutritious but underutilised crops that are grown in heterogeneous rainfed environments ranging from hills to coastal agro-ecosystems in India. In the last two decades, these rainfed ecosystems are affected by various climate change related issues, important being change in the rainfall pattern. These changes vary from place to place. So there is need for high location specificity in varietal selection with the participation of farmers under each micro agro-ecosystem, instead of broad general recommendation domain made in large programmes. With this objective, Participatory Varietal Selection (PVS) was tried-in five sites in India under a research project 'Revalorising Small millets in Rainfed Regions of South Asia'. The methodology adopted comprised of situation analysis to identify farmers' needs in a cultivar, short listing of the traditional as well as released varieties likely to be suitable for the changed rainfall regimes, on-farm evaluation through mother and baby trials, and promotion of identified suitable varieties through community based channels.

In the two cycles of PVS trials, 60 traditional varieties, 45 released varieties and 12 pre-release varieties in four small millets viz finger millet (*Eleusine coracana*), little millet, (*Panicum sumatrense*), kodo millet (*Paspalum scrobiculatum*) and barnyard millet (*Echinochloa frumentacea*) were tested with the involvement of 578 men and 333 women farmers. Based on farmers' preferences and performance in the trials, 1 to 4 potential varieties were identified in each crop for each site. The results of these studies highlighted the importance of farmers' participation in the varietal selection process, as they used a combination of traits for varietal selection. It is expected that this study will demonstrate the importance of scaled up PVS for enhancing the resilience and will create a case for including potential traditional varieties for promotion under State funded crop support systems.

Keywords - Varietal diversity, Traditional varieties, Preference analysis, PVS, Small millets

Introduction

Small millets are nutritious but underutilised crops that are integral part of rainfed ecosystems in India. They are grown in marginal and heterogeneous rainfed environments ranging from hills to coastal agro-ecosystems. In the last two decades, these rainfed ecosystems are affected by various climate change related issues. The main issues faced by the small millet farmers are late onset of rainfall, changes in the dryspell pattern within the crop period and reduction in rainfall amount. These issues have led to repeated crop loss, increase of fallow lands, loss of livelihoods and out-migration. So it is essential to ensure effective adaptation of small millet farmers at micro level for climate change, to enhance the resilience of their livelihoods.

Presence of varietal diversity in crops in general is expected to aid the farmers to cope with the unexpected risks faced due to change in climate. But in the last two decades decline in inter and intra-species diversity among small millets is being observed in various degrees in India. So there is need for enhancing varietal diversity of small millets. Though climate change is happening everywhere, it affects each location differently and the local level impact also varies across the locations (ACEDRR, 2008). So there is need for varietal selection under each micro agro-ecosystem, with the participation of farmers to identify suitable varieties, instead of broad general recommendation domain made in large programmes. For this purpose the participatory varietal selection (PVS), a novel approach in selection of cultivars, was tried in the study. PVS was thought to be more appropriate (Yadavendra and Witcombe, 2007), as this approach is more rapid and cost-effective in identifying farmer-preferred cultivars, provided a suitable choice of cultivars exists.

This research was carried out as part of an action research project, 'Revalorising Small millets in Rainfed Regions of South Asia', aimed at enhancing the production and consumption of small millets, by using gender sensitive participatory approaches to address constraints related to the production, distribution and consumption. This project is supported under CIFSRR by IDRC and DFATD, Canada.

Materials and methods

This study was undertaken in five distinct agro-climatic regions of India during 2011-2012, covering four small millets viz. finger millet (*Eleusine coracana*), little millet, (*Panicum sumatrense*), kodo millet (*Paspalum scrobiculatum*) and barnyard millet (*Echinochloa frumentacea*). Finger millet is cultivated extensively in three project sites namely Anchetty (Tamil Nadu), Bero (Jharkhand) and Semiliguda (Odisha), while it is also grown on a smaller scale in Jawadhu Hills, another project site in Tamil Nadu. The main crop of the latter site is little millet, which is also an important crop in Semiliguda. Barnyard millet and kodo millet are grown at Peraiyur site. All the four crops are cultivated mainly under rainfed situations.

In this study a schematic approach with the following components was followed in the given sequence: 1) Understanding of varietal diversity in the sites, 2) PVS and 3) Establishing community based seed systems. The execution involved continual structured involvement and interaction of farming community and scientists through the course of the study. For understanding the status of varietal diversity, participatory methods like transect walk, biodiversity contest and focus group discussion were followed. The PVS method adopted included the following: 1) Situation analysis to identify farmers' needs in a cultivar, 2) A search for suitable materials to test with farmers, 3) Experimentation on its acceptability in farmers' fields and 4) Wider dissemination of farmer-preferred cultivars. Experimentation on acceptability of suitable materials in farmers' fields included mother trials, baby trials and informal research and development.

Based on the local farmers' needs in a cultivar and the input provided by the active researchers working on these crops, a set of promising varieties, comprising both traditional and released ones, were short listed for each crop in each relevant site. The short listed varieties were evaluated for their suitability in diverse farm situations prevalent in each site by conducting mother trials during 2011 and 2012 crop seasons on farmers' fields. The mother trials in each crop involved 8-10 promising varieties tested across the villages as un-replicated trials. However, replicated trials (RCBD) with same set of varieties, one in farmer's field and another in research institution, was also taken up during 2012. In mother trials, plot size for each variety was 40 sq.m and 12 sq.m in replicated trials. Crop in mother

trials were raised following farmers' practice in the site, like sowing seeds by broadcasting. Recommended agronomic practices like appropriate fertilizer doses and line sowing were adopted only in the replicated trials. Special care was taken for ensuring distribution of trials across the villages in the site and involvement of women in the trials. Data were collected on various plant growth and yield parameters, which were analysed using appropriate statistical procedure. In addition to quantitative assessment, farmers' preference analysis was also carried out, wherein both men and women farmers, assessed varietal performance in certain field trials as individuals and as groups. They individually selected the first three preferred varieties among the tested varieties and shared the reasons for the same. Individual score values of each variety (as 1st, 2nd and 3rd preference) were converted into weighted scores. The most suitable varieties of finger millet, little millet, barnyard millet and kodo millet were identified for each site based on the analysis of trials data and farmers' preferences. Such identified varieties were further tested in baby trials with more number of farmers in each site in the following years (2012 and 2013), for further confirmation of their suitability by evaluating in larger plot size (minimum of 200 sq.m) with farmers' variety as check. In baby trials, frequency analysis of positive and negative opinion of trial farmers along with the analysis of yield data was followed for identifying the suitable varieties. Varieties selected in baby trials in 2012 will be taken further for large scale trials during 2013. Seeds of most preferred varieties emerging from PVS will be mass multiplied for further promotion in the region, leading to enhanced varietal diversity of the four crops.

Results

Status of varietal diversity in project sites

Finger millet – Anchetty presented a different picture than other three sites in terms of high penetration of released varieties (Table 1). Most of the area under finger millet in Anchetty is covered by two released varieties (GPU 28 and INDAF 5). The local farmers here have been cultivating many released varieties such as HR 911, INDAF series and Sharadha, for over two decades. High degree of varietal diversity was observed in Semiliguda, with 19 traditional varieties. Most of the area under finger millet in Semiliguda, Bero and Jawadhu Hills were with few popular traditional varieties.

Table 1: Status of varietal diversity in small millets at the study sites

Project sites	No. of varieties present		Popular varieties	
	Traditional	Released	Number	Name
FINGER MILLET				
Anchetty	2	3	2	GPU 28 (R), INDAF 5 (R)
Bero	4	-	2	<i>Demba (T), Lohardagiya (T)</i>
Jawadhu Hills	2	-	1	<i>Muttan kelvaragu (T)</i>
Semiliguda	19	2	4	<i>Bati (T), Mati (T), Kalakarenga (T), Sunamani (T)</i>
LITTLE MILLET				
Jawadhu Hills	9	-	3	<i>Sittan (T), Karusittan (T), Vella samai (T)</i>
Semiliguda	8	2	1	<i>Bada saon (T)</i>
BARNYARD MILLET				
Peraiyur	3	-	1	<i>Sadai (T)</i>
KODO MILLET				
Peraiyur	4	-	1	<i>Siru varagu (T)</i>

R- Released variety; T- Traditional variety

Table 2: Status of hamlet level varietal diversity of small millets at the study sites

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

Source: Baseline survey, RESMISA project, 2011.

Little Millet – A large number of traditional varieties of little millet were observed Jawadhu Hills (9) as well as at Semiliguda (8). Out of them, only *Sittan*, *Karusittan* and *Vella samai* in Jawadhu Hills and *Bada saon* in Semiliguda are widely cultivated (Table 1).

Barnyard millet and Kodo millet – At Peraiyur site not much diversity was noticed either in barnyard millet or in kodo millet. Only traditional varieties were found to be under cultivation in each crop. Among them *Sadai* in barnyard millet and *Siru varagu* in kodo millet were more popular.

The results of the study indicated that though there was presence of many varieties in the sites, not more than two varieties covered majority of the area in each of the four crops studied. Further varietal diversity at hamlet level was very limited in all the sites (Table 2). This situation clearly indicated the need for increasing varietal diversity of small millets in the sites. As the baseline survey in the study sites indicated that more than 90% of the farmers have the practice of using farm saved seeds, the best strategy for enhancing varietal diversity is creating more options regarding the preferred varieties with the involvement of farmers, and popularising the same for reaching large number of farmers. For the same PVS was attempted in the sites.

Participatory varietal selection

In the two cycles of mother trials conducted in 2011 and 2012 and one cycle of baby trial conducted in 2012, 60 traditional varieties, 45 released varieties and 12 pre-release varieties of four small millet crops were tested across the five sites, with the involvement of 578 men and 333 women farmers. The results of mother and baby trials are presented in Table 3 and 4.

Finger millet – Among the 18 varieties (7 traditional, 9 released and 2 pre-release) included in mother trials in Anchetty, 4 varieties namely *Kempu*, *Halukuli*, GPU 66 and Sharadha were identified as the suitable varieties. The baby trials in 2012 validated the suitability of the first three varieties. In Anchetty, as mentioned earlier, farmers have already with them better performing varieties like GPU 28 and the need of the hour is having alternatives that perform *on par* with these varieties. *Kempu* and *Halukuli* met this expectation due to their yielding ability and were preferred by the farmers. Similarly the performance of Sharadha, an old released variety, was also *on par* with those of top yielders and as it is already being grown in certain pockets of the site, it was chosen for further promotion in other areas based on the farmers' preference. A pre-release variety, GPU 66, was preferred by the farmers due to its large panicle size.

At Bero, among the 10 varieties (4 traditional, 4 released and 2 pre-release) included in mother trials, 4 varieties namely A 404, GPU 28, GPU 66 and GPU 67 were identified as the suitable varieties. Baby trials in 2012 reconfirmed the suitability of the first two varieties. The varieties A 404 and GPU 28 were preferred for their high yielding ability and medium duration. While GPU 66 was preferred due to medium duration, tall plants with large semi-compact panicles, GPU 67 was preferred due to its short duration, synchronised maturity and non-lodging character. Besides, the popular traditional varieties *Lohardagiya* and *Demba*, expressed high yielding ability, which need to be exploited in crop improvement research further.

At Jawadhu Hills, among the 12 varieties (5 traditional, 5 released and 2 pre-release) included in mother trials, 4 varieties namely *Kempu*, *Ragalli sivalli*, GPU 28 and GPU 66 were identified as the suitable varieties. Considering the presence of just two traditional varieties of finger millet in the site, all the four farmers' preferred varieties were included for evaluation during 2013.

Table 3: Identification of promising varieties through PVS in small millets- 2011 & 2012

Project sites	Mother Trials		Baby Trials		No. of varieties included in mother trials			No. of varieties selected for further testing			
	No. of varieties	No. of trials	No. of varieties	No. of trials	Trad	Rele	Pre-R	Trad	Rele	Pre-R	Total
FINGER MILLET											
Anchetty											
- 2011	15	27	--	--	7	10	1	2	1	1	4
- 2012	10	14	3	34							
Bero											
- 2011	6	25	--		4	5	1		2	2	4
- 2012	9	24	2	44							
Jawadhu Hills											
- 2011	7	12	--	--	5	6	1	2	1	1	4
- 2012	10	24	--	--							
Semiliguda											
- 2011	21	16	--	--	18	6	1		1	2	3
- 2012	10	21	2	67							
LITTLE MILLET											
Jawadhu Hills											
- 2011	8	33	--	--	8	5		2	1		3
- 2012	9	22	2	35							
Semiliguda											
- 2011	8	16	--	--	5	5		1			1
- 2012	10	22	--	--							
BARNYARD MILLET											
Peraiyur											
- 2011	19	16	--	--	8	9		3	1		4
- 2012	10	18	3	64							
KODO MILLET											
Peraiyur											
- 2011	4	5	--	--	5	3	4	1		1	2
- 2012	10	14	--	--							

Trad- Traditional variety; Rele- Released Variety; Pre-R- Pre release variety

At Semiliguda, among the 25 varieties of finger millet (18 traditional, 5 released and 2 pre-release) included in mother trials, 4 varieties namely Bhairabi, Chilika, GPU 66 and GPU 67 were identified as the suitable varieties. Baby trials in 2012 validated the suitability of the Bhairabi and not Chilika. The variety Bhairabi was preferred due to its traits namely high yield, medium duration, non-lodging, ease in threshing and bold grains. The variety GPU 66 was preferred due to its bigger panicle size and high yield while GPU 67 was preferred due to its non-lodging nature and uniform maturity. The variety Chilika was not preferred by majority of the farmers in 2012 due to its traits namely grain loss from finger breakage during harvest, poor threshability and small grains. *Kalakarenga* and *Mati*, the two popular traditional varieties, expressed high yielding ability and could be useful in further varietal improvement.

Little millet – At Jawadhu Hills, of the 13 varieties (8 traditional and 5 released) included in mother trials, 3 varieties namely CO 4, *Koluthana* and *Perungolai* were identified as the suitable varieties. Baby trials in 2012 reconfirmed the suitability of CO 4 and other two will be tested in 2013. The variety CO 4 was preferred because of its tallness (more fodder yield) and *Koluthana* for its semi-compact panicles. *Perungolai* was selected because of its large semi-compact panicles and tall stature. The popular local cultivars, *Sittan* and *Karusittan*, expressed high yielding ability and less grain shattering at maturity, which could be exploited in breeding research.

At Semiliguda, among the 10 varieties (5 traditional and 5 released) included in mother trials, *Kala saon* was identified as the suitable variety. In farmers' preference analysis, *Bada saon* was the most preferred variety due to high yielding ability, suitability for sloppy lands and ease in harvesting and threshing. It could be exploited for further varietal improvement.

Table 4: Performance of promising small millets varieties in baby trials, 2012

Project sites	Test variety	Local check varieties	Number of trials	Average grain yield (Kg/ac)		No. of trials with yield over the check	
				Test variety	Check variety	Increase	Decrease
FINGER MILLET							
Anchetty	GPU 66	INDAF 5, GPU 28	12	1028	1012	7	5
	<i>Kempu</i>		10	768	756	4	6
	<i>Halukuli</i>		10	876	896	5	5
Bero	A 404	<i>Demba, Lohardagiya, Hybrid, Dudarice</i>	19	1156	952	10	1
	GPU 28		18	736	610	11	5
Semiliguda	Bhairabi	<i>Bodi, Bada, Dinda, Badu, Dasrabodi, Sana, Bada, Bodel</i>	30	784	744	19	11
	Chilika		19	856	752	16	3
LITTLE MILLET							
Jawadhu Hills	CO 4	<i>Sittan, Siruvellai, Siru samai, IR 8</i>	19	337	360	10	9
BARNYARD MILLET							
Peraiyur	CO 2	<i>Sadai</i>	15	1040	992	12	3
	<i>Mallankinaru</i>		16	1196	1104	15	1
	<i>Mallankinaru 1</i>		16	1148	1076	12	3

Barnyard millet – At Peraiyur, of the 17 varieties (8 traditional and 9 released) included in mother trials, 4 varieties namely CO 2, *Mallankinaru*, *Mallankinaru1* and *Aruppukottai* were identified as the suitable varieties. Baby trials in 2012 reconfirmed the suitability of first three varieties. The local popular variety, *Sadai* expressed high yielding ability, which needs to be exploited for further varietal improvement.

Kodo millet– At Peraiyur, among the 12 varieties (5 traditional, 3 released and 4 pre-release) included in mother trials, 2 varieties namely *Uppu varagu* and TNAU 111 were identified as the suitable varieties. While *Uppu varagu* was the highest yielder, TNAU-111 was preferred by the farmers for its bold grain in addition to good yielding ability. *Siru varagu*, the local popular variety, expressed high yielding ability, which needs to be exploited for further varietal improvement.

Discussion

The present study indicated that participatory varietal selection is a robust and efficient approach to identify additional suitable varieties within a short period. One to four varieties were identified for each crop in each of the five sites in two PVS cycles. Joshi et al (1997) also reported that the PVS approach provided farmers with the benefits of new genetic materials five to six years in advance of the formal system and with minimum effort. The utility of PVS approach in understanding farmers criteria for selecting variety and analysing reasons for non-adoption of released variety in finger millet has been reported by Gowda *et al* (2000).

Though yield appeared to be the main criteria for assessing the superiority of a variety, the trial farmers also took into consideration of several other traits/ dimensions before preferring a variety. Presence of varietal trials on their own fields provided every trial farmer an opportunity to closely observe the performance of each variety. In addition to high yielding ability (high tillering, bigger panicle size & bold grains), crop duration, non-shattering of grains at maturity, non-lodging, uniform maturity, and good fodder yield were also considered. Women farmers, in particular, were more concerned with grain quality traits, such as colour, taste, grain hardness and keeping quality. The results also revealed that some of the popular traditional varieties from the nearby area were suitable, indicating such possibility of introducing varieties from neighbouring areas. Such varieties have the advantage of being evolved in similar ecology and hence show good adaptation. PVS also brought immediate benefits to the target farmers in having access to large number of potential varieties and they have already with them the seeds of promising varieties identified by them. Further the study indicated the need for local community organisations to locate these participatory research efforts and to give continuity.

The impact of PVS largely depends on the adoption of identified varieties by the local farmers in the study sites. Some of the possible next steps to build on the efforts so far made include: 1) Initiation of decentralised system of quality seed production and distribution at community level in each site, to promote both the existing as well as the newly identified suitable varieties on a sustainable basis¹. 2) Purification of potential traditional varieties and promoting proper seed selection among farmers in order to preserve their identity. 3) Conservation of vanishing varieties through relevant grassroots level institutions and

¹ See Walker, 2006 on need for such decentralized seed system.

custodian farmers. 4) Participatory plant breeding to fully exploit the high genetic potential of traditional varieties.²

The project has demonstrated the effectiveness of scaled up PVS for enhancing the resilience of small millet farmers. Some of the policy suggestions that emerge from this study are: 1) PVS to be used by national agricultural research systems for refining their districtwise recommendation of varieties, particularly where specific adaptation to agro-ecosystem is required like Eastern Ghats and where quality parameters plays important role in varietal selection. 2) Role of local community organisations in varietal improvement need to be recognized and they need to be given State support for establishing community-based seed systems, that effectively integrate on-farm conservation, varietal improvement and varietal distribution.³ 3) Popular traditional varieties need to be included in the formal public seed system for production and distribution and also in other State funded crop support systems. 4) Farmers' rights related to these varieties need to be recognised and secured through various ways, including geographical indication.

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² See Ceccarelli and Grando, 2007 for more on need for participatory plant breeding.

³ See Joshi et al, 1997 and Joshi and Witcombe, 1996 for institutionalisation of PVS approach and involvement of relevant grassroots level institutions for improving varietal evaluation system.

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