Farmers’ participatory breeding for upland rice in eastern India

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Abstract

Lack of access to new, high-yielding rice varieties, and to information about new varieties, are major constraints for resource-poor farmers in eastern India. There is no effective local seed system, and new varieties have not been adopted because of their lack of early vigour, short stature and poor response to low-impact management. Although local cultivars can survive the poor environmental conditions, they do not produce high yields. Traditional breeding approaches have been ineffective in producing modern, high-yielding varieties that can withstand growing conditions under local management practices. A participatory breeding project begun in 1997 aimed to get farmers involved in testing new varieties on their own fields along with traditional cultivars. Results were outstanding. Farmers consistently selected more successful varieties than breeders, and were able to select superior progenies from the segregating generation. The project showed that participatory varietal selection (PVS) and participatory plant breeding (PPB) are excellent ways of helping breeders to understand the problems facing farmers, and allow the farmers to take an active part in driving their farming practices forward.

Introduction

Most upland rice farmers, particularly in eastern India, are resource-poor and are not able to use purchased inputs. Improved varieties developed for rainfed uplands have not been fully adopted by farmers. The local cultivars have the desirable characters to withstand unfavourable growing conditions but they yield less than a tonne per hectare. Traditional breeding approaches for developing improved rice varieties have not been very effective. By the time on-farm trials are conducted, the majority of the genotypes that might have appeared promising from the farmers’ point of view have usually been discarded. Farmers prefer varieties that will perform well under multiple cropping and integrated farming situations. They are also looking for varieties that might provide products and by-products for household needs other than food.

Past experience clearly shows how breeders have failed to adequately address the problems of upland ecosystems. Variety adoption has been meagre and spread has been slow and restricted. The impact of modern varieties was poor mainly due to their shorter stature, lack of early vigour and poor responsiveness to low-input management. Farmers are not in favour of taking risks in unpredictable environments. On-farm research with farmers’ participation aims at involving farmers in selecting and testing new varieties along with existing traditional types under their own management practices. A participatory breeding project was started in 1997 with this objective, under the Indian Council of Agricultural Research (ICAR) – International Rice Research Institute (IRRI) collaborative programme. The project has two major components – plant breeding and social science. The breeding component consisted of two distinct parts:

- Participatory varietal selection (PVS), where existing cultivars or fixed breeding lines were exposed to selection by farmers (Witcombe et al., 1996)
- Participatory plant breeding (PPB), in which farmers were involved in selecting lines from segregating populations.

Materials and methods

Site selection

Three villages in Hazaribag District were selected for this project on the basis of their representation of the environments targeted in the breeding work, diversity and range of ecological conditions, involvement of women in farm activities, availability of previous survey
Farmer selection

Ten farmers from each village were selected, based on their primary occupation being rice farming, especially upland rice, ownership of the operational land holding, and some degree of literacy. With a few exceptions most of the farmers selected in the first year continued to participate until the third year.

Participatory varietal selection (PVS)

The PVS trials were conducted for 3 consecutive years during 1997–99, with 15–16 upland rice genotypes (including the local check, Brown Gora). In the first year, the trial was conducted in farmers’ fields in three villages, one set managed by farmers and another set managed by breeders in adjacent blocks. Breeders also conducted the same trial at the research station. From the second year the trial was conducted in all three villages under farmer management, except for the seeding, and at the research station by breeders. Most of the test entries of the PVS trial were continued for 3 years. A few entries ranked as very poor by both farmers and breeders were replaced with new ones in the second and third years of testing. The trials were unreplicated complete-block designs (CBD) in farmers’ fields and replicated randomised complete-block designs (RCBD) at stations. The participating farmers of a given village and the breeders evaluated all the trials conducted in that village and also at the research station. The genotypes were ranked at two phenological stages (vegetative and reproductive) as ‘most-liked’ to ‘least-liked’, on the basis of their selection criteria. In addition, breeders also recorded duration, height, yield and yield components, and reaction to diseases and pests in all the trials. To compare the ranks given by farmers and breeders, the Kendall coefficient of concordance (W) was used as described in Siegel (1956). Farmers’ and breeders’ rankings were compared following the Spearman rank coefficient of correlation. Details about the methodology used can be found in Courtois et al. (2001).

Participatory plant breeding (PPB)

PPB started one year after PVS, after farmers were given some basic training on the objectives and methodology of single plant/line selection in a segregating population. One hundred segregating lines from 12 crosses in the F5 generation were grown at one on-farm site (Khorahar) and at the research station. Lines were scored by farmers and breeders at both sites at different crop stages. At maturity, single-plant selections were made separately by farmers and breeders at both sites. The plants selected by farmers and breeders on-station and at Khorahar were grown in separate blocks in the same field in their respective sites in the 1999 wet season. The farmers and breeders continued their selection on the respective materials and sites and, during the 2000 wet season, four sets of final (bulk) selections were made, i.e., breeders’ and farmers’ selections on-station, and breeders’ and farmers’ selections on-farm. These four sets were pooled, along with three checks (Brown Gora, Kalinga III, and Vandana) and evaluated both on-farm and on-station during the 2001 wet season in an alpha-lattice design with two replications. Analysis of the PPB trial data was conducted using a mixed model, with selector and selection environments taken as fixed, and lines within selection environment x selector combinations considered random. The analysis was conducted with the REML algorithm of SAS PROC MIXED.

Results

PVS trials

The coefficient of concordance among farmers was highly significant in all the trials conducted in all 3 years. This indicated that farmers’ rankings were not randomly attributed and that there was a good agreement among them. The concordance among breeders’ rankings was also high but often not significant because of the smaller number of breeders. The rank correlation between farmers’ and breeders’ average rankings was highly significant except in a few cases (1997 on-farm results and on-station in 1999). This indicated a good agreement between farmers and breeders in varietal choice. The farmers’ or breeders’ rankings at maturity were not always highly correlated with yield, especially the farmers’ ranking in low-yielding trials. This may be because farmers consider criteria other than grain yield while selecting varieties for their farms. It may also be because ranking was undertaken before harvest.

There was no correlation between farmers’ and breeders’ rankings and duration or plant height, with a few exceptions. The variance component analysis for the on-farm trials showed that there were large and significant differences among cultivars in grain yield under farmer management. The grain yield data averaged over the four on-farm sites and 3 years showed that one elite line (RR 348-5) significantly outyielded Vandana, and produced about 100% more grain than Brown Gora (Table 1).

No variety x location or variety x year interaction was detected (Table 2). The three-way interaction, variety x location x year, was large, but cannot be separated from the within-trial error in this analysis, as the trials were unreplicated. This result does not support the hypothesis that varieties exhibit specific adaptation to particular sub-environments within the target region of the research station. The repeatability or broad-sense heritability of different on-farm and on-station trials
were estimated to judge the precision of the trial. It was found that the repeatability of on-station trials was poor, compared to on-farm trials. This may be because of the low yield of the on-station trials, where continuously grown upland rice results in poor soil fertility.

The regression of on-farm performance on on-station performance was non-significant. This means that on-station testing is not able to predict the on-farm performance of the genotype, and there is a need to integrate on-farm testing at an early stage of the breeding programme. At the end of 3 years of PVS trials farmers selected five varieties: RR 354-1, RR 347-166, RR 151-3, RR 166-645 and RR 51-1 using their own selection criteria. The highest-yielding line, RR 348-5, was not selected by the farmers. Farmers do not consider yield the only important trait.

RR 166-645 was preferred for its long, slender grains. RR 51-1 appealed to the farmers for its dark green leaves and high tillering ability. Farmers preferred tall varieties as they need fodder for their cattle. Farmers’ perception on cooking quality was that RR 354-1 and RR 347-166 were better than their local variety or even Vandana.

During the 2000 wet season, seeds of these varieties were given to farmers in two villages to grow in their fields along with the check (Brown Gora). In spite of severe drought, RR 347-166, RR 151-3 and RR 354-1 performed better than the farmers’ variety in most of the farmers’ fields. However, RR 51-1 failed as it was found to be susceptible to drought. Drought tolerance was not taken into account by farmers, as the last 3 years were almost favourable. Now we need to improve this otherwise good genotype for drought tolerance.

Mother and Baby trials (see Appendix) were started during the 2001 wet season. The analysis of Mother trial data at three on-farm sites showed that there were large and significant differences among cultivars in grain yield under farmer management (Table 3). The on-station data are not included in the ANOVA because there were large differences between on-station and on-farm performance. There was no significant cultivar x location interaction (Table 4). This implies that there was no rank change in varietal performance within this sub-environment.

Averaged over the three sites, RR 347-1, RR 354-1, and RR 347-166 significantly outyielded Vandana (Table 3). These lines also performed well during 1999–2001.

### Table 1. Mean grain yield (t ha⁻¹) of upland cultivars and breeding lines evaluated under farmer management in four villages near Hazaribag, Jharkand, over four wet seasons

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Number of trials</th>
<th>Mean¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brown Gora</td>
<td>12</td>
<td>1.12</td>
</tr>
<tr>
<td>Vandana</td>
<td>11</td>
<td>1.74</td>
</tr>
<tr>
<td>RR 347-166</td>
<td>12</td>
<td>1.92</td>
</tr>
<tr>
<td>RR 348-5</td>
<td>12</td>
<td>2.25</td>
</tr>
<tr>
<td>RR 151-4</td>
<td>9</td>
<td>1.11</td>
</tr>
<tr>
<td>RR 203-16</td>
<td>9</td>
<td>1.47</td>
</tr>
<tr>
<td>RR 354-1</td>
<td>12</td>
<td>2.12</td>
</tr>
<tr>
<td>RR 51-1</td>
<td>12</td>
<td>1.78</td>
</tr>
<tr>
<td>RR 151-3</td>
<td>12</td>
<td>1.68</td>
</tr>
<tr>
<td>RR 166-645</td>
<td>12</td>
<td>1.49</td>
</tr>
<tr>
<td>RR 50-5</td>
<td>9</td>
<td>1.63</td>
</tr>
<tr>
<td>RR 139-1</td>
<td>12</td>
<td>1.25</td>
</tr>
</tbody>
</table>

LSDₜ₀ for means over nine trials 0.47

1. Over years and locations

### Table 2. Variance components for cultivars evaluated under farmer management in four villages near Hazaribag, Jharkand, over four wet seasons

<table>
<thead>
<tr>
<th>Source</th>
<th>Variance component</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultivar</td>
<td>0.077</td>
</tr>
<tr>
<td>Cultivar x location</td>
<td>0</td>
</tr>
<tr>
<td>Cultivar x year</td>
<td>0</td>
</tr>
<tr>
<td>Cultivar x location x year</td>
<td>0.246</td>
</tr>
</tbody>
</table>

### Table 3. Mean grain yield (t ha⁻¹) of upland cultivars and breeding lines evaluated under farmer management in three villages and on-station in Hazaribag, Jharkhand, wet season 2001

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Chichi</th>
<th>Khorahar</th>
<th>Peto</th>
<th>Mean¹</th>
<th>CRURRS²</th>
</tr>
</thead>
<tbody>
<tr>
<td>RR 354-1</td>
<td>1.32</td>
<td>1.47</td>
<td>1.70</td>
<td>1.49</td>
<td>2.67</td>
</tr>
<tr>
<td>RR 347-1</td>
<td>1.46</td>
<td>1.53</td>
<td>1.30</td>
<td>1.43</td>
<td>2.92</td>
</tr>
<tr>
<td>RR 347-166</td>
<td>1.61</td>
<td>1.55</td>
<td>1.10</td>
<td>1.42</td>
<td>3.25</td>
</tr>
<tr>
<td>RR 348-5</td>
<td>0.74</td>
<td>1.65</td>
<td>1.50</td>
<td>1.30</td>
<td>2.78</td>
</tr>
<tr>
<td>RR 345-2</td>
<td>1.47</td>
<td>1.38</td>
<td>1.00</td>
<td>1.29</td>
<td>2.30</td>
</tr>
<tr>
<td>Kalinga III</td>
<td>1.13</td>
<td>1.30</td>
<td>0.80</td>
<td>1.08</td>
<td>1.83</td>
</tr>
<tr>
<td>RR 361-1</td>
<td>1.03</td>
<td>1.28</td>
<td>0.90</td>
<td>1.07</td>
<td>2.35</td>
</tr>
<tr>
<td>CR 876-6</td>
<td>1.29</td>
<td>1.20</td>
<td>0.70</td>
<td>1.06</td>
<td>1.95</td>
</tr>
<tr>
<td>RR 51-1</td>
<td>1.44</td>
<td>0.87</td>
<td>0.80</td>
<td>1.04</td>
<td>2.67</td>
</tr>
<tr>
<td>Brown Gora</td>
<td>1.26</td>
<td>1.22</td>
<td>0.60</td>
<td>1.03</td>
<td>1.85</td>
</tr>
<tr>
<td>RR 151-3</td>
<td>1.09</td>
<td>1.10</td>
<td>0.50</td>
<td>0.90</td>
<td>2.10</td>
</tr>
<tr>
<td>Vandana</td>
<td>1.01</td>
<td>0.95</td>
<td>0.70</td>
<td>0.89</td>
<td>2.43</td>
</tr>
<tr>
<td>RR 166-645</td>
<td>1.24</td>
<td>0.87</td>
<td>0.40</td>
<td>0.84</td>
<td>2.25</td>
</tr>
<tr>
<td>RR 363-737</td>
<td>0.90</td>
<td>0.92</td>
<td>0.60</td>
<td>0.81</td>
<td>2.38</td>
</tr>
<tr>
<td>RR 139-1</td>
<td>0.55</td>
<td>1.32</td>
<td>0.35</td>
<td>0.74</td>
<td>1.87</td>
</tr>
<tr>
<td>RR 361-783</td>
<td>0.51</td>
<td>0.90</td>
<td>0.33</td>
<td>0.58</td>
<td>1.15</td>
</tr>
<tr>
<td>LSDₜ₀</td>
<td>0.70</td>
<td>0.70</td>
<td>0.70</td>
<td>0.42</td>
<td>0.76</td>
</tr>
</tbody>
</table>

1. Over years and locations

### Table 4. Combined analysis of variance for cultivars evaluated under farmer management in three villages near Hazaribag, Jharkand, wet season 2001

<table>
<thead>
<tr>
<th>Source</th>
<th>MS</th>
<th>F</th>
<th>Pr&gt;F</th>
<th>Variance component</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultivar</td>
<td>0.64</td>
<td>3.43</td>
<td>0.002</td>
<td>0.05</td>
</tr>
<tr>
<td>Cultivar x location</td>
<td>0.19</td>
<td>1.49</td>
<td>0.077</td>
<td>0.02</td>
</tr>
<tr>
<td>Residual</td>
<td>0.13</td>
<td></td>
<td></td>
<td>0.13</td>
</tr>
</tbody>
</table>
2000. They yielded about 40% more than Brown Gora and about 30% more than Kalinga III in 2001, and consistently outperformed these lines in previous years. They should be evaluated in large-scale PVS trials. Variance component analysis was conducted to estimate the precision of on-farm trials through estimation of repeatability or broad-sense heritability. The broad-sense heritability of grain yield measured in the on-farm trials was relatively high, as it was in previous years. The results showed that evaluation of genotypes at three sites, with three replicates per site, would give adequate precision for the detection of cultivar differences (Table 5).

In Baby trials, three varieties were given to each farmer to grow along with the local variety. Farmers’ perceptions for different varieties were recorded. At Chichi, two farmers preferred RR 354-1, and one farmer each preferred RR 347-1, RR 363-737, Vandana and Kalinga III. In most of the trials severe weed infestation was the reason given by farmers for failure of the trials. In a few cases drought damaged the crop at key phenological stages.

**PPB**

Farmers concentrated on fewer crosses than breeders. They rejected crosses that did not produce plants that fit their criteria. In general, farmers preferred breeding lines with tall stature, high tillering and long panicles. Plants generated from certain crosses (VHC 1253 x Sathi 34–36, N 22 x RR 20–5, Annada x RR 151–3 and RR 139–1 x IR 57893–08) were preferred by both farmers and breeders.

The results indicate that on average, farmer selections significantly outperformed breeder’s selections, and that selection on-station was superior to selection on-farm (Table 6). Farmers’ selections yielded almost twice as much as breeders’ selections (Table 7). Of the five highest-yielding lines, four were selected by farmers on the research station (Table 8). They were also found superior to check varieties.

### Table 5. Predicted broad-sense heritability (H) of grain yield for cultivars evaluated under farmer management in three villages near Hazaribag, Jharkand, wet season 2001

<table>
<thead>
<tr>
<th>Sites</th>
<th>Replicates</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>0.23</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td>0.44</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>0.50</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>0.70</td>
</tr>
</tbody>
</table>

### Table 6. F-tests for effects of selection by farmers versus breeders and selection on-farm versus on-station on the grain yield of selected lines evaluated under farmer management at Khorahar, Jharkand, 2001

<table>
<thead>
<tr>
<th>Source</th>
<th>F</th>
<th>P&lt;.05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selector (farmer vs breeder)</td>
<td>16.6</td>
<td>0.0002</td>
</tr>
<tr>
<td>Selection environment</td>
<td>20.4</td>
<td>0.0001</td>
</tr>
<tr>
<td>(station vs farm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Selector x selection environment</td>
<td>5.5</td>
<td>0.0246</td>
</tr>
</tbody>
</table>

1. F-tests of main effects of selector and selection environment were significant (P< F 0.0002 and 0.0001), respectively

### Table 7. Effect of selection by farmers versus breeders and selection on-farm versus on-station on the grain yield (g plot-1) of selected lines evaluated under farmer management at Khorahar, Jharkand, 2001

<table>
<thead>
<tr>
<th>Selection environment</th>
<th>Selector</th>
<th>Breeder</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-farm</td>
<td>243</td>
<td>162</td>
<td>202</td>
</tr>
<tr>
<td>On-station</td>
<td>566</td>
<td>264</td>
<td>415</td>
</tr>
<tr>
<td>Mean</td>
<td>405</td>
<td>213</td>
<td></td>
</tr>
</tbody>
</table>

### Table 8. Means and selection history of the checks and five highest-yielding lines

<table>
<thead>
<tr>
<th>Line</th>
<th>Selection history</th>
<th>Grain yield (g plot-1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RR 356-77</td>
<td>Farmer-selected on-station</td>
<td>831</td>
</tr>
<tr>
<td>RR 356-72</td>
<td>Farmer-selected on-station</td>
<td>825</td>
</tr>
<tr>
<td>RR 356-74</td>
<td>Farmer-selected on-station</td>
<td>769</td>
</tr>
<tr>
<td>RR 356-71</td>
<td>Farmer-selected on-station</td>
<td>569</td>
</tr>
<tr>
<td>RR 356-51</td>
<td>Breeder-selected on-station</td>
<td>519</td>
</tr>
<tr>
<td>Kalinga III</td>
<td></td>
<td>413</td>
</tr>
<tr>
<td>Vandana</td>
<td></td>
<td>413</td>
</tr>
<tr>
<td>Brown Gora</td>
<td></td>
<td>256</td>
</tr>
<tr>
<td>LSD&lt;sub&gt;0.05&lt;/sub&gt;</td>
<td></td>
<td>412</td>
</tr>
</tbody>
</table>

**Discussion**

Farmer agreement on ranking varieties was highly significant, although there were differences in opinion. The relatively high agreement contradicted our initial assumption that farmers’ preference would vary because of the diversity in their socioeconomic backgrounds. This may be due to the limited number of farmers involved in the project, or to the low diversity in wealth, caste, ethnicity etc. The high agreement among breeders indicated similarity in selection. The agreement between farmers and breeders was good in most of the cases. Participation brings little improvement when there is close agreement between farmers and breeders.

The degree of agreement is highly influenced by the materials used for the selection. For example, in the uplands of eastern India, the variety has to be tall and mature within 100 days. Less variability within the tested genotype perhaps influenced the farmers’ and breeders’ preference for variety or traits. The rankings of farmers
and breeders were correlated with yield in only a few cases, as farmers also consider other factors in their decision. Though duration and stature had little association with yield, these are important characters in varietal choice. Again, because of the low variability in the tested material, these were not identified as important. Therefore, ranking of varieties must be combined with survey data about farmers’ selection criteria to get the actual information (Courtois et al., 2001).

The results of 3 years of on-farm testing indicated that the varieties tended to rank similarly across farms. Therefore, the $G \times E$ was not a significant factor influencing varietal performance. This indicated that an on-station breeding programme can serve a purpose in the targeted region. But the precision of on-farm trials was as high as that of on-station trials, and 3 years of on-station trials failed to predict the on-farm performance. This clearly indicates that PVS should be integrated at an early stage of testing for better prediction of varietal performance.

Farmers’ intentions of voluntarily testing the new varieties in their own fields indicated that access to the new varieties or information is the major constraint, as the local seed system is not very effective. Out of five varieties they tested during the 2000 wet season two did not perform well and were rejected by farmers. At an early stage farmers may adopt more varieties, but some will later be dropped, as the farmers test them over a number of years. Once the variety is adopted by farmers it can be spread from farmer to farmer, because the farmers from the neighbouring villages also took seeds from the adopting village (Joshi et al., 2001).

In PPB, where both farmers and breeders made selections from the segregating population, farmers selected progenies from fewer crosses. Farmers immediately rejected the crosses that did not produce progenies according to their criteria. Knowing the background of the crosses, perhaps breeders were expecting desirable segregants in the later generation.

The significant superiority of farmers’ selection over breeders’ selection was quite unexpected. It has established that farmers are able to identify high-yielding entries (Ceccarelli et al., 2001). The better performance of on-station selection over on-farm selection indicated that selection at the research station can be useful in the target region. This may be due to the low, but consistent, yield of the research station. Of course, we need to confirm this result on a larger scale in the next season.

### Conclusion

The PVS programme has given the breeders a systematic way to approach the farmers. The interaction with farmers and social scientists involved in the project helped breeders and farmers develop a better understanding of the complexity of the problem. As the local seed system is non-functioning, access to new varieties or information about new technology seemed to be major constraints. Proper allocation of resources for varietal testing is needed, as on-station evaluation alone cannot predict the performance of the cultivar in the target region.

The PPB work has given very interesting results. Although it is very early in the testing stage, it appears that farmers can manage a segregating population and were able to select superior progenies from the segregating generation. This indicates that it is possible to expose breeding materials to farmers at an early stage.

### References


Joshi KD, Sthapit BR, Witcombe JR (2001) How narrowly adapted are the products of decentralized breeding? The spread of rice varieties from a participatory plant breeding programme in Nepal. Euphytica 122: 3, 589–597


Participatory varietal selection: Lessons learned from the Lao upland programme

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Abstract

Several thousand traditional upland rice varieties have been collected in Laos. Between 1992 and 2000, approximately 2000 of these were evaluated for grain yield and other agronomic characteristics in researcher-managed trials in northern Laos, in an effort to identify high-yielding traditional varieties for dissemination to upland farmers. A few of the tested varieties were given to farmers to evaluate in collaboration with district extension officers before 2001, but data were returned from only 6% of the on-farm trials. In 2001, a new participatory varietal selection (PVS) programme was designed and implemented to obtain information about farmer preference and on-farm performance of the upland varieties, and to increase the efficiency of the screening effort. In the first stage, on-farm PVS was conducted with 32 farmers in five provinces. Farmers evaluated eight short- or eight medium-duration varieties selected by researchers in the earlier agronomic testing programme. Preference data were successfully obtained from 84% of the farms and yield data from 63%, a 10-fold increase in the on-farm trial success rate over the previous programme. Farmers strongly preferred early-maturing, large-seeded varieties with large panicles and strong stems, and disliked varieties with few tillers or tillers that ripened non-uniformly. These criteria will be incorporated into the initial stages of varietal screening in the future. The correlation between variety means over farms for grain yield and preference rating was 0.82 in the medium-maturity trial and 0.54 in the early trial. Occasionally, high-yielding cultivars were not preferred, but the lowest-yielding cultivars were never preferred, indicating that agronomic selection for grain yield helps to select varieties farmers prefer. A farmer-preferred, early-maturing variety (Nok) that significantly outyielded the local checks was identified. This and five other lines are being evaluated in a scaled-up PVS programme in 2002.

Introduction

Between 1992 and 2000 more than 13,000 traditional rice samples (representing over 3000 different varieties) were collected from Laos. More than 7,300 of these samples were upland rice varieties. Using this collection, a system was set up to identify superior varieties for wide release. While germplasm from breeding programmes is also evaluated, the focus is on the traditional varieties. The rationale behind this is that the Lao prefer glutinous rice and there are relatively few improved glutinous varieties.

The process of evaluation involves four steps. The Huay Khot Research Station in Luang Prabang province annually receives a new set of 300 accessions from the Lao genebank, that are evaluated on-station in an observational nursery (OBN 1). From this, 20–30% of the varieties are selected for a second observation nursery (OBN 2). A limited number of varieties (8–16) are selected from the OBN 2 for multilocational yield trials (MLYT). Variety evaluation in these first three stages is based primarily on yield and duration (preference for early-maturing varieties). Varieties selected from these MLYTs are then evaluated on-farm. Between 1992 and 2000, over 2000 varieties were evaluated through this system and 27 were selected for on-farm evaluation. For on-farm evaluation, varieties (typically 60 g of each variety per farmer) were sent to district officers, who identified cooperating farmers. The success rate in this final stage was poor. Between 1994 and 2000, 235 farmers were involved in on-farm evaluation. However, data were only collected from 15 farmers (6%). As of 2001, there were no varieties that could be recommended for the uplands, due mainly to limited data on farmer preference and performance under farmer management.
In initiating a participatory varietal selection (PVS) programme there were two broad objectives. Firstly, there was a need to accelerate the evaluation of upland material. Continuing at the current rate (about 300 varieties entering the evaluation process each year), it will take over 20 years to evaluate all the upland varieties. Identifying and using farmer-preferred characteristics, it is possible to rapidly screen varieties using passport data (passport data are available for all rice samples held in the genebank) and in the OBN 1. Secondly, it was recognised that changes needed to take place in the final stage of evaluation (on-farm testing). While the programme was able to collect agronomic data from the first three stages of the evaluation process, the final stage has produced no information on farmer preference.

To achieve these objectives, activities in the first year of PVS involved:
- Training researchers and district officers in participatory research methods
- Evaluating varieties on-farm using participatory research methods
- Identifying characteristics farmers prefer in their rice varieties.

Materials and methods

On-farm PVS was conducted with 32 farmers in five provinces: Luang Prabang (10 farmers), Oudomsay (6 farmers), Luang Namtha (4 farmers), Sayaboury (6 farmers), and Xieng Khouang (6 farmers). Seed availability limited the number of farmers able to evaluate the 16 glutinous upland rice varieties included in the trials. Twelve varieties were selected from the 2001 MLYTs and 4 from previous trials (Vieng, Hom, Dam and Makhthoua). These varieties were divided into two groups depending on their duration (Table 1).

For the 2001 PVS trials, participating farmers were given one set (early or medium) of eight varieties (110 g per variety). This was enough to sow a 15 m² area of each variety. Farmers were given assistance with plot layout and sowing but managed the plots according to their normal practices.

Table 1. Varieties and accession numbers evaluated during the 2001 PVS trials

<table>
<thead>
<tr>
<th>Early-maturing Accession number</th>
<th>Variety name</th>
<th>Medium-maturing Accession number</th>
<th>Variety name</th>
</tr>
</thead>
<tbody>
<tr>
<td>LG 7347</td>
<td>Taa roon</td>
<td>LG 7051</td>
<td>Do hom</td>
</tr>
<tr>
<td>LG 6911</td>
<td>Deng said</td>
<td>LG 6432</td>
<td>Makhine soung</td>
</tr>
<tr>
<td>LG 7771</td>
<td>Kou yongke</td>
<td>LG 7023</td>
<td>Da cheung</td>
</tr>
<tr>
<td>LG 6499</td>
<td>Nok</td>
<td>LG 7084</td>
<td>Paneur</td>
</tr>
<tr>
<td>LG</td>
<td>Vieng</td>
<td>LG 6655</td>
<td>Lebmeu</td>
</tr>
<tr>
<td>LG</td>
<td>Hom</td>
<td>LG 1724</td>
<td>Dam</td>
</tr>
<tr>
<td>LG 6905</td>
<td>Sang</td>
<td>LG 6593</td>
<td>Sangon</td>
</tr>
<tr>
<td>LG 6501</td>
<td>Deng</td>
<td>LG 2387</td>
<td>Makhthoua</td>
</tr>
</tbody>
</table>

Between flowering and maturity, researchers visited each farmer and conducted a preference analysis (PA). In the PA the farmers were asked to rank each variety using seeds, placing more seeds on boards for varieties they liked. They were then asked to indicate the positive and negative characteristics of the varieties. Finally, they were asked which varieties they would continue to evaluate next year on their own. At harvest, the researchers and farmers harvested each plot and measured grain yield.

Analysis

Of the 32 farmers evaluating varieties, 27 participated in the PA and yield data were collected from 20. Yield data from four of the sites where the data was collected were not used in the analysis because of poor plot layout.

Individual farmer variety rankings were standardised across farmers by expressing the ratings (seeds placed by each farmer on the board) as a proportion of the total number of seeds placed on the board by each farmer. The ratings were further standardised to a mean of 0 and SD of ±1 for each farmer. Least-squares means were estimated using PROC MIXED METHOD=REML in SAS, with varieties considered fixed, and farms random effects.

Correlations between measured grain yield and farmer preference ratings were estimated for those farms from which both types of data were collected.

Results and discussion

General

Compared to previous years, the 2001 on-farm trials were very successful. PA data were collected from 84% of the farmers and yield data from 63%. This good success can be at least partially attributed to timely training (particularly in participatory research methodology) and continuous follow-up during the course of the season.

In some cases, the PA could not be conducted due to early crop damage by livestock. Yield data could not be collected from some farmers due to damage by livestock, wild pigs or rats. These are factors that the researchers can do little about. However, at four sites, PA and yield data were collected, but due to poor plot layout, the data could not be used in the analysis. Related to this, some of the trials were in fields where the local variety (used as the check) had longer growth duration than those being evaluated. This resulted in worse than normal pest damage. In future, there will need to be training in these areas, and simpler designs involving fewer varieties will be used.

Preference analysis: preferred plant characteristics

During the PA, farmers were asked to identify reasons why they liked or did not like particular varieties. These reasons were summarised from all the PAs and are given in Figure 1. Large panicles, big seed and strong stems...
Participatory varietal selection: Lessons from Lao

were the most commonly referred to positive characteristics. In contrast, farmers did not like varieties that produced few tillers, had short panicles or had panicles that matured non-uniformly. All the varieties evaluated were of short and medium duration, therefore, preference for short duration did not stand out prominently in this PA. However, early maturation was mentioned as a positive character and late maturation as a negative character. Earlier research had identified farmer preference for early- and medium-maturing varieties, and therefore, only such varieties were included in the on-farm evaluation.

Using these criteria, varieties can now be eliminated early in the evaluation process, saving time and limited resources. For example, passport data (including data for some of these characteristics) exist on most varieties in the collection. Using this database some varieties could easily be eliminated from the evaluation process. Also, in the OBN 1, variety scoring should include these characteristics, to ensure that varieties selected for further testing will not be rejected by farmers for reasons that are already obvious.

Grain yields and farmer variety ranking

In the early-maturing trial the highest grain yield (GY) was 2.14 t ha⁻¹ (Nok). This was significantly higher than the average of the local early-maturing varieties which yielded 1.5 t ha⁻¹. In the medium-maturing trial the highest yield was 1.94 t ha⁻¹ (Makthoua), similar to the mean yields of the local varieties (1.82 t ha⁻¹).

An analysis of data from only those farmers from whom both yield and preference data were obtained showed significant differences in yield and preference in the medium-maturity group, but not in the early-maturing group (yield, \(P=0.06\)). Yields and farmer preference ratings (PR) (standardised) were associated. The correlation between variety means over farms for GY and PR was 0.82 in the medium-maturity trial and 0.54 in the early trial. Occasionally, high-yielding cultivars were not preferred, but the lowest-yielding cultivars were never preferred. This indicates that agronomic selection for grain yield helps to select varieties farmers prefer.

A test of cultivar \(\times\) province interaction was conducted, using the within-province cultivar \(\times\) farmer interaction as an error term. There was no detectable cultivar \(\times\) province interaction for GY. A significant interaction was observed for PR in the early cultivar set; the cultivar Kouyonke was strongly preferred in Luang Prabang, but had a very low preference score in Sayabouli. The reason for this rank reversal is not clear. Certainly, one may expect interactions between cultivars and different farmers, ethnic groups, or environments. However a larger number of farmers must be surveyed for such an analysis to be reliable.

What next?

Based on farmers’ preferences and GY, Taa roon, Nok, Do hom, Makhine soung, Dam and Makthoua were selected for further evaluation in 2002 (Table 2). Seed of

Figure 1. Results from the preference analysis (PA) summarizing positive and negative plant characteristics most mentioned by farmers. Twenty-seven farmers participated in the PA. The number of times a characteristic is mentioned can be more than 27 because farmers were evaluating eight varieties.
these varieties are being multiplied during the 2002 dry season. A Mother and Baby trial design (see Appendix) will be used for the 2002 analysis.

One Mother trial will be placed in each village, which will permit many farmers to evaluate varieties side by side. Baby trials will consist of each farmer receiving a single variety to compare with their own variety. In each village, we anticipate three or more farmers evaluating each variety (a total of 18 or more farmers per village). The number of villages depends on the success of the seed multiplication. Yield data will be collected from the Mother trial. In the Baby trials, farmers will be asked to compare the two varieties and to provide information collected on growing conditions, soil type, etc. This information can be gathered during and after the growing season to provide some comparison of grain quality.

Farmers need to be involved earlier in the selection process. We have already indicated that results from the PA could be used to help screen out varieties early in the evaluation process. However, farmers could also be involved in the MLYT. This was done in 2001 but results are not yet available. Farmer involvement at this stage requires a different methodology.

**Lessons learned**

- Compared to earlier on-farm work the success of on-farm evaluation using participatory methods was very good.
- In the future, more training emphasis needs to be placed on good plot layout if a number of varieties are to be evaluated at a single location.
- Better care needs to be taken in working with farmers, so that the duration of the varieties being tested matches the duration of the local check variety.
- Too many varieties were evaluated by each farmer. This resulted in several problems: 1. farmers could not remember variety names, 2. the PA took too long, and 3. it was easy for farmers and researchers to get varieties mixed up. Based on our experiences, no more than five varieties should be evaluated by any one farmer. When evaluating many varieties a simple question could be, ‘Which varieties do you plan to further evaluate next year?’ Farmers were always quick to identify such varieties. These would naturally be the ones in which the farmer is most interested.
- In future evaluations it would be good to gather additional information from the farmer about the environment such as, soil type, soil colour, drought occurrence (if so, early, middle or late-season). This would allow us to test interactions between cultivars and environments.
- In future evaluations we need to ask farmers to evaluate post-harvest characteristics of the rice, such as threshability, milling quality and taste. This was not done this year due to the limited amount of seed each farmer received.
- More seed (at least 0.5 kg and preferably 1 kg) needs to be provided to each farmer for evaluation. This will require that a system of seed multiplication is in place. Seed multiplication during the dry season is currently being evaluated.

**Conclusion**

Based on 2002 results, we identified how two broad objectives of the variety improvement programmes can be achieved. Firstly, the evaluation process could be accelerated by taking into account farmer preferences early in the evaluation process (either by using passport data or in screening the OBN 1). Secondly, a system for on-farm evaluation has been identified, that has produced encouraging results.
Upland rice varietal access, test and multiplication (ATM)

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Abstract

Upland rice farmers usually conduct their own on-farm evaluations when presented with a new technology, such as seeds of a new upland rice variety. This strategy was conceived as the Rice Varietal ATM (Access, Test and Multiplication) Project. The project was designed to provide both the hardware and software of selected upland rice production technologies to resource-poor rice farmers. Farmers were provided with small quantities of new, high-yielding upland rice varieties, and other researcher-generated rice production technologies. If the farmers found the material promising, it was multiplied for wider use. All cooperators underwent a one-day training course prior to the start of a farmer-managed trial.

Results revealed that all farmer-cooperators who grew the new rice lines in upland areas succeeded in their seed-testing phase. Usually, successful Rice Varietal ATM trials were conducted by farmers who were prepared to plant upland rice during the cropping season, who had the required land available, and who were willing to fund and manage the trial. Most importantly, the new seed materials usually yielded more than the farmers’ existing or local varieties.

Introduction

The Rice Varietal ATM Project is a research/extension strategy that involves seed testing, evaluation, selection and multiplication by farmers of upland rice varieties from farmer-managed trials.

The trials were carried out with upland rice farmers in Arakan, Cotabato. It may be noted that prior to the conduct of trials, most of the farmers apply fertilizers and chemical sprays to control pests but yields are generally low at about 1 t ha⁻¹. The landholdings were small as over 80% of the farmers only had 0.1 – 1.0 ha of land.

Methodology

The Rice Varietal ATM project (Figure 1) followed the Public Education Campaign (PEC) model (Figure 2) that was guided by the following concepts: facilitate access to information and technology through training, farmers test (farmers try the technologies on their fields), and multiply (produce in larger scale or disseminate to other farmers for wide use of technology).

The Public Education Campaign (PEC) model
Poor or low utilization of technologies could be due to farmers’ lack of information or access to seeds and other inputs. By conducting short courses (e.g., 2- or 3-day

Figure 1. Rice varietal ATM methodology
training) and providing start-up materials (e.g., 1 kg seed kits), farmers get access to information and the hardware of technology so that they can proceed with their own informed evaluation. If satisfied with the performance of the technology on their own farms, it is very likely that they will multiply the seeds (in case it is a rice variety) for wider use. Chances are that close relatives and friends who have observed the performance of the technology will try to access via seed exchange or purchase, thereby facilitating farmer-to-farmer sharing of technology. The transfer of capability or skill from researcher to farmer justifies the ‘education’ dimension of the model.

The model works best under the following conditions:

- Committed manpower to analyze farmers needs and identify appropriate teaching methodologies
- Availability of and timely provision of seed kits or the hardware of the technology
- Effective linkage with other partner institutions for a sustained and effective provision of technical advice after PEC
- Continuing liaison with such information/technology sources as research institutions.

1. Breeding network trial

Promising breeding lines of upland rice, collected from several countries, were tested in the breeding network trial. From this trial, promising lines were identified based on the following criteria:

1. Adaptation to local conditions
2. High yield
3. Resistance to drought and blast.

The presence of the breeding network in their local municipality allowed farmers to observe the varieties or lines. Some of these achieved yields that were 50% higher than their own varieties, and had resistance to pests, diseases and drought.

2. Advanced yield trial

The advanced yield trial (AYT) was composed of promising, high-yielding lines from the breeding network trial. The AYT further tested the performance of these lines. Yield, productive tillers per linear metre, days to maturity, plant height, and pest and disease occurrence were all measured in the AYT.

3. Farmers’ evaluations of rice lines in the AYT

Farmers were usually asked to evaluate the upland rice lines in the AYT at the trial site during field days. The holding of field days by the Upland Rice Research Consortium (URRC) in Arakan became a necessary component of the trials and allowed farmers to closely observe and evaluate entries in the AYT using their own criteria. Farmers were asked to write down the rating of their most-preferred varieties and their least-preferred ones. They were also asked to identify the criteria they commonly used in judging a preferred variety.

Results of farmers’ evaluations were usually considered in succeeding trials or activities. Entries that performed well in the AYT that were highly favoured by farmers were given to them for further testing in their own fields.

4. Farmer-managed varietal assessment

a. Seed Testing Phase: small-area varietal evaluation.

The varietal trials were carried out and managed by farmers. Each participating farmer was assigned at least two promising varieties (5 kg of seed each) and asked to grow them alongside their local variety in the same field under the same management. The farmers were trained to use a 2-page monitoring instrument with a calendar, with which they recorded their farm practices and general observations on the performance of the varieties. The monitoring instrument was based on an earlier survey conducted on the criteria used by upland rice farmers in evaluating a variety. Farmer-to-farmer sharing of information on promising lines occurred in this phase.

Eight cultivars were tested in 22 farmers’ fields. Among the promising and recommended varieties tested were: B 6144, PR 23813-2-53, IR 55423-01, PR 23706-26, C-22, UPL Ri-5, PSB Rc-1 and PSB Rc-5.

Only 6 of the 22 farmer-cooperators were able to plant the seed kits given them on their upland farms (Table 1). Each farmer tested at least two upland rice varieties/promising selections. The rest reported that they sowed them in lowland areas.

b. Seed Multiplication Phase: wide area-varietal evaluation.

If farmer-cooperators are satisfied with the results in the seed-testing phase, they will likely multiply the seeds for wider use. Usually, the produce from the seed-testing phase is used as material for seed multiplication in a wider area. It is hoped that farmer-to-farmer information dissemination will be strongest during this phase.

1 The URRC is a collaborative programme of the International Rice Research Institute (IRRI) and the member country’s research agency involved in upland rice – in this case the Philippine Rice Research Institute – and the university, which co-implements the rice trials.
Results and discussion

Selected socio-demographic characteristics of rice farmer-cooperators

Twenty-two upland rice farmers from Arakan, Cotabato, served as the farmer-cooperators of the project. Most (77%) of them were male members of the Ilongo ethnic group (82%), with ages ranging from up to 40 (41%) to 41–60 (46%). Generally, the upland rice farmer-cooperators were literate; about 91% of them had reached or finished elementary and high school. Almost half of them (41%) had been growing rice for 21 years or more. It should be noted that most (82%) of these farmer-cooperators owned a small portion of upland rice farm, ranging from 0.1 to 1.0 ha. Usually, the farmers' sources of seeds were their neighbours or fellow farmers (77%), USM (36%) and cooperatives (55%).

Rice farming practices during the pre-ATM phase

Fertilizer application. Most (68%) of the upland rice farmer-cooperators used compound fertilizers on their farms. The rate and time of application ranged from 1 to 3 bags ha⁻¹ at the tillering stage (47%). Other farmers used urea (36%) and ammonium sulphate (23%) at the rate of 1 to 3 bags at tillering and panicle initiation stages.

Pest management. Most (91%) of the farmers used pesticides to control rice pests and diseases. Very few (9%) claimed to use such biological control agents as plants with pesticidal properties. The upland rice farmers manually control weeds usually with the help of family members.

Yield from their own varieties. Before the intervention of the project to test promising upland varieties, the cooperating farmers grew traditional varieties and lowland rice varieties such as MASIPAG lines and IR36. When these farmer-adopted varieties were compared to each other, the highest average yield obtained by rice farmers was from IR36. The average yield of IR36 was 1.25 t ha⁻¹ followed by Dinorado (1.00 t ha⁻¹). The MASIPAG lines yielded an average of 0.78 t ha⁻¹.

Varieties/promising rice lines identified by the project and performance of recommended cultivars

Four varieties (C 22, UPL Ri-5, PSB Rc-1 and PSB Rc-5) and four promising rice varieties (B 6144, PR 23813-2-53, IR 55423-01, and PR 23706-26) were identified by the project (Table 2).

Table 2. Varieties/promising rice lines identified and tested by the Rice Varietal ATM Project

<table>
<thead>
<tr>
<th>Cultivars</th>
<th>Cultivars tested</th>
<th>Release year</th>
</tr>
</thead>
<tbody>
<tr>
<td>B 6144</td>
<td>✔</td>
<td>–</td>
</tr>
<tr>
<td>PR 23813-2-53</td>
<td>✔</td>
<td>–</td>
</tr>
<tr>
<td>IR 55423-01</td>
<td>✔</td>
<td>–</td>
</tr>
<tr>
<td>PR 23706-26</td>
<td>✔</td>
<td>–</td>
</tr>
<tr>
<td>C-22</td>
<td>–</td>
<td>1972</td>
</tr>
<tr>
<td>UPL Ri-5</td>
<td>–</td>
<td>1980</td>
</tr>
<tr>
<td>PSB Rc-1</td>
<td>–</td>
<td>1990</td>
</tr>
<tr>
<td>PSB Rc-5</td>
<td>–</td>
<td>1997</td>
</tr>
</tbody>
</table>

Yield performance of some upland rice varieties/selections in farmer-cooperators’ fields.

Based on the data, UPL Ri-5 gave the highest average yield (Table 3). This was followed by PR 23813-2-53 and IR 55423-01. B 6144 PSB Rc-1, PSB Rc-5 and C 22, yielded less than other test entries.

Table 3. Yield (t ha⁻¹) of upland rice varieties/promising rice lines and farmers’ preferences

<table>
<thead>
<tr>
<th>Variety</th>
<th>Number of cooperators</th>
<th>Average yield (t ha⁻¹)</th>
<th>Yield range (t ha⁻¹)</th>
<th>Farmers’ preference (f = number of farmers reporting)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Variety tested</td>
</tr>
<tr>
<td>C 22</td>
<td>2</td>
<td>2.28</td>
<td>2.14–2.42</td>
<td>1</td>
</tr>
<tr>
<td>PSB Rc-1</td>
<td>1</td>
<td>1.78</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>PSB Rc-5</td>
<td>1</td>
<td>1.63</td>
<td>–</td>
<td>1</td>
</tr>
<tr>
<td>UPL Ri-5</td>
<td>2</td>
<td>3.22</td>
<td>2.85–3.60</td>
<td>2</td>
</tr>
<tr>
<td>B 6144</td>
<td>10</td>
<td>2.44</td>
<td>1.80–3.38</td>
<td>6</td>
</tr>
<tr>
<td>IR 55423-01</td>
<td>6</td>
<td>2.86</td>
<td>2.63–3.10</td>
<td>5</td>
</tr>
<tr>
<td>PR 23813-2-53</td>
<td>7</td>
<td>2.91</td>
<td>2.60–3.23</td>
<td>7</td>
</tr>
<tr>
<td>PR 23706-26</td>
<td>1</td>
<td>2.23</td>
<td>–</td>
<td>1</td>
</tr>
</tbody>
</table>
Farmers’ preferences. Generally, most farmer-cooperators preferred the new seed materials to their existing variety. Judging by the limited number of respondents for the other rice varieties, a good number of farmers preferred PR 23813-2-53.

Positive and negative qualities of new upland rice varieties as observed by farmers. The released variety UPL Ri-5 is high-yielding but is susceptible to bacterial leaf blight, leaf folder and stem borer (Table 4). Two pre-released varieties, B 6144 and IR 55423-01, were observed to be susceptible to lodging. B 6144 lodged at the milk grain stage. All the other entries showed a high degree of resistance to lodging. The farmer-cooperators who tested B 6144 claimed that this line was high-tillering but was susceptible to narrow brown spot, leaf folder and bacterial leaf blight.

IR 55423-01 and PR 23813-2-53 were observed to be susceptible to bacterial leaf blight and narrow brown spot diseases.

Table 4. Positive and negative qualities of upland rice varieties as observed by farmers

<table>
<thead>
<tr>
<th>Variety</th>
<th>Positive qualities</th>
<th>Negative qualities</th>
</tr>
</thead>
<tbody>
<tr>
<td>UPL Ri-5</td>
<td>High-yielding</td>
<td>Susceptible to bacterial leaf blight, leaf folder and stem borer</td>
</tr>
<tr>
<td>PSB Rc-1</td>
<td>–</td>
<td>Susceptible to narrow brown spot</td>
</tr>
<tr>
<td>PSB Rc-5</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>C-22</td>
<td>–</td>
<td>Susceptible to sheath blight</td>
</tr>
<tr>
<td>B6144</td>
<td>High-tillering</td>
<td>Lodges at milk grain stage</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Susceptible to narrow brown spot, leaf folder and bacterial leaf blight</td>
</tr>
<tr>
<td>IR 55423-01</td>
<td>High-tillering</td>
<td>Susceptible to lodging</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Susceptible to bacterial leaf blight</td>
</tr>
<tr>
<td>PR 23813-2-53</td>
<td></td>
<td>Susceptible to narrow brown spot and bacterial leaf blight</td>
</tr>
<tr>
<td>PR 23706-26</td>
<td>Early-maturing</td>
<td>–</td>
</tr>
</tbody>
</table>

Conclusions

The primary objective of the project was to find out whether selected researcher-generated technologies (e.g., promising new upland rice varieties) perform well in farmers’ fields under their own management. The Rice Varietal ATM project has demonstrated its value as a way by which farmers can evaluate a conventional technology package (e.g., variety) under their own field conditions. This project also facilitates the provision of feedback from the farm to the experiment station. Such information can be used in setting research priorities and goals to serve the varietal needs of the farmer-clientele.

Results of the farmer-managed trials indicated that farmers can make better objective evaluations when experiments are done by them, since the project provides a forum for rice farmers to integrate their indigenous technologies with introduced research-generated technologies.

Although one of the released varieties (UPL Ri-5) performed better than any of the pre-released varieties, this result is not conclusive since has only been tested for one cropping season.
Addressing genetic improvement and on-farm diversity through farmer participatory breeding: A case study of rainfed rice in Faizabad and Siddharthnagar districts, eastern Uttar Pradesh, India

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Abstract

Resource-poor farmers in Uttar Pradesh, India, face a number of production constraints to rainfed rice growing, ranging from poor performance of traditional varieties and a lack of access to new ones, to unpredictable weather. A farmer participatory breeding (FPB) programme that began in 1997 sought to address those problems by developing new rice genotypes. During the 4 years of the study, several important points were established: Farmers could visually rate for yield with high accuracy, and their visual yield ratings were the best predictor of farmer preference. Some cultivars produced very high yields under low-input management and were highly preferred by farmers. However, some high-yielding varieties were not preferred, while some farmers preferred varieties that did not give a high yield.

Introduction

In Uttar Pradesh rice is grown in 5.5 million ha, of which 2.2 million ha (40%) of rice lands are rainfed lowland and 0.7 million ha are upland (13%). The impact of the Green Revolution is hardly visible in such areas due to several factors:

- Poor and inconsistent performance of on-station developed varieties when grown under farmers’ management
- An inability to meet farmers’ preferences for quality
- A lack of information about new varieties or poor access to seeds of them, or lack of both information and seed.

The major production constraints in rainfed rice include an unpredictable combination of droughts and floods, build-up of pests and diseases, poor physical soil conditions and socioeconomic limitations. Farmers are resource-poor, which limits their risk-management strategies in rice cultivation. Therefore, the development of rice varieties suitable for these fragile ecologies will make a positive impact on the millions of poor people whose livelihoods depend on them.

Narendra Deva University of Agriculture and Technology (NDUAT) in Faizabad, eastern India, in collaboration with International Rice Research Institute (IRRI), initiated a farmer participatory breeding (FPB) programme in 1997. In this approach, the needs and priorities of farmers were taken into account during the early evaluation of rice genotypes, both on-station and in farmers’ fields.

This paper discusses the FPB approach and its impact on on-farm diversity conservation by the participating farmers.

Materials and methods

Three typical rainfed sites were chosen – Sariyawan and Mungeshpur in Faizabad, and Basalatpur in Siddharthnagar districts. Basalatpur represented a favourable lowland environment, while Mungeshpur and Sariyawan represented shallow but submergence- and drought-prone areas. Three approaches were followed:

Participatory plant breeding (PPB)

This included F₁ generations of six different crosses involving diverse parents. These segregating populations were jointly assessed by farmers and breeders on-station.
and in farmers’ fields. Two breeders and five farmers selected separately from F_4 to F_6 during the 1997, 1998 and 1999 cropping seasons. Altogether, 50 populations were developed and tested in three replications on-station and in two replications on-farm. From these, six lines for Faizabad and five lines for Siddharthnagar conditions – identified by breeders, farmers or both – were selected and compared in field trials. Observations were recorded on such traits as yield.

**Participatory varietal selection (PVS)**

This was initiated during the 1997 rainy season and continued in the 1998 rainy season. Fifteen to 20 entries were tested on-station and in farmers’ fields. The entries included advanced breeding lines from the IRRI-led Shuttle Breeding project, released varieties, and the most common local varieties. Two farmers each from the villages of Mungeshpur (drought-prone), Sariyawan (drought- and submergence-prone), Faizabad and Basalatpur (submergence-prone), and Siddharthnagar were chosen for PVS experiments. Final PVS trials were conducted during 2001, both on-station and on-farm in Faizabad district.

**Mother and Baby PVS programme**

This was initiated during the wet season of 2001, and consisted of replicated researcher-managed Mother trials with 15 genotypes at Masodha Rice Research Station, Faizabad. In these experiments recommended fertilizer doses were used. Nine farmers in Siddharthanagar district conducted the Baby trials in three villages. Each Baby trial included five genotypes and was entirely managed by farmers. The alpha-lattice incomplete-block design was used for the layout and analysis of the Baby trials. Simple rating scales (1-5) for different characteristics were used for statistical analysis. A simple form was used to elicit additional information from the farmers on the traits and to obtain suggestions on how to improve the trials.

**Important findings of PPB and PVS**

**PPB**

With few exceptions, the genotypes flowered earlier in farmers’ fields than on-station. However, yields in farmers’ fields were generally lower, as the genotypes suffered prolonged waterlogging, particularly at Siddharthnagar. While a coarse-grained type (IR 700803-43-NDR-2-9335) selected by the farmers performed best both on-farm and on-station at Faizabad, the farmers in Siddharthnagar preferred an early type (123-day duration) that gave a maximum yield of 5.1 t ha⁻¹ on-station and 3.2 t ha⁻¹ in farmers’ fields.

**PVS**

Ten farmers (five women and five men) visited individual plots and ranked the genotypes grown in different farmers’ fields. Farmers’ selection criteria were based on ecological needs, livelihood uses, gender and social and economic background. Mungeshpur and Sariyawan farmers preferred genotypes with drought tolerance and early to medium maturity. In contrast, Basalatpur farmers selected slightly later-maturing genotypes with submergence tolerance and long, slender grains.

In general, rice grain yields observed on-farm were lower than on-station. However, some of the cultivars produced very high yields (> 4 t ha⁻¹ under low-input management) and were highly preferred by farmers.

Farmers did select more than one variety (eight in this case), indicating that PVS/PPB can help maintain varietal diversity on-farm. Such traits as threshability, submergence tolerance, and grain shape were also preferred in this set of cultivars. Straw traits, and pest and disease resistance ratings were not selected by farmers. Data for grain yield collected from the on-farm trials were highly repeatable.

**Mother and Baby PVS trials**

Significant differences were observed for grain yield among the genotypes tested in the Mother trials. Farmers perceived significant differences between the cultivars for grain yield, submergence tolerance, threshability (particularly women farmers), grain shape and overall acceptability.

Differences in measured grain yield were highly significant. The reliability of yield measurements was much higher than expected for on-farm trials. Two of the highest-yielding genotypes gave over 4 t ha⁻¹ on-farm, and were highly preferred by farmers over their own varieties. However, one high-yielding genotype was not preferred, but no clear reason for this anomaly could be determined from the questionnaire results.

On a single-plot basis, farmers’ visual yield ratings were highly correlated with measured yield (r = -0.84) (Table 1). Farmers’ yield rating and farmers’ preference rating were also highly correlated (0.75). Breeders preference rating was highly correlated with measured yield (-0.81) and farmers’ yield rating (0.94).

On a genotype mean basis, farmers’ yield rating and measured yields were highly correlated (0.90). Farmers had a strong preference for cultivars they rated highly for yield (r = 0.81) (Table 2).

**On-farm diffusion and varietal diversity**

While PVS trials continued, farmers picked up a few lines which they found promising and grew them on larger plots. For example in Faizabad villages, 23 farmers grew three genotypes namely NDR 40032, NDRSB 9830102 and NDRSB 9730020 in 3.83 hectares during the 2000 crop year. The following year, 36 farmers grew the same genotypes in 4.84 hectares. In Siddharthnagar, the number of farmers who used the genotypes such as NDRSB 96005, NDR 40032, NDRSB 9730020, and
Table 1. Correlations among plot values for measurements and ratings taken by farmers and breeders in Baby trials in three villages in Siddarthnagar, rainy season 2001

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Farmer preference rating</th>
<th>Breeder preference rating</th>
<th>Farmer yield rating</th>
<th>Farmer submergence tolerance rating</th>
<th>Farmer threshability rating</th>
<th>Farmer grain shape rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measured grain yield</td>
<td>0.59</td>
<td>0.81</td>
<td>0.84</td>
<td>0.53</td>
<td>0.69</td>
<td>-0.46</td>
</tr>
<tr>
<td>Farmer preference rating</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breeder preference rating</td>
<td>0.75</td>
<td>0.74</td>
<td>0.48</td>
<td>0.61</td>
<td>0.61</td>
<td>0.59</td>
</tr>
<tr>
<td>Farmer yield rating</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farmer submergence tolerance rating</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farmer threshability rating</td>
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<td></td>
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</tr>
<tr>
<td>Farmer grain shape rating</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Table 2. Correlations among cultivar means for measurements and ratings taken by farmers and breeders in Baby trials in three villages in Siddharthnagar, rainy season 2001

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Farmer preference rating</th>
<th>Breeder preference rating</th>
<th>Farmer yield rating</th>
<th>Farmer submergence tolerance rating</th>
<th>Farmer threshability rating</th>
<th>Farmer grain shape rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measured grain yield</td>
<td>0.67</td>
<td>0.87</td>
<td>0.90</td>
<td>0.61</td>
<td>0.89</td>
<td>0.57</td>
</tr>
<tr>
<td>Farmer preference rating</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breeder preference rating</td>
<td>0.80</td>
<td>0.81</td>
<td>0.74</td>
<td>0.83</td>
<td>0.77</td>
<td>0.75</td>
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<tr>
<td>Farmer yield rating</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Farmer submergence tolerance rating</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Farmer threshability rating</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farmer grain shape rating</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3. On-farm diffusion of genotypes selected through PVS, 2000-2001

<table>
<thead>
<tr>
<th>Sites (Year)</th>
<th>Genotypes</th>
<th>Number of farmers</th>
<th>Total area (ha)</th>
<th>Yield range (t ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faizabad (2000)</td>
<td>NDR 40032</td>
<td>2</td>
<td>0.16</td>
<td>3.5–5.5</td>
</tr>
<tr>
<td></td>
<td>NDRSB 9830102</td>
<td>18</td>
<td>2.17</td>
<td>2.8–3.7</td>
</tr>
<tr>
<td></td>
<td>NDRSB 9730020</td>
<td>3</td>
<td>1.50</td>
<td>3.5–4.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>23</td>
<td>3.83</td>
<td></td>
</tr>
<tr>
<td>Faizabad (2001)</td>
<td>NDR 40032</td>
<td>4</td>
<td>0.56</td>
<td>3.2–4.1</td>
</tr>
<tr>
<td></td>
<td>NDRSB 9830102</td>
<td>23</td>
<td>3.10</td>
<td>2.5–3.6</td>
</tr>
<tr>
<td></td>
<td>NDRSB 9730020</td>
<td>9</td>
<td>1.18</td>
<td>4.2–5.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>36</td>
<td>4.84</td>
<td></td>
</tr>
<tr>
<td>Siddharthnagar (2000)</td>
<td>NDRSB 96005</td>
<td>6</td>
<td>1.15</td>
<td>2.4–4.2</td>
</tr>
<tr>
<td></td>
<td>NDRSB 40032</td>
<td>8</td>
<td>0.80</td>
<td>3.5–5.2</td>
</tr>
<tr>
<td></td>
<td>NDRSB 9730020</td>
<td>12</td>
<td>2.85</td>
<td>3.7–5.6</td>
</tr>
<tr>
<td></td>
<td>Kamini</td>
<td>6</td>
<td>0.85</td>
<td>1.6–2.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>32</td>
<td>5.65</td>
<td></td>
</tr>
<tr>
<td>Siddharthanagar (2001)</td>
<td>NDRSB 96005</td>
<td>5</td>
<td>0.90</td>
<td>3.4–4.7</td>
</tr>
<tr>
<td></td>
<td>NDR 40032</td>
<td>8</td>
<td>1.20</td>
<td>3.6–4.8</td>
</tr>
<tr>
<td></td>
<td>NDRSB 9730020</td>
<td>19</td>
<td>4.60</td>
<td>3.9–5.6</td>
</tr>
<tr>
<td></td>
<td>Kamini</td>
<td>11</td>
<td>1.70</td>
<td>1.5–2.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>43</td>
<td>8.40</td>
<td></td>
</tr>
</tbody>
</table>

1. These seeds were disseminated in Nepal by relatives of farmer cooperators. In Siddharthnagar, other genotypes such as NDRSB 9730004, NDRSB 9830102 and Sugandha were also adopted by farmers.
Kamini increased from 32 to 43 from 2000 to 2001. The area grown to these genotypes also increased from 5.65 to 8.40 hectares during the same period. (Table 3). This clearly indicates that farmer participatory breeding will not only increase the existing diversity of rice varieties grown under rainfed conditions but also allows farmers to grow improved varieties which were chosen by them.

**Conclusions**

- Farmers could visually rate for yield with a high degree of accuracy
- Farmer visual yield ratings were the best predictor of farmer preference
- Some preferred varieties were not high-yielding (e.g., NDRSB 9830102, that produced 2.5–3.6 t ha⁻¹), and some high-yielders, such as NDR 40032 (3.2–4.1 t ha⁻¹) and NDRSB 9730020 (4.2–5.8 t ha⁻¹) were not preferred
- Some cultivars produced very high yields (> 4 t ha⁻¹) under low-input management, and were highly preferred by farmers
- Over the years of the study, farmers did not continue to grow all the lines that they had selected in previous years. This was because they took into account additional information from various trials and later observations (such as sensory evaluation, milling recovery, and drought incidence), in order to finally decide whether to select or reject a variety.
Introduction

Indonesia has about 1.5 million ha of upland rice, about 12% of the total rice-growing area in the country. Generally, upland rice in Indonesia is cultivated by poor farmers on problem soils. The national average yield of upland rice in 2000 was 1.9 t ha⁻¹, compared to that of lowland rice, 4.6 t ha⁻¹.

In the islands of Sumatra, Kalimantan, and Iran Jaya, where most of the upland rice-growing area is found, the major constraints are diseases including blast, brown spot, and sheath blight, and soil problems including acidity, aluminium toxicity, and phosphorous deficiency. In the semi-arid zones of East Java, West and East Nusa Tenggara, drought is the major constraint. In intercropping systems, that are widespread in these areas, shade is also a constraint.

Some improved varieties of upland rice have been released; however, most farmers still cultivate traditional varieties. The severe blast pressure in high-rainfall areas of Sumatra and Kalimantan is the single most severe constraint to the adoption of improved varieties. The blast resistance of improved varieties often breaks down after being cultivated for only two or three seasons.

Another reason why improved varieties are not adopted by farmers could be that their characteristics do not meet farmer preferences. Participatory selection, in which farmers are encouraged to select breeding lines based on their own preferences in comparison with their own varieties, was designed to overcome this second problem. An experiment on selection of promising breeding lines suitable for an upland cultivated area in Sumatra was conducted using Mother and Baby trials.

Materials and methods


The Mother trial was laid out as a randomised complete-block design with four replications and an individual plot size of 5 x 4 m. Cultivation methods followed those recommended by the extension services,
including 30 × 15-cm spacing and 150-125-100 kg ha⁻¹ of urea-SP36-KCl fertilizer application. For the Baby trial, 0.5 kg seed of each entry was given to selected farmers. To reduce the resource requirement and also reduce the complexity of the trials for farmers, six entries were distributed to each farmer from the total of 18. Farmers were asked to cultivate the materials using their own methods. The seeds were given to farmers along with a questionnaire with the characters to be scored in comparison to the farmer’s own variety. These characters included vigour, competitiveness with weeds, reaction to brown spot, reaction to blast, lodging, maturity, yield, grain shape, eating quality, threshability, overall farmer opinion and the reason. Scores given to the characters were: 1 = very good; 2 = good; 3 = medium (equal to farmer variety); 4 = bad; 5 = very bad.

Results and discussion

Limboto, a newly released variety, and B 9071F-TB-7 appeared to have the best phenotypic acceptability with an average score of 3.5 (Table 1). All the promising breeding lines were selected for good agronomic characteristics and resistance to blast. Cirata and Way Rarem are high-yielding improved varieties. In the experiment, however, these two improved varieties could not yield up to their potential mainly due to a heavy infestation of blast. Almost all plants of the line TB 177E-TB-28-B-3 were killed by the disease and no agronomic data could be recorded. This illustrates the breakdown of the resistance and the variability of the pathogen. Heavy rainfall during the flowering stage caused high neck blast pressure. Most of the lines were susceptible and had many unfilled grains. Limboto had the fewest unfilled grains and, along with TB 47H-MR-10 and IR 30176B-1-B-2-2-MR-2 produced the most filled grains. Limboto and TB 47H-MR-10 yielded the most (2.5 t ha⁻¹) in the Mother trial and the yield of B 9071F-TB-7 was not significantly lower than this (Table 2).

No variability was found among trial entries for competitiveness with weeds, lodging, and threshability and this was reflected in the farmers’ scores, so none of these data are presented here. All of the farmers scored the vigour of the new released variety Limboto as good and most of them also scored lines B 9071F-TB-7 and TB 47H-MR-10 as having good vigour in the Baby trials. The scores made by farmers for vigour and for their overall opinion on the entries were closely correlated (r = 0.91). However, the correlation coefficients of the scores for vigour with yield (r = −0.77) and overall opinion with yield (r = −0.66) were lower. Yield is usually the most important character determining farmers’ preference for a rice variety, but in this experiment the farmers had been asked to score the entries before harvesting. The trial was heavily infected by neck blast, which made it difficult for the farmers to predict the yield. This might account for a lower correlation coefficient between yield and overall opinion than between vigour and overall opinion. Moreover, the notes made by farmers (Table 3) indicated that such other characters as blast resistance, panicle size, grain shape, and grain size influenced preferences.

Most of the farmers scored the tested material as bad in comparison with their own variety because of its susceptibility to blast. This indicated that blast is the most important constraint to upland rice cultivation in the area. Some of the farmers’ varieties were also attacked by the disease, but most were not. There were at least 15 different local varieties cultivated by farmers in the region where the Baby trial was conducted. The high genetic variability of the local varieties is a good defence against the blast pathogen. Introducing many different breeding lines to substitute for the diverse array of local varieties

Table 1. Performance of some breeding lines and varieties of upland rice in the Mother trial conducted in Lampung, West Sumatra, 2001/2

<table>
<thead>
<tr>
<th>Line/variety</th>
<th>Height (cm)</th>
<th>Tiller number</th>
<th>Maturity (days)</th>
<th>Phenotypic acceptability</th>
<th>Grains panicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>B 9071F-TB-7</td>
<td>85</td>
<td>14</td>
<td>112</td>
<td>3.5</td>
<td>82*</td>
</tr>
<tr>
<td>B 85036E-TB-19-13-3</td>
<td>114*</td>
<td>14</td>
<td>105</td>
<td>4.5</td>
<td>75*</td>
</tr>
<tr>
<td>TB 177E-TB-28-B-3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TB 47H-MR-10</td>
<td>89</td>
<td>14</td>
<td>114</td>
<td>4.0</td>
<td>92</td>
</tr>
<tr>
<td>IR 30176B-1-B-2-2-MR-2</td>
<td>87</td>
<td>13</td>
<td>108</td>
<td>5.0</td>
<td>84</td>
</tr>
<tr>
<td>BIO 528B-TB-12-1-1</td>
<td>89</td>
<td>13</td>
<td>112</td>
<td>4.5</td>
<td>58*</td>
</tr>
<tr>
<td>BIO 511B-TB-61-2-4</td>
<td>64*</td>
<td>14</td>
<td>115</td>
<td>6.0*</td>
<td>71*</td>
</tr>
<tr>
<td>BIO 530A-5-14-2-2-8</td>
<td>76*</td>
<td>14</td>
<td>114</td>
<td>6.0*</td>
<td>65*</td>
</tr>
<tr>
<td>Cirata</td>
<td>79*</td>
<td>14</td>
<td>109</td>
<td>5.5*</td>
<td>70*</td>
</tr>
<tr>
<td>Way Rarem</td>
<td>85</td>
<td>14</td>
<td>116</td>
<td>5.0</td>
<td>65*</td>
</tr>
<tr>
<td>Limboto</td>
<td>88</td>
<td>14</td>
<td>114</td>
<td>3.5</td>
<td>89</td>
</tr>
</tbody>
</table>

1. Averaged score for phenotypic acceptability 1–9: 1 = very good; 9 = very bad
* Differs significantly from the check variety Limboto based on LSD 0.05
Table 2. Mean vigour scores, overall scores of farmer opinion, and yield of breeding lines and varieties of upland rice in the Mother and Baby trial conducted in Lampung, West Sumatra, 2001/2

<table>
<thead>
<tr>
<th>Average score Line/variety</th>
<th>Farmer number</th>
<th>Average score</th>
<th>Average yield (t ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Vigour Opinion</td>
<td>Baby Mother</td>
</tr>
<tr>
<td>B 9071F-TB-7</td>
<td>9</td>
<td>2.4</td>
<td>3.0</td>
</tr>
<tr>
<td>B 85036E-TB-19-13-3</td>
<td>9</td>
<td>3.8</td>
<td>4.0</td>
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<tr>
<td>TB 177E-TB-28-B-3</td>
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<td>5.0</td>
<td>4.0</td>
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<tr>
<td>TB 47H-MR-10</td>
<td>10</td>
<td>2.2</td>
<td>2.4</td>
</tr>
<tr>
<td>IR 30176B-1-B-2-2-MR-2</td>
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<td>3.0</td>
<td>3.1</td>
</tr>
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<td>BIO 530A-5-14-2-2-8</td>
<td>9</td>
<td>3.6</td>
<td>3.3</td>
</tr>
<tr>
<td>Cirata</td>
<td>10</td>
<td>3.6</td>
<td>3.3</td>
</tr>
<tr>
<td>Way Rarem</td>
<td>10</td>
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<td>2.9</td>
</tr>
<tr>
<td>Limboto</td>
<td>15</td>
<td>2.0</td>
<td>2.3</td>
</tr>
</tbody>
</table>

* Differs significantly from the check variety Limboto based on LSD 0.05.

Table 3. Number of scores for farmer opinion¹ given to each line and variety and the corresponding notes made by farmers

<table>
<thead>
<tr>
<th>Line/variety</th>
<th>Number of scores</th>
<th>Mean</th>
<th>Note</th>
</tr>
</thead>
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<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>B 9071F-TB-7</td>
<td>–</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>B 85036E-TB-19-13-3</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>TB 177E-TB-28-B-3</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>TB 47H-MR-10</td>
<td>–</td>
<td>7</td>
<td>–</td>
</tr>
<tr>
<td>IR 30176B-1-B-2-2-MR-2</td>
<td>–</td>
<td>4</td>
<td>–</td>
</tr>
<tr>
<td>BIO 528B-TB-12-1-1</td>
<td>–</td>
<td>4</td>
<td>–</td>
</tr>
<tr>
<td>BIO 511B-TB-61-2-4</td>
<td>–</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>BIO 530A-5-14-2-2-8</td>
<td>–</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Cirata</td>
<td>–</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Way Rarem</td>
<td>–</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Limboto</td>
<td>–</td>
<td>13</td>
<td>2</td>
</tr>
</tbody>
</table>

¹ Scores for farmer opinion, 1 = very good; 2 = good; 3 = medium (equal to farmer variety); 4 = bad; 5 = very bad

could maintain this high genetic variability, and might be a good approach for increasing rice yield while maintaining blast resistance. Since breeding lines are continuously developed in the breeding programme, similar trials could be conducted with a new set of breeding lines in the following growing seasons. The continuous deployment of breeding lines might develop genetic variability and blast resistance.
Participatory variety selection: An initiation in Bangladesh

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Abstract

In Bangladesh breeders habitually develop rice varieties using the centralised breeding approach. Recommended varieties produced by this method are popular in favourable rice production systems but local (farmer-preferred) varieties still dominate in less-favourable environments. Efforts were initiated to evaluate 14 salt-tolerant genotypes at four sites in the coastal saline area through a farmer participatory approach in the rainy season of 2001. Researcher-managed trials were conducted and consultative farmer participation was employed at crop maturity. Thirty to 40 farmers took part in the participatory varietal selection (PVS) at each site and selected 10 genotypes that included two varieties recommended for coastal wetlands. The farmers reported that, for the first time, they had the opportunity to select varieties according to their own judgement from a basket of new genotypes made available to them. All the PVS farmers agreed to grow their selected varieties under their own management in the following season. Deputy Directors from the agricultural extension service attended the PVS activities at the four sites and noted that it was a bottom-up approach. The direct involvement of farmers in choosing varieties for their needs is an excellent method of selection. They recommended supporting this effort since it effectively brought farmers, NGOs and extension agents together.

Introduction

Breeders in Bangladesh are developing new rice varieties through on-station trials without the involvement of farmers. The bottlenecks of this approach can be realised by observing the popularity of a variety produced by this system in one region but not in others. Moreover, the value of these varieties for marginal, risk-prone and stressed environments is limited. Hence, evaluation of genotypes in the real, target environment and the participation of the end users in the process of variety development have been emphasised. Participatory varietal selection (PVS) was initiated to identify high-yielding rice varieties for the coastal saline areas of Bangladesh.

Materials and methods

Fourteen advanced breeding lines of BRRI (BR) and IRRI (IR) origin, including two BR varieties known to be salt-tolerant at 6–8 dS/m, were selected for the PVS trial. The trial was conducted at six sites in the coastal areas of Feni (Sonagazi), Noakhali, Laxmipur (Ranggati), Kaliganj, Shayamnagar and Satkhira (Figure 1). One popular farmer’s variety was used at each site in this trial. There was a single-replicate trial at each site with an individual plot size of 2 x 8 m. Fertilizers were applied (80:60:40 kg NPK ha⁻¹) with a split application of N at 15, 40 and 60 days after transplanting. Insecticide was applied twice to protect the crops from stem borer infestation. Zinc sulphate was applied at 10 kg ha⁻¹ at the tillering stage of the crop. The farmer (owner of the trial plots) was involved in crop husbandry including weeding the plots twice.
PVS was organised at four sites: Sonagazi, Ramgati, Noakhali and Satkhira. At crop maturity, 30–40 farmers from three or four villages around the sites were invited in cooperation with the Department of Agricultural Extension (DAE). Ten grassroots-level extension personnel (block supervisors) working around each site, local NGOs, leaders, administrators and the Deputy Directors of Agricultural Extension (DDAE) of the respective districts attended the function.

The 30–40 PVS farmers were divided into three groups of 10–15 (Figure 2). Scientific personnel guided each group. Each farmer was given a PVS sheet (Figure 3). The purpose of the trial was explained to create enthusiasm among the participating farmers. The PVS sheets on which the varietal preferences were recorded were collected from the farmers and a discussion was held on their reactions to the PVS exercise.

The farmers appreciated having a basket of new available varieties/genotypes and the opportunity to choose among them using their own judgement. They reported that the PVS genotypes had:
- Lodging tolerance
- Acceptable grain shape
- Suitability for local conditions
- Higher grain yield than local varieties.

The DDAE reported that:
- DAE’s extension policy was top-down and therefore adoption of new technologies is low
- Farmers’ need-based technology would be developed by PVS and thus rapid dissemination of the technology could be expected
- Farmers would have the ready-made opportunity to acquire seed of improved varieties for increased production
- Farmers, NGOs and extension agents should sincerely support this effort.

### Table 1. Advanced lines and varieties selected by PVS farmers at four sites in the coastal districts of Bangladesh, 2001

<table>
<thead>
<tr>
<th>Variety</th>
<th>Sonagazi</th>
<th>Noakhali</th>
<th>Ramgati</th>
<th>Satkhira</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>BR5778-156-1-3-HR1</td>
<td>5</td>
<td>2</td>
<td>—</td>
<td>16</td>
<td>23</td>
</tr>
<tr>
<td>BR5778-156-1-3-HR14</td>
<td>15</td>
<td>8</td>
<td>—</td>
<td>28</td>
<td>51</td>
</tr>
<tr>
<td>BR5778-156-1-3-HR15</td>
<td>16</td>
<td>4</td>
<td>—</td>
<td>16</td>
<td>36</td>
</tr>
<tr>
<td>IR66401-2B-14-1-1</td>
<td>3</td>
<td>—</td>
<td>1</td>
<td>9</td>
<td>13</td>
</tr>
<tr>
<td>BR5999-82-3-2-HR1</td>
<td>18</td>
<td>3</td>
<td>14</td>
<td>3</td>
<td>38</td>
</tr>
<tr>
<td>BR5999-82-3-2-HR10</td>
<td>10</td>
<td>3</td>
<td>13</td>
<td>5</td>
<td>31</td>
</tr>
<tr>
<td>BR5999-82-3-2-HR16</td>
<td>6</td>
<td>13</td>
<td>28</td>
<td>8</td>
<td>55</td>
</tr>
<tr>
<td>BR5333-34-4-6</td>
<td>14</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>14</td>
</tr>
<tr>
<td>BRRI Dhan40</td>
<td>16</td>
<td>19</td>
<td>19</td>
<td>9</td>
<td>63</td>
</tr>
<tr>
<td>BRRI Dhan41</td>
<td>28</td>
<td>18</td>
<td>28</td>
<td>12</td>
<td>86</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>131</td>
<td>70</td>
<td>103</td>
<td>106</td>
<td>410</td>
</tr>
</tbody>
</table>

### Results and discussion

It was observed that none of the varieties at any site was ranked excellent, since all the participating farmers selected one to four genotypes/varieties at each site (Table 1). It was agreed that 1 kg of seed of the selected PVS entries would be supplied to each farmer. All the farmers will grow their selections under their own management in the next rainy season.
Large-scale participatory varietal selection in Cambodia

EL JAVIER1 AND M SAROM2

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2. Cambodian Agricultural Research and Development Institute, PO Box 1, Phnom Penh, Cambodia

Abstract

Participatory varietal selection (PVS) has contributed substantially to the spread of new varieties of rice in Cambodia. Of the more than 5,000 trials conducted between 1990 and 2000, 91% were successful, but some failed because of drought, flood or other factors.

Introduction

Cambodia has very diverse rice environments. About 91% of its 2 million ha rice area are cultivated in the wet season. This area consists of 86% rainfed lowland, 4% deepwater, and 1% upland. Dry-season rice covers 9% of the total rice area of Cambodia. Most of the wet-season rice areas are unfavourable because of several abiotic and biotic stresses.

The Cambodia / IRRI / Australia Project (CIAP) started in the late 1980s with the goal of increasing Cambodia’s rice productivity. In August 1999, the Cambodian Agricultural Research and Development Institute (CARDI) was created. In 2000, it started to function and assume the leadership in rice research in the country.

Materials and methods

A comprehensive variety testing programme was started by CIAP in 1989. It involves the following sequential stages of on-station variety evaluation – observational yield trial, preliminary yield trial, and advanced yield trial (AYT). This is followed by participatory variety selection (PVS), conducted in farmers’ fields. Varieties are released based on the results of AYT or the combined results of AYT and on-farm trials. PVS involves testing 1–3 varieties that can be either released or promising.

There are two components of PVS. The first one is known as the on-farm variety adaptive trial (OFAT-V). Its objectives are to:

1. Monitor the performance of released and promising varieties in farmers’ fields
2. Allow farmers to select the best varieties under their own management practices
3. Obtain feedback from farmers about the test entries
4. Serve as a source of good seed for use by farmers
5. Provide a demonstration field for released and promising varieties.

The trial has the farmer’s best varieties as local checks. The amount of seed for each test entry is 1–1.5 kg. The suggested plot size is 100 m² (20m × 5m or 10m × 10m).

The other type of on-farm trial is called the variety-nutrient-pest monitoring trial (OFAT-VNP). Its objectives are to:
1. Monitor the performance of recommended varieties under different levels of fertilizer and soil type
2. Determine the incidence of insect pests and diseases under different levels of fertilizer and soil type
3. Provide a demonstration field for CIAP’s current technology
4. Serve as a basis for improving technology recommendations.

Two types of factorial treatment design are used. Design I involves a combination of two varieties (recommended and farmer’s variety) and three fertilizer treatments (0, 1, and 1.5 times the recommended fertilizer rate). Design II has three varieties (two recommended varieties and a farmer’s variety) and two fertilizer treatments (0 and recommended fertilizer rate). For both designs, a trial is composed of six plots. Trials
are conducted in different soil types. More data are collected in OFAT-VNP than in OFAT-V. Data collected were: grain yield, straw yield, harvest index, DTF, plant height, tiller number, panicle number, and cultural practices employed.

CIAP/CARDI has governmental organisations (GO) and non-governmental organisations (NGO) as co-operators that liaise with the participating farmers. Co-operators are responsible for a range of activities. They receive protocol for trials, select farmer participants, assist in site selection, field layout and data collection, and monitor trials (seeding, transplanting, reproductive stage, harvesting). Staff from CIAP/CARDI monitor the trials. For OFAT-V, each co-operator receives US$ 35–50 per trial. Co-operators for OFAT-VNP receive more than this per trial. NGOs fund the OFATs they conduct.

Results and discussion

A total of 5,139 OFAT-V and OFAT-VNPs were conducted from 1990 to 2000. Most of them tested short-duration varieties, and trials for upland rice varieties were the least numerous (Table 1). The percentage success rate ranged from 18% (upland) to 91% (aromatic group). From 1997 to 1999, 357 OFAT-VNPs were conducted with 77% success. Some trials failed because of drought, flood, submergence, rats, birds, crabs, rabbits, security problems, poor layout and wrong choice of test entries for certain environments.

Table 1. Number of PVS trials conducted and their success (%), 1990–2000

<table>
<thead>
<tr>
<th>Trial</th>
<th>Number of trials</th>
<th>Success (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFAT-V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short duration</td>
<td>1952</td>
<td>78</td>
</tr>
<tr>
<td>Medium duration</td>
<td>824</td>
<td>61</td>
</tr>
<tr>
<td>Medium duration</td>
<td>938</td>
<td>87</td>
</tr>
<tr>
<td>Long duration</td>
<td>990</td>
<td>83</td>
</tr>
<tr>
<td>Deepwater</td>
<td>326</td>
<td>57</td>
</tr>
<tr>
<td>Upland</td>
<td>76</td>
<td>18</td>
</tr>
<tr>
<td>Aromatic</td>
<td>33</td>
<td>91</td>
</tr>
<tr>
<td>OFAT-VNP</td>
<td>357</td>
<td>77</td>
</tr>
</tbody>
</table>

Three released short-duration varieties (IR66, IR72, and Kru) were tested in irrigated to partially irrigated farmers’ fields from 1990 to 1993. IR66 had the highest yield and was the variety most preferred by farmers (Table 2). The farmers’ own varieties were least preferred.

In the following years, IR66 was replaced by a newly released variety IR Kesar. The average yields of Kru and IR Kesar were higher than those of farmers’ varieties from 1993 to 1995 (Table 3). Both recommended varieties had higher preference than the local check varieties. However, more farmers gave first preference to their own varieties compared to the previous years. These farmers used IR66 as their local check variety, reflecting the adoption of released varieties.

In 1996, a very high-yielding line (IR84725) in station trials was tested against IR Kesar and Kru in farmers’ fields (Table 4). IR84725 showed yield superiority over released and local check varieties. It had the highest preference rating. However, it was dropped from further testing due to its poor grain qualities. Finding progenies from this line with good grain characteristics failed. In other on-farm trials, some promising lines that performed well were discarded later because of grain quality problems. From 1996, promising lines have had to pass a grain quality test before they are tested in farmers’ fields.

In 1997, on-farm VNP trials were conducted in various soil types using released pure line selections from Cambodian traditional varieties. In Bakan soil type, released varieties CAR 1, CAR 2 and CAR 3 and the local checks had comparable mean yields (Table 5) without fertilizer. However, released varieties gave higher yields than the local varieties under recommended nutrient

Table 2. Yield of recommended short-duration varieties in 232 wet-season and 200 dry-season on-farm trials and farmers’ preferences, 1990–93

<table>
<thead>
<tr>
<th>Entry</th>
<th>Yield (t ha⁻¹)</th>
<th>Farmers’ preference</th>
</tr>
</thead>
<tbody>
<tr>
<td>IR66</td>
<td>3.6</td>
<td>220 87</td>
</tr>
<tr>
<td>IR72</td>
<td>3.4</td>
<td>72 157</td>
</tr>
<tr>
<td>Kru</td>
<td>3.4</td>
<td>99 144</td>
</tr>
<tr>
<td>Local checks</td>
<td>3.1</td>
<td>19 16</td>
</tr>
</tbody>
</table>

Table 3. Yield of recommended short-duration varieties in 235 wet-season and 230 dry-season on-farm trials and farmers’ preferences, 1993–95

<table>
<thead>
<tr>
<th>Entry</th>
<th>Yield (t ha⁻¹)</th>
<th>Farmers’ preference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kru</td>
<td>3.2</td>
<td>136 148</td>
</tr>
<tr>
<td>IR Kesar</td>
<td>3.3</td>
<td>204 108</td>
</tr>
<tr>
<td>Local check</td>
<td>3.0</td>
<td>67 135</td>
</tr>
</tbody>
</table>

Table 4. Yield of recommended short-duration test entries in 71 wet-season and 381 dry-season on-farm trials and farmers’ preferences, 1996/7

<table>
<thead>
<tr>
<th>Entry</th>
<th>Yield (t ha⁻¹)</th>
<th>Farmers’ preference</th>
</tr>
</thead>
<tbody>
<tr>
<td>IR Kesar</td>
<td>3.5</td>
<td>105 167</td>
</tr>
<tr>
<td>Kru</td>
<td>3.4</td>
<td>44 112</td>
</tr>
<tr>
<td>IR 84725</td>
<td>3.7</td>
<td>187 96</td>
</tr>
<tr>
<td>Local check</td>
<td>3.4</td>
<td>69 68</td>
</tr>
</tbody>
</table>
management. In a very poor soil (Table 5), local check varieties were better than released varieties regardless of nutrient management employed. This information helps plant breeders to more clearly define their target environments.

**Table 5. Yield of entries (t ha$^{-1}$) in on-farm VNP trials conducted on two soil types, 1997**

<table>
<thead>
<tr>
<th></th>
<th>Bakhan soil$^1$</th>
<th>Koktrap soil$^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Zero fertilizer</td>
<td>Recommended fertilizer</td>
</tr>
<tr>
<td>CAR 1</td>
<td>1.4</td>
<td>2.0</td>
</tr>
<tr>
<td>Local check</td>
<td>1.2</td>
<td>1.8</td>
</tr>
<tr>
<td>CAR 2</td>
<td>2.0</td>
<td>2.7</td>
</tr>
<tr>
<td>Local check</td>
<td>2.1</td>
<td>2.5</td>
</tr>
<tr>
<td>CAR 3</td>
<td>1.8</td>
<td>2.5</td>
</tr>
<tr>
<td>Local check</td>
<td>1.8</td>
<td>2.3</td>
</tr>
</tbody>
</table>

1. CAR 1 evaluated in 2 trials, CAR 2 in 6, and CAR 3 in 4
2. CAR 1 evaluated in 2 trials and CAR 2 and 3 in 4 trials each

**Conclusions**

In general, on-farm trials met their objectives. On-farm trials have contributed substantially in the spread of new varieties in Cambodia. NGOs have played significant roles in the success of PVS.
An introduction to data management and analysis for participatory varietal selection trials

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Abstract

Data from on-farm varietal trials are usually not considered as amenable to statistical analysis as data from research station experiments. This is because variability is believed to be higher in farmers’ fields; and the data from simple experiments are considered to be inappropriate for statistical analyses. However, in this paper, we show, with examples, how data from simple participatory varietal selection (PVS) experiments using Mother and Baby designs can be usefully analysed using existing statistical methods. The data collected on quantitative traits and farmers’ perceptions demand the application of parametric and non-parametric methods.

Introduction

We explored means of analysing and interpreting data from simple on-farm experiments, and have found many existing statistical methods that are directly relevant to participatory varietal trials. This paper aims to demonstrate the application of various statistical methods for analysing quantitative and qualitative data from participatory varietal selection (PVS) trials.

Creating spreadsheets

PVS data are often poorly documented. A researcher should be able to prepare abstracts of information in many ways and subject data to statistical analyses without much extra effort. To do so, data from Mother and Baby trials should be entered in spreadsheets so that they can be analysed without re-entry of data. This requires data to be organised in columns where each column is a single descriptor, or trait, so that a two-way ANOVA is possible in statistical programmes such as Minitab (Table 1).

Design of PVS trials and type of data

A simplified Mother and Baby trial design (Snapp, 1999; and Julien de Meyer and Marianne Bänziger pers. comm.) that does not require complex layout plans is used for PVS trials (see Appendix).

1. Mother trials (single-replicate all-entries) allow direct comparison among all varieties. Farmers (sites) serve as replications. Mother trials are kept to a minimum, because they are researcher-intensive.

The following type of data are usually collected in these trials:
- Quantitative data on traits such as grain yield, straw yield, days to flowering
- Ranking of all the varieties for such traits as cooking quality and market price.

2. For the Baby trials (single-replicate, single-variety) each farmer provides a replication and there are more Baby trials than Mother trials. Household level questionnaires (HLQs) are collected from each farmer to record their perceptions about a new variety as ‘more’, ‘same’ or ‘less’ in comparison to the local check for many traits including yield and quality (see Appendix). Sometimes quantitative data for yield is obtained, although considerable practical difficulties have to be overcome.

1. Analysis of data from Mother trials

Analysis of quantitative data

The analysis of a two-way data table, with varieties on one side and farmers (replications) on the other, is straightforward and can be computed as a randomised complete-block design using standard statistical packages.

We analysed the data of single-replicate all-entries Mother trials of six varieties of upland rice conducted by 12 farmers in Jharkhand in the rainy season of 2001. There was significant variation among varieties and...
An introduction to data management

farmers (Table 2). These significances are conservative, as the error term to test the main effects is the varieties x farmers’ interaction that includes a large field-to-field variation.

Analysis of matrix ranks

Two-way ANOVA. The six varieties in the nine-replicate Mother trial were scored (1 = lowest; 6 = highest) for grain yield by consensus in focus group discussions. The data were analysed by a two-way ANOVA with nine replications and six varieties. The ANOVA revealed significant differences among varieties and farmers for ranks at $P<0.001$.

The mean ranks for varieties of interest were: Ashoka 200F = 4.3; Ashoka 228 = 4.7; Kalinga III = 3.0; and BG 102 = 2.4. The lsd (5%) = 0.71 was computed. The mean scores of Ashoka 200F and Ashoka 228 do not differ but both have significantly higher scores than the check varieties Kalinga III and BG 102.

Friedman’s method for randomised blocks.
Alternatively Friedman’s non-parametric method can be used. The matrix scores of the six varieties within each block (farmer) are assigned ranks (1=lowest; 6=highest) for making the paired comparisons. Friedman’s method yields a $X^2$ value for each comparison. The results were similar to that of the ANOVA, since $X^2$ for 1 df for Ashoka 200F vs. Ashoka 228 = 1.78 (non-significant); and for Ashoka 200F vs. Kalinga III = 9.00 ($P<0.01$); Ashoka 200F vs. BG 102 = 9.00 ($P<0.01$); Ashoka 228 vs. Kalinga III = 5.44 ($P<0.05$); and Ashoka 228 vs. BG 102 = 9.00 ($P<0.01$).

2. Analysis of data from Baby trials

Analysis of quantitative data

Grain yield data when collected can be analysed as follows:

Analysis of paired-plots by randomised-block design or paired t-test. In Baby trials, a pair is composed of new and local cultivars sharing a common field. These data can be analysed as a two-way ANOVA. This design is a special case of the randomised-block design where there are only two treatments and the $n$ farmers represent the blocks.

An alternative analysis of paired plots is provided by the paired t-test (Snedecor and Cochran, 1973). Which of these two analyses should be preferred varies with the interest of the researcher. For example, when it is desired to assess if the varieties were tested over variable fields, then the ANOVA technique will provide a separate sum of squares for testing variation among farmers’ fields that is not possible with a paired t-test.

Table 2. Analysis of variance for grain yield (t ha$^{-1}$) of six varieties of upland rice tested in Mother trials in Jharkhand, India, rainy season 2001

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>$F$</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sites (Farmers)</td>
<td>(s-1) =11</td>
<td>2973</td>
<td>270.27</td>
<td>35.95</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Varieties (a)</td>
<td>(a-1) =5</td>
<td>1046</td>
<td>209.20</td>
<td>27.83</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Sites x varieties (error)</td>
<td>(s-1) (a-1) =55</td>
<td>413</td>
<td>7.51</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>(as-1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
We analysed grain yield (t ha\(^{-1}\)) of the upland rice variety Ashoka 200F tested alongside the local check variety BG 102 in Jharkhand, India, in the rainy season of 2001 in 22 Baby trials.

Both analyses similarly concluded that there were significant differences between varieties for grain yield (Table 3). Since there is 1 degree of freedom for varieties the computed \( F = t^2 \). The advantage of the ANOVA technique is clear as it discerns significant differences among the farmers’ fields over which the varieties were tested. Note that the \( F \)-test assumes the farmers \( \times \) varieties interaction to be non-significant and it cannot be tested in the present case. The paired \( t \)-test, assumes that each pair of observations is not independent but related; if one member of the pair is high, so is the other, i.e., they are positively correlated. This can be verified by performing a correlation or regression analysis.

**Regression analysis.** Regression of grain yield (t ha\(^{-1}\)) of Ashoka 200F on to the grain yield of the local variety was significant (\( a = 0.123 \pm 0.106; b = 1.44 \pm 0.08 \)) with a very high \( R^2 = 0.94 \). The regression coefficient of the new variety is more than one indicating its increased response to improving environmental conditions. However, the yield of the new variety in the poor environment is still higher than the local check. The new variety is thus adaptable to the sample of target environments and can be a potential replacement for the local variety.

**Non-parametric methods.** We also investigated the use of some alternative non-parametric methods that make no assumptions for specific distribution for the population.

**Friedman’s method for randomised blocks.** This is an alternative to the two-way analysis of variance. In this method the varieties (\( a = 2 \)) are ranked within each block or farmer; \( b = 22 \) in our case. If there are ties, they are treated in the conventional manner (by average ranks). The ranks are summed for each variety and the statistic \( H \) or \( \chi^2 \) is computed (Sokal and Rohlf, 1995). \( \chi^2 \) is distributed as \( \chi^2 \left[a-1\right] \), where \( a \) is the number of varieties. Our computed value of \( \chi^2 = 21.98 \) is significant at \( P<0.001 \). We conclude, as for the ANOVA and the paired \( t \)-test, that the grain yield of Ashoka 200F is significantly higher than the local variety.

**Wilcoxon’s signed-ranks test.** This method is more widely used than the Friedman’s test for paired-plots. The differences between the grain yields of the varieties across farmers are computed and ranked without regard to the signs so that the smallest absolute difference is ranked 1 and the largest is ranked 22. Tied ranks are computed as averages as usual. The original signs of differences are then assigned to the corresponding ranks. The sum of the positive and the negative ranks are computed, and whichever is smaller in absolute value is labelled \( T \). This is compared with the critical value of \( T \) in statistical tables for the corresponding sample size.

In our case the value of \( T = 0 \). Since this is less than the table value at the two-tailed 1% level (see Table A9 in Snedecor and Cochran, 1973) the null hypothesis is rejected. Thus Ashoka 200F significantly yields more than the local variety.

### Analysis of perception (qualitative) data

**Z-test for comparing percentage perceptions.** Standard errors can be computed for percentage perceptions and compared to test the significance of differences. In HLQs returned by 40 farmers comparing the Ashoka 200F variety of rice to the local check in 2000 in Jharkhand, 78% perceived Ashoka 200F to have ‘more’, 23% to have ‘same’, and none ‘less’ yield than the local variety. In this case \( N = 40 \); variance of proportion \( (p) = pq/n \) where \( q = (1 - p); SE \) for ‘more’ = \( \sqrt{(pq/n)} = \sqrt{(0.78 \times 0.23)/40} = \pm 0.07 \). We may compare ‘more’ with ‘same’ by computing, \( Z = (p_1 - p_2)/\sqrt{(p_1 q_1/n_1 + p_2 q_2/n_2)} \). The computed \( Z = 0.78-0.23/\sqrt{2(0.78 \times 0.23)/40} = 5.81^{**} \); \( >1.96 \) the value of normal deviate \( (Z) \) at \( P<0.05 \). The null hypothesis is rejected and we can conclude that a significantly larger number of farmers perceived Ashoka 200F to be higher-yielding than the check variety.

**Chi-squared test.** Alternatively, a Chi-squared \((\chi^2)\) test may be applied for the perception of 40 farmers of which 31 recorded ‘more’, nine the ‘same’, and 0 ‘less’ for the grain yield of Ashoka 200F over the local check. A \( \chi^2(2 \text{ d.f.}) = 38.15 \ (P<0.01) \) was computed on a 1:1:1 hypothesis. It shows that significantly more farmers perceive Ashoka 200F to be higher-yielding than the local variety.

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**Table 3. ANOVA and paired \( t \)-test for grain yield (t ha\(^{-1}\)) for 22 Baby trials of A200F vs. local in Jharkhand, India, rainy season 2001**

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>MS</th>
<th>( F )</th>
<th>( P )</th>
<th>Mean A200F</th>
<th>Mean Local</th>
<th>( t )</th>
<th>( P )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmers (F)</td>
<td>21</td>
<td>2728</td>
<td>18.4</td>
<td>&lt;0.001</td>
<td>1.43</td>
<td>0.91</td>
<td>4.52</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Varieties (V)</td>
<td>1</td>
<td>3028</td>
<td>20.4</td>
<td>&lt;0.001</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>F x V</td>
<td>21</td>
<td>148</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

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Discussion
We have shown how simple experiments (Mother and Baby design) conducted by farmers provide data that can be statistically analysed by existing, robust parametric and non-parametric statistical techniques.

**We recommend that researchers**
- Conduct some Mother trials and a large number of Baby trials
- Analyse the data from Mother trials to compare all the new varieties among themselves
- Analyse the matrix rank data from Mother trials using parametric or non-parametric methods
- Analyse Baby trials as paired-plots, i.e., use a paired t-test or, preferably, a randomised-block design analysis
- Do a regression analysis of paired-variety data to test the response of the new variety in relation to the check variety
- Alternatively, use non-parametric methods such as Friedman’s test, Wilcoxon’s signed-rank test to compare paired varieties
- Analyse farmers’ perceptions from HLQs by non-parametric methods.

**Implications for drought-prone station trials**
While performing a combined analysis of multilocational research station trials only balanced sets are usually considered. The trials from drought-prone locations where only a few entries may survive in the trial are rejected as ‘failed trials’. However, the few entries that survive, in fact, provide the most valuable information for marginal areas. This demands modification of multilocational analysis. If data from partly successful trials are analysed by the paired-plot techniques, described in this paper, there seems little need to reject a drought-prone site.

Acknowledgement
This publication is an output from projects R7281 and R7542 funded by the UK Department for International Development (DFID) Plant Sciences Research Programme (PSP) for the benefit of developing countries. The views expressed are not necessarily those of DFID.

References
Participants in this session were primarily social scientists, and represented both national programmes and non-governmental organisations (NGOs) in the Philippines, India, and Nepal.

The group identified lack of social science capacity as the primary constraint to the integration of social science expertise in participatory plant breeding/participatory varietal selection (PPB/PVS) programmes. The shortage of skilled social scientists is acute in most national programmes. This situation is unlikely to change in the near future. There was a consensus that training plant breeders in robust methods for participatory rural appraisal (PRA), the study of seed networks, and preference analysis is likely to be the most feasible approach to integrating social science in participatory crop improvement.

Best practices

It was generally agreed that the involvement of social science professionals in PPB/PVS is most important at the goal-setting stage. However, the group felt that simple diagnostic methods and tools can give breeders and agronomists the information needed to set breeding priorities and identify target groups of farmers.

It was also agreed that the use of ‘key informants’, ‘nodal farmers’, and ‘leading farmers’ can increase impact. It was noted that these different community roles are not always filled by the same person. Some concerns were expressed about relying too heavily on ‘leading farmers’.

Support was expressed by some members of the group for the use of positive approaches to information collection and PRA, notably the Appreciative Enquiry technique, where the focus is on identifying the favourable features of farmer practices and varieties.

Some participants cautioned that long-term relationships with farmers can negatively affect data quality by narrowing the sample of farmers contacted, or by the initiation of a ‘feedback’ loop between farmers and breeders, in which farmers may be influenced by the priorities and methods of researcher. This was not a consensus point, however. Some participants noted that long-term relationships with farmers can increase their capacity and effectiveness as research partners, and can allow farmers to participate in planning and evaluation research.

Training needs

Because of the lack of professional social scientists working in agricultural research in national programmes, the group agreed that there is an urgent need for breeders and agronomists to be trained in PRA. Most agronomists and breeders also need training at a very basic level in communicating with farmers and in cultural sensitivity. Training in participatory methods must be institutionalised in the training of plant breeders.

Research needs

There was a consensus on the need for research on how to quickly and efficiently identify nodal and social networks for seed dissemination, and how to link with these networks to increase the adoption of superior varieties. Information is also needed on the stability of farmer networks over time and crops.

There is also a critical need for research on methods for assessing rice quality in the context of PVS or PPB programmes. Quality is recognised as the key element influencing farmer preference in many situations, yet effective, large-scale methods for participatory quality evaluation have not been developed.
Seed systems and PVS – scaling up for impact

Chair: PQ Craufurd
Discussants: KD Joshi, PK Sinha

Eleven researchers, representing India, Ghana, Nepal, and the Philippines participated in the discussion. It was generally agreed at the outset that the availability of seed of farmer-preferred varieties is one of the major constraints to their spread. The discussion focussed on PVS and seed systems for released and unreleased varieties in the context of rainfed upland systems.

Best practices

Participants identified several practices that had met with some success in promoting dissemination of farmer-preferred varieties. These included:

Farmer groups or community-based seed multiplication (CBSM) programmes

Farmer or CBSM groups have been successful in some contexts. Farmer training and outside facilitation is needed to make these groups sustainable and effective.

Seed-producing villages

The Central Rainfed Upland Rice Research Station (CRURRS) in Jharkand, India, is experimenting with a system in which whole villages specialise in seed production of a single variety, with assistance from the research station, which provides seed and technical backstopping. The producing village then generates income by selling seed to farmers in the surrounding areas. This approach, which is similar to contract commercial seed production, has not been widely tested, and is likely to be best suited to the initial introduction of new varieties, with substantial researcher involvement. Centralisation of seed production in this manner would facilitate seed certification systems based on the ‘Truthfully Labelled’ or ‘Quality Declared’ designations.

Use of nodal farmers to encourage farmer-to-farmer spread of preferred varieties

Nodal farmers are central links in local seed-exchange networks. If farmers who are known and respected sources of seed for the community are identified and integrated in PVS and seed distribution programmes, farmer-to-farmer spread can be enhanced.

Seed/diversity fairs

Farmer-to-farmer seed exchange can be promoted through seed or diversity displays and contests at agricultural fairs.

Large-scale PVS programmes

Large-scale PVS programmes using Mother and Baby or informal research and development (IRD) designs have demonstrated effectiveness in facilitating extensive variety testing, with substantial adoption and dissemination of some varieties in the trials. But important questions remain as to how often these trials should be conducted in a given region, and how the programmes should be designed to maximise their effectiveness as dissemination tools.

Practices that do not work

Private-sector seed distribution

In general, the private sector will not find it profitable to distribute seed in marginal areas. Particularly in the uplands, farmers use little purchased seed and minimise investment in all inputs.

Seed banks and community-based seed multiplication schemes

Seed banks and CSBM programmes have not been found to be sustainable without outside facilitation.

Formal-sector involvement in dissemination of unreleased varieties

In some countries, it is not possible from a regulatory standpoint for formal-sector institutions to support the dissemination of unreleased varieties.

Research and training needs

Support for community-based seed multiplication

Substantial training and support is needed for farmer groups or villages undertaking seed production projects. Support is needed on production, maintaining purity, and drying and storage to maintain quality.
**Disseminating information**

It was agreed that the flow of information about the performance, quality, and availability of new varieties is very important in promoting adoption. Fairs, cultural activities, and religious ceremonies are all potential venues for information exchange. Research is needed to identify the most effective channels for providing farmers with information.

**Further study on farmer-to-farmer dissemination**

Farmer-to-farmer dissemination has been extremely successful in dissemination of several rainfed rice varieties (notably Mahsuri) among small-scale farmers in Asia. More research is needed on the conditions that foster this spread, and on the speed and manner in which it occurs.
The discussion focused on describing ‘best practices’ for rainfed rice breeding programmes. Steps in the process where integration is beneficial include the following:

**Selection of the target environment and farmer population, and setting breeding goals**

Participatory rural appraisal (PRA), focus group discussions, and other participatory research tools need to be made more accessible to formal breeding programmes. Farmers, millers and consumers must be consulted in the setting of breeding goals.

**Selection of parents and donors for hybridization**

Participatory crop improvement experience stresses the need to use adapted local varieties as parents. At the same time, one of the strengths of conventional plant breeding programmes is their access to a broad range of germplasm from other regions. Exotic germplasm has been used very successfully in the DFID upland rice participatory plant breeding (PPB) programme in India, where IR64 has been used as a parent in upland targeted crosses for stressful environments.

Conventional breeding programmes can efficiently produce heterogeneous populations for farmer selection or lines for participatory varietal selection (PVS). The importance of careful parent choice for small breeding programmes was stressed, and the value of a strategy based on screening large populations of a few well-chosen crosses for stressful environments.

**Screening for diseases, problem soils, drought, and submergence tolerance**

There was consensus that conventional breeding programmes can have an advantage in screening large, heterogeneous or segregation populations for tolerance to well-characterised biotic and abiotic stresses, notably disease and insect resistance, submergence, salinity, other problem soils, and possibly drought.

Programmes relying solely on on-farm selection may not be able to apply consistent selection pressure for such resistances when stresses are sporadic in occurrence. Managed-stress nurseries on research stations are very useful on pre-screening material before it is exposed to farmer selection.

**Post-harvest evaluation**

Early evaluation of cooking and eating quality is essential to the success of breeding programmes. PVS programmes are very effective in collecting information from farmers on harvestability, storability, and quality of advanced breeding lines, but there was strong consensus that quality evaluation must be conducted as early as possible in the cultivar development process, and certainly no later than the first year of yield evaluation.

JR Witcombe and collaborators described their use of micromilling and participatory approaches to organoleptic testing to ensure that genotypes of unacceptable quality are discarded before they are subjected to expensive agronomic evaluation on-station or by farmers.

**Integration of PVS in conventional breeding programmes and cultivar-testing systems**

Several strategies for integrating PVS into varietal testing were discussed. It was suggested by several participants that on-farm PVS of the Mother and Baby model is best initiated during or following multi-environment yield testing, or during testing for national release. GN Atlin noted that in many rainfed rice programmes it would be beneficial to introduce a preliminary PVS step to complement or replace initial on-station replicated yield testing, which is often poorly predictive of farmer preference.

**Seed production**

Rate of adoption is strongly associated with seed availability. Conventional breeding programmes rarely have the capacity to produce and distribute large quantities of seed of new varieties. Participatory, community-based seed production approaches need to be pursued by formal-sector programmes.

**VARIETAL RELEASE**

Greater use of PVS data by national release committees to complement data from on-station trials in making varietal release decisions is likely to result in a higher proportion of released varieties being acceptable to farmers.
The group outlined the respective roles and potential synergies of the formal research institutions and agricultural development organisations (ADOs) in varietal development. Specific areas in which ADO contributions are important include:

- Determining farmers’ needs and preferences, and helping breeders understand and prioritize these
- Representing farmers’ interests in seed production organisations and varietal release committees
- Help in scaling-up on-farm evaluation, especially for quality and sensory parameters
- Help in involving farmers in selection in early generations
- Influencing policy-makers and other NGOs.

The formal breeding sector has critical contributions to make in the following areas:

- Collection, characterisation, evaluation, and dissemination of germplasm
- Crossing and development of populations
- Screening for disease, insect, and abiotic stress tolerances in managed-stress nurseries
- Facilitating the varietal release process
- Producing breeder seed
- Packaging and transferring technology for faster delivery to farmers

Overall, the strengths of ADOs centre on their ability to contact farmers, integrate them into the planning and decision-making process, and facilitate large-scale testing and seed distribution. Formal-sector breeding programmes have great capacity to access and screen germplasm under managed-stress conditions, and to develop novel populations, but are constrained in their ability to work directly with large numbers of farmers. Integrating the strengths of ADOs and formal breeding programmes can greatly speed up the development and dissemination of improved varieties.

Several important factors in the success of partnerships between ADO and formal breeding programmes were identified:

- The ADO partner should have the resources, capacity, and interest needed to participate in research and development
- A formal framework for collaboration, usually in the form of a Memorandum of Understanding, is needed between the ADO and research organisation
- Simple methods for experiment management and data collection are needed
- ADOs and farmers need to be involved in dissemination of information and seed through informal channels
- Credit for successes must be shared between the formal programme and the ADO.
A Mother and Baby Trial System

JR WITCOMBE
Department for International Development (DFID) Plant Sciences Research Programme (PSP), Centre for Arid Zone Studies (CAZS), University of Wales, Bangor, Gwynedd LL57 2UW, UK

1. The Mother and Baby trial system recognises the difficulty of obtaining reliable yield data from many, widely dispersed participatory trials, so in these trials – called Baby trials – only farmers’ perceptions on yield are collected.

<table>
<thead>
<tr>
<th>The ‘Mother’ Trial</th>
</tr>
</thead>
<tbody>
<tr>
<td>● many cultivars, several locations, one replicate per location</td>
</tr>
<tr>
<td>● researcher-designed, farmer-managed, farmer level of inputs</td>
</tr>
<tr>
<td>● yield and maturity measured by researchers</td>
</tr>
<tr>
<td>● consultative evaluation of other traits</td>
</tr>
</tbody>
</table>

2. Yield data are collected from Mother trials – carefully managed and monitored trials where all of the entries are compared with each other.

<table>
<thead>
<tr>
<th>The ‘Baby’ Trial</th>
</tr>
</thead>
<tbody>
<tr>
<td>● one or two new cultivars per farmer</td>
</tr>
<tr>
<td>● compared to local cultivar or second new variety</td>
</tr>
<tr>
<td>● farmer-managed, farmer inputs</td>
</tr>
<tr>
<td>● evaluation of farmer’s perceptions</td>
</tr>
</tbody>
</table>

3. The Mother and Baby trials are followed by methods of popularisation, i.e., informal research and development (IRD) and seed sales and dissemination.

<table>
<thead>
<tr>
<th>The next step</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage</td>
</tr>
<tr>
<td>Initial</td>
</tr>
<tr>
<td>Adaptive (can be done simultaneously with Mother and Baby trials)</td>
</tr>
<tr>
<td>After recommendation</td>
</tr>
</tbody>
</table>
5. Research station trials and Mother trials must include ‘check’ varieties. These checks are essential entries in the trials and include farmer-preferred varieties and promising entries. Unless these are included it is not possible to tell if a test variety is better or worse than the ones currently promoted in the formal and informal seed supply system.

6. Detailed protocols for the design and conduct of the Mother trials are described below.
Description of the Mother trial

**Purpose**
The Mother trial gives statistically analysable data on yield per hectare.

**Design**
Each trial consists of a single replicate of an RCBD. Hence every Mother trial has a separate randomisation.
The plots should have a border of the Local variety wherever possible.
Plot size will vary with the land available but are larger than is normally used in research station trials.

**Number and location**
There are only a few Mother trials compared to the number of Baby trials. As a minimum, three Mother trials are grown in each of two villages. The three Mother trials in a village are grown by different farmers in different fields.

**Colour-coding of entries**
Not required.

**Selection of farmers**
The Mother trials will be conducted in villages in which GVT is well established with farmers that have cooperated with the project in the past. There is no need to change the farmers and locations over years so the trials will become progressively easier to run.

**Management**
As farmer’s practice. Two changes are possible (seed priming to obtain more uniform stand establishment, and additional weeding if required).

**Costs**
Only for Mother trials can the farmer be compensated for the use of his or her land. This is done when (a) farmer is reluctant to devote such a large area of land to the trial or (b) when the project wishes to retain the seed from the trial. A project can pay for the estimated amount of produce that would have been obtained from the area of the trial. The project can also pay for purchased inputs (fertilizer) but the fertilizer dose must still be as farmer’s usual practice.
Labour is supplied free of cost by the farmer. The seed from the Mother trial belongs to the project when compensation has been given, but the fodder from the trial belongs to the farmer.

**Responsibilities**
1. **Layout**
   project staff
2. **Sowing**
   supervised by project staff
3. **Growing and management**
   farmer (but see management above)
4. **Monitoring and data collection**
   project staff
5. **Harvesting and threshing**
   supervised by project staff
6. **Plot measuring**
   project staff
7. **Plot weighing**
   harvest weighed by project staff (whole-plot harvest) to determine yield per hectare

**Pre-harvest participatory evaluation**
A matrix ranking of the performance of the varieties can be done by a group of interested farmers when the varieties are near to maturity.

**Post-harvest participatory evaluation**
Optional (because yield data is the primary objective). Can be done if the participating farmer is allowed to retain some of the harvest. A post harvest interview to rank the varieties is useful.

**Repeat**
The Mother trial is repeated on the research station as a conventional three- or four-replicate, RCBD. Additional check and test varieties can be added to the trial if desired.
### Baby trials

**Purpose**  
The Baby trials give statistically analysable data on farmers’ perceptions and acceptance of varieties.

**Design 1**  
*Single test entry*  
Single variety per farmer compared to Local check.

**Design 2**  
*Two test entries*  
Two varieties per farmer. This method is more powerful, and colour coding helps farmers lay out the trials correctly without staff supervision at sowing time.  
When there are two test entries there may, or may not be, a *formal* Local check. There will always be an *informal* Local check (the farmer’s own crop, or a neighbour’s crop, grown on an adjacent or nearby field, or the farmer’s recollection).

**Number and location**  
There are many more Baby trials than Mother trials. To avoid confusion it is simpler not to have any farmer growing both a Mother and a Baby trial. As a minimum, trials should be in four villages. Each variety should be tested a minimum of a total of six times (and to get six successful trials more are initially needed). Baby trials are not repeated on the research station.

**Colour-coding of entries**  
Highly desirable. Varieties are allocated colours (e.g., red, blue, green, yellow, white) and supplied in cotton bags of that colour. The name of the variety, and the year of supply, is also written on the bag. Each bag is supplied with four short bamboo pegs of the same colour with which farmer should mark out the plot.

**Selection of farmers**  
By group meeting of villagers and random allocation of varieties to farmers. All three wealth ranks should be included.

**Management**  
Strictly as farmer’s practice.

**Costs**  
Farmers pay all costs. All seed and fodder belongs to the farmer. The only subsidy is that the seed is provided free of charge.

**Responsibilities**

<table>
<thead>
<tr>
<th>Responsibility</th>
<th>Party</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Layout</td>
<td>farmer (layout is discussed in detail in the group meeting)</td>
</tr>
<tr>
<td>2. Sowing</td>
<td>farmer</td>
</tr>
<tr>
<td>3. Growing and management</td>
<td>farmer</td>
</tr>
<tr>
<td>4. Monitoring</td>
<td>project staff complete page 1 of the HLQ (see below) that describes the trial. This needs to be completed whilst the trial is in the field – preferably after the last fertilizer application</td>
</tr>
<tr>
<td>5. Harvesting and threshing</td>
<td>farmer</td>
</tr>
<tr>
<td>6. Plot measuring</td>
<td>not required</td>
</tr>
<tr>
<td>7. Plot weighing</td>
<td>not required</td>
</tr>
</tbody>
</table>

**Post-harvest evaluation**  
Essential. Project staff complete page 2 of the HLQ and pages 3 and 4 as well in the case of Design 2 (see below). Data in the HLQ is collected on a ‘more, same or less’ qualitative evaluation. By not collecting yield data, many more trials can be conducted to give a more reliable estimate of farmers’ perceptions.

---

1. The number of varieties is low so all possible paired comparisons (n(n-1)/2) can be made. For example, with four varieties there are 6 possible comparisons, with five varieties 10, and with six there are 16 comparisons. However, there is no need to compare every variety with every other variety, so when the number of varieties is larger a sample of comparisons (e.g., comparisons where each entry appears twice and comparisons are allocated randomly = n comparisons) can be made and validly analysed.
Non-participatory data – Mother trials

7. Yield data are collected by carefully measuring the area of each plot and the total plot yield. Other traits such as plant height and days to 50% flowering or tassel are also recorded. A complete data set (optional traits in italics) will comprise the following.

1. Sowing date
2. Days to 60% flowering
3. Days to maturity
4. Plant stand
5. Yield per plot (kg)
6. Plot area (length and breadth)
7. Straw yield (kg per plot)
8. Incidence of diseases
9. Incidence of insect pests
10. Comments on the trial, e.g., occurrence of drought

Matrix ranking – Mother trials

8. Two examples are given of matrix ranking for Mother trials below – one for rice and one for maize. Not all of the characters need to be ranked, only those considered important by farmers. There is no point in trying to rank a trait if farmers say there is little difference between the varieties.

9. It will not be possible to matrix rank the varieties for post-harvest traits unless:
   - The participating farmer has been allowed to retain the seed, i.e., it has not been purchased by the project
   - Sufficient time has elapsed after harvest for grain processing, consumption and sales.

The Household Level Questionnaire (HLQ) Baby trials

10. Baby trials are monitored by HLQs. These consists of either 2 or 4 pages

<table>
<thead>
<tr>
<th>HLQ components</th>
<th>For Design 1</th>
<th>For Design 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Page 1 Trial details</td>
<td>Page 1 Trial details</td>
<td>Page 1 Trial details</td>
</tr>
<tr>
<td>Page 2 Test entry versus Local variety</td>
<td>Page 2 Test entry 1 versus Test entry 2</td>
<td>Page 2 Test entry 1 versus Test entry 2</td>
</tr>
<tr>
<td></td>
<td>Page 3 Test entry 1 versus Local variety</td>
<td>Page 4 Test entry 2 versus Local variety</td>
</tr>
</tbody>
</table>

11. It may not be obvious how the question on page 1 of the HLQ about the cross-section of the trial should be answered, so examples are given here
**MATRIX RANKING OF VARIETIES IN FOCUS GROUP DISCUSSIONS (FGDs) FOR RICE**

Rank varieties on a scale where Best = Total number of varieties being evaluated e.g., 1-5 when there are 5 varieties with 5 = best and 1 = worst

Ranking to be done by group consensus

<table>
<thead>
<tr>
<th>Variety</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1</td>
<td></td>
</tr>
<tr>
<td>V2</td>
<td></td>
</tr>
<tr>
<td>V3</td>
<td></td>
</tr>
<tr>
<td>V4</td>
<td></td>
</tr>
<tr>
<td>V5</td>
<td></td>
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<tr>
<td>V6</td>
<td></td>
</tr>
<tr>
<td>V7</td>
<td></td>
</tr>
<tr>
<td>V8</td>
<td></td>
</tr>
</tbody>
</table>

**Number of participants in FGD =**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>V1</th>
<th>V2</th>
<th>V3</th>
<th>V4</th>
<th>V5</th>
<th>V6</th>
<th>V7</th>
<th>V8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germination</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Days to 50% flowering</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Days to maturity</td>
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<td>Plant height</td>
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<td>Additional traits of farmers' liking</td>
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</table>
## MATRIX RANKING OF VARIETIES IN FGDs FOR MAIZE

Rank varieties on a scale where Best = Total number of varieties being evaluated e.g., 1–5 when there are 5 varieties with 5 = best and 1=worst

Ranking to be done by group consensus

<table>
<thead>
<tr>
<th>Variety</th>
<th>Name</th>
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<tbody>
<tr>
<td>V1</td>
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<tr>
<td>V2</td>
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<td>V3</td>
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<td>V4</td>
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<td>V5</td>
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<td>V6</td>
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<td>V7</td>
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<td>V8</td>
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### Number of participants in FGD =

<table>
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<th>Parameter</th>
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<th>V2</th>
<th>V3</th>
<th>V4</th>
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<th>V6</th>
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<td>Number of cobs</td>
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<td>Overall preference</td>
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Page 1. Household Level Questionnaire for Farmer-Managed Participatory Research (FAMPAR) Baby Trial

The answers in the boxes on this page describe the trial

**KEY INFORMATION**

<table>
<thead>
<tr>
<th>Farmer name</th>
<th>Village</th>
<th>Falia</th>
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<tbody>
<tr>
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</table>

State        Year

<table>
<thead>
<tr>
<th>Season</th>
<th>Crop</th>
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</thead>
<tbody>
<tr>
<td>kharif/rabi/summer</td>
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</table>

<table>
<thead>
<tr>
<th>Interviewer</th>
<th>Date of interview</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Names of V1 and V2 | Colour codes of V1 and V2 | V2 is
Variety 1 (V1) |                     | V1 is a test entry
Variety 2 (V2) |                     | Local / test entry

**TRIAL DETAILS**

<table>
<thead>
<tr>
<th>Variety 1</th>
<th>Variety 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date of sowing</th>
<th>Slope (score)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>level / gentle / steep</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Date of harvest</th>
<th>Slope (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;10% / 10–20% / &gt;20%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Was the crop irrigated?</th>
<th>If YES then how many times?</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES/NO</td>
<td></td>
</tr>
</tbody>
</table>

Map of the trial

Cross-section of the trial

Draw the trial layout with the positions of Variety 1 and Variety 2. Include field name

Draw the topography of the trial

Any other comments on conduct of trial e.g., is weeding, plant population, intercropping the same for Variety 1 and Variety 2?

<table>
<thead>
<tr>
<th>FYM</th>
<th>Urea</th>
<th>DAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variety 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variety 2</td>
<td></td>
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</tr>
</tbody>
</table>

Did Variety 1 get more/same/less FYM than Variety 2? 
Did Variety 1 get more/same/less Urea than Variety 2? 
Did Variety 1 get more/same/less DAP than Variety 2?

Was Variety 1 grown under the same management as Variety 2? YES / NO
Appendix

Page 2. COMPARE VARIETY 1 WITH VARIETY 2

The answers in the boxes on this page determine if Variety 1 is better, about the same, or worse than Variety 2

Did the crop suffer from a drought period? (Note that for varieties that differ in maturity, the same drought period may affect flowering in one variety and grain filling in the other).

<table>
<thead>
<tr>
<th>Seedling stage</th>
<th>Tillering/late vegetative</th>
<th>Flowering/silking and tasseling</th>
<th>Grain filling/cob formation</th>
</tr>
</thead>
<tbody>
<tr>
<td>V 1 and 2</td>
<td>V 1 and 2</td>
<td>V 1 YES/NO</td>
<td>V 1 YES/NO</td>
</tr>
<tr>
<td>YES/NO</td>
<td>YES/NO</td>
<td>V 2 YES/NO</td>
<td>V 2 YES/NO</td>
</tr>
</tbody>
</table>

1. Establishment

Variety 1 is [better/same/worse] for establishment than Variety 2?

2. Flowering time (tasseling)

Variety 1 is [earlier/same/later] to flower than Variety 2?

If flowering time (tasseling) is different then by how many days?

Variety 1 is [__] days earlier than Local (Either ‘days earlier’ or Variety 1 is [__] days later than Local ‘days later’ as applicable)

3. Yield

Variety 1 yields [more/same/less] than Variety 2?

If the yield is different provide more information in the box below. Give the farmer’s description e.g., in Local units, as a proportion (e.g., half as much again), or a percentage.

4. Grain quality

Variety 1 is [better/same/worse] in quality than Variety 2?

5. Market price

Variety 1 is [higher/same/lower] in price than Variety 2?

6. Overall preference

Variety 1 is [better/same/worse] overall than Variety 2?

7. Intention variety 1

Will the farmer grow Variety 1 next year? [YES/NO]

8. Intention variety 2

Will the farmer grow Variety 2 next year? [YES/NO]

Question 8 applies only if Variety 2 is a test entry. (Otherwise it is assumed that the Local variety will be grown next year.)

Add any other information that the farmer thinks is important. This could include reaction to pests and diseases; quality traits such as taste, cooking quality, milling quality; and whether the farmer mentions that he or she has given seed to others.

Variety 1

Variety 2
Appendix

Page 3. ONLY FOR DESIGN 2 (TWO TEST ENTRIES)
COMPARE VARIETY 2 WITH THE LOCAL VARIETY

The answers in the boxes on this page determine if Variety 1 is better, about the same, or worse than the Local variety

1. **Establishment**
   Variety 1 is ___________ for establishment than the Local variety?

2. **Flowering time (tasseling)**
   Variety 1 is ___________ to flower than the Local variety?
   
   If flowering time (tasseling) is different then by how many days?
   Variety 1 is ___________ days earlier than Local
   Variety 1 is ___________ days later than Local
   Either ‘days earlier’ or ‘days later’ as applicable.

3. **Yield**
   Variety 1 yields ___________ than the Local variety?
   
   If the yield is different provide more information in the box below. Give the farmer’s description e.g., in Local measures, as a proportion (e.g., half as much again), or a percentage.

4. **Grain quality**
   Variety 1 is ___________ in quality than the Local variety?

5. **Market price**
   Variety 1 is ___________ in price than the Local variety?

6. **Overall preference**
   Variety 1 is ___________ overall than the Local variety?

Add any other information that the farmer thinks is important. This could include reaction to pests and diseases; particular quality traits such as taste, cooking quality, milling quality; and whether the farmer mentions that he or she has given seed to others.

Comments on the Local variety versus Variety 1
Appendix

Page 4. ONLY FOR DESIGN 2 (TWO TEST ENTRIES).
COMPARE VARIETY 2 WITH THE LOCAL VARIETY

The answers in the boxes on this page determine if Variety 1 is better, about the same, or worse than the Local variety

1. Establishment
Variety 2 is ________ better/same/worse ________ for establishment than the Local variety?

2. Flowering time (tasseling)
Variety 2 is ________ earlier/same/later ________ to flower than the Local variety?

If flowering time (tasseling) is different then by how many days?
Variety 2 is ________ days earlier than Local ________ Either ‘days earlier’ or ________ days later than Local ________ days later’ as applicable.)

3. Yield
Variety 2 yields ________ more/same/less ________ than the Local variety?

If the yield is different provide more information in the box below. Give the farmer’s description e.g., in Local measures, as a proportion (e.g., half as much again), or a percentage.

4. Grain quality
Variety 1 is ________ better/same/worse ________ in quality than the Local variety?

5. Market price
Variety 1 is ________ higher/same/lower ________ in price than the Local variety?

6. Overall preference
Variety 1 is ________ better/same/worse ________ overall than the Local variety?

Add any other information that the farmer thinks is important. This could include reaction to pests and diseases; particular quality traits such as taste, cooking quality, milling quality; and whether the farmer mentions that he or she has given seed to others.

Comments on the Local variety versus Variety 1

7. Rank of three varieties
Rank Variety 1, Variety 2 and Local variety in order of preference

<table>
<thead>
<tr>
<th>Rank</th>
<th>Variety name</th>
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<tbody>
<tr>
<td>1</td>
<td></td>
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<tr>
<td>2</td>
<td></td>
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<tr>
<td>3</td>
<td>(Worst)</td>
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</table>
Participants

Organising Committee
GN Atlin
TR Paris
JR Witcombe

DFID invitees
JR Witcombe
DS Virk
KA Steele
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