12

Farmer Participatory Approaches for Varietal Improvement

A. Joshi and J.R. Witcombe

Introduction

Participatory varietal selection (PVS) is the selection by farmers on their own fields of finished or near-finished products from plant breeding programmes. These include released cultivars, varieties in advanced stages of testing, and well characterised material such as advanced non-segregating lines in inbreeding crops, or advanced populations in outbreeding crops. In contrast, participatory plant breeding (PPB) employs the active participation of farmers in breeding programmes, and will usually involve farmers selecting genotypes from genetically variable, segregating material. The difference between PVS and PPB may not appear to be great at first sight. However, PPB requires more resources and more time than PVS, and PVS identifies material that can be supplied more rapidly by the formal seed sector. The contrasting impacts of PVS and PPB on biodiversity have been discussed by Witcombe and Joshi (1995) and Witcombe *et al*. (1996).

Most of the published work on participatory research for varietal breeding and selection can best be defined as participatory varietal selection, since farmers were given near-finished or finished products to test in their fields (e.g., Maurya *et al.*, 1988; Sperling, 1993; Joshi and Witcombe, 1996). There are few examples in the literature of participatory plant breeding, but Sthapit *et al*. (1995 and 1996) give a well-described example of PPB in Nepal to select chilling-tolerant rice from F_5 bulk families. For participatory plant breeding in India, the authors, in collaboration with SN Goyal of Gujarat Agricultural University, have created a broadly-based maize composite.

We discuss here the work of the KRIBHCO Indo British Rainfed Farming Project, West, (KRIBP(W)) on PVS in rice, chickpea, maize, and black gram and on PPB in maize and rice. The work on PVS in rice and chickpea has been reported in the literature (Joshi and Witcombe, 1995 and 1996) so only highlights of this work are presented, whereas the work carried out so far on maize and black gram is described fully.

Participatory Varietal Selection

Participatory varietal selection to identify preferred cultivars has three phases: identifying farmers' needs; searching for suitable material to test with farmers; and experimentation on farmers' fields. Once identified, the seed of farmer-preferred cultivars needs to be rapidly and cost-effectively supplied to farmers.

Identification of farmers' needs in crop cultivars

The identification of farmers' needs is a form of market research. It allows cultivars that are likely to match their requirements to be selected for testing, and the avoidance of cultivars that will be obviously unacceptable. Various methods can be used, separately or in combination, to identify these requirements, including techniques in participatory rural appraisal (PRA), the examination of the crops in farmers' fields, or the pre-selection of varieties by farmers from trials of many entries grown on a research station or on farm.

If resources permit, the landraces described by the farmers interviewed in PRAs should be collected and grown in a trial that has recommended cultivars as a control. This can provide information that a PRA may not have revealed because:

- the extent of diversity can be evaluated in the trial;
- the degree of agreement between the names given to landraces by farmers and their phenotypes can be determined, and
- the performance of recommended cultivars can be compared to local germplasm.

Moreover, superior landraces can be identified in the trials that are worth including in a PVS programme or that can be used as parents for a PPB programme.

Search among released material and advanced lines

After the farmers' requirements have been identified, a search is carried out to identify appropriate cultivars for inclusion in the selection programme. The cultivars may be national, state or regional releases, both recent and old, and may also be 'pre-release' material at an advanced stage of testing. Suitable cultivars for resource-poor farmers exist amongst the released cultivars, and are worthy of inclusion in PVS programmes because farmers may have never seen them.

The suitability of released cultivars for resource-poor farmers

When including released cultivars for PVS it is assumed that centralised breeding has produced cultivars adapted to low-yielding environments and that among these released cultivars there will be ones that will be preferred by farmers over those they are currently growing. However, it is recognised that centralised breeding may be less efficient than decentralised breeding in producing cultivars adapted to marginal agricultural environments. (See Chapter 1.2 for a discussion on selection for specific adaptation in multilocational trials).

There is much evidence, discussed in Chapter 2.1, that most of the cultivars grown by farmers are old, and that only a few of the released cultivars are widely grown. Hence, a key assumption in the PVS of released cultivars is that cultivar replacement rates are lower than optimal because farmers have never seen a range of new cultivars. All that is needed is for farmers to be given seed of the already-existing cultivars that are suitable for the project area, but have either not been recommended or are unavailable in the area. Such cultivars can be introduced from other states for a participatory varietal selection programme; in most crops in India, cultivars can be found that have only been released and widely grown in a single state.

Advantages of released cultivars in uptake of research results

Choosing from amongst released cultivars has the advantage that any NGO or GO can, in principle, readily procure seeds in sufficient quantities for testing with farmers. If they are identified as being farmer acceptable it should be much easier, than is the case for pre-release or breeder's lines, to provide large quantities of seed to the farmers with little delay. However, to enlarge the basket of choices and exploit recent outputs from plant breeding research, pre-release cultivars were also included in the search process. In all of the crops studied, a number were identified as being suitable for testing with farmers. Some of these pre-release cultivars would be defined by others as advanced material, e.g., Maurya *et al*. (1988).

Experimentation for PVS

Various testing and evaluation systems can be employed that can vary greatly with the extent of farmer participation (Table 12.1). Many ‘on farm trials’ are conducted almost entirely by researchers on farmers’ fields, so there is little or no involvement of farmers. At the other extreme, very limited inputs can be provided by outsiders, such as scientists and development workers, by giving farmers a range of cultivars to grow without any further outside help. Outsider involvement in evaluation can also be minimised. Farmers can be asked in informal discussions which of the cultivars they like the most, or the subsequent demand for seed from farmers can be used as the selection criterion. According to the preferences found from the discussions or demand for seed, an NGO, a seed company, or a GO can make decisions on what seeds to provide to farmers. Informal research with minimal outsider inputs can be highly cost effective, and can be used by for NGOs with limited resources that wish to provide seed of farmer-acceptable improved cultivars.

In KRIBP(W), the trials were carried out by farmers in Farmer Managed Participatory Research (FAMPAR) varietal trials. These trials were divided into introductory and adaptive trials; small quantities of seed were given to farmers in the introductory trials, but, to avoid overestimating acceptability, seed was sold at commercial rates in the adaptive trials (Joshi and Witcombe, 1995). The introductory trials have three components - design, management and evaluation. To indicate how these trials can be conducted by project staff that often have little training in agricultural science, a modified extract from a training manual used in the project is presented in the Box.

Table 12.1 Methods of varietal selection with varying degrees of farmer participation.

Methods, in increasing order of importance of farmer participation	Examples	Evaluation primarily	Example institutions
1. Researcher-managed and evaluated on-station trials (Farmers may visit station to identify farmer-acceptable material).	All coordinated project programmes and national research centres. All SAUs.	Yield data	Research
2. Researcher-managed on-farm trials. Unreplicated design. (Farmers may be involved in evaluation)	Front-line demonstration and adaptive trials.	Yield data	Research and extension
3. Farmer-managed, replicated design, on-farm trials, with scientists’ supervision. Several entries per farmer	Farmers Field Varietal Trial (FFVT) in Nepal	Yield data Farmers’ perceptions	Research and extension
4. Farmer-managed using a recommended package of practices. Unreplicated design with many farmers.	Minikit programme.	Yield data	Extension
5. Farmer-managed, unreplicated design, on-farm trials. One cultivar per farmer. Replication across farmers.	The FAMPAR trials of KRIBP(W), KRIBP(E). GO/NGO collaboration in Rajasthan. Weltzien R. *et al.* this volume.	Yield data Farmers’ perceptions	Research Extension NGO
6. Trials as in 5	The FAMPAR trials of KRIBP(W).	Farmers’ perceptions only	NGO Extension Research
7. Farmer-managed trials. No formal design either within a farm or across farmers	Informal Research and Development (IRD) of Lumle Agricultural Research Centre, Nepal and KRIBP(W).	Informal, anecdotal	NGO Extension Research

The Conduct of FAMPAR Introductory Trials

Design

Replication

The basic unit of replication is a participating farmer, with each farmer allocated a single introduced variety. In each village each cultivar should be replicated equally. However, sometimes limited availability of seed will mean that some entries can be replicated less often than others.

The next unit of replication is the village. There is no need to conduct trials in every project village because a representative sample is sufficient. Often the trials are conducted in only three villages in KRIBP(W), one in each of the three states of the project.

Randomisation

Each participating farmer is randomly assigned a single variety - ideally, farmers are asked to remove a bag of seed from a sack. If the allocation is made before the seed is available the varieties can be represented by slips of labelled paper.

Plot size

Sufficient seed should be provided for plot sizes that are large, but not too large to present an undue risk for the farmer. For example, in rice 1-2 kg of seed can be provided. For rainfed sowings, a second bag of seed should be provided in case the rains fail in the period after the first sowing. This does not apply to *rabi* crops, such as chickpea, where only one sowing is possible.

Layout

Only one variety is given to each farmer to simplify the design of the trial and reduce planting errors. The introduced variety is grown adjacent to a plot of the local variety (see below).

Management

Plot selection

It is vital to select carefully the plot where the farmer grows the test cultivar alongside the local variety. For example, in sloping fields the farmer should not grow one cultivar on the upper and the other on the lower slope. It is essential that a researcher and the farmer jointly visit the proposed experimental plots and agree on the trial site and its layout. One of the most important questions to be resolved is whether the selected plot is usually used to grow that crop. If not, then it needs to be resolved if it represents well the fields usually used by the farmer for that crop. If not, then the farmer may be choosing an atypical, poor plot to reduce risk. At the time of the visit, the plots can be marked with pegs. At the time of sowing, the division of the two plots can be conveniently marked by growing a single row of a different crop between them.

Cultural practices

Farmers should be asked not to change their normal cultural practices in any way. The trial is not designed to test a package, but to test a single component, the new cultivar. The only exception to unchanged cultural practices is to change sowing rate when the seed size of the new variety differs greatly from the local. Usually this will be when the introduced variety has larger seeds, necessitating an increase in the weight of seed sown per area to achieve the same plant stand.

Evaluation

If *design* and *management* are correctly done, then the *evaluation* is the easiest part of the process.

Farm walks
The trials can be evaluated with varying degrees of intensity depending on the resources available. Whatever level of evaluation is employed, the most essential component is the 'farm walk'. In the farm walk the participating farmers visit each other's plots. It allows each cultivar to be assessed by a group of farmers on its performance *across all of the replications.* It is the farm walks that allow comparative data to be collected on all of the varieties in a trial.

Data collection
Focus Group Discussions (FGDs), before and after harvest, are carried out and data recorded on all aspects of the test entries including taste, market value, threshing characteristics and storability. The FGD uses a standard proforma that has to be completed but which allows the comments and the overall conclusions of the group to be recorded in a narrative fashion. A 'matrix ranking' of the varieties is completed in which the varieties are ranked trait by trait. Although the ranking is done for many traits, the overall ranking on the acceptability of the varieties is the most important.

In some cases, questionnaires can be completed for individual households - household-level questionnaires (HLQs). These assess the reactions of household members to the variety they grew. It allows the assessment of every participating household, and reliable percentage scores can be obtained.

Yield data
If yield data are required they can be obtained in a participatory way. The area of the plots are measured. Farmers, after harvesting the plots separately, measure the yield obtained from each plot. The benefits of the measurement of yield data using farmer participatory methods have been discussed by Poate, 1988.

For example, a participatory approach was used for estimating yields per area of rice in KRIBP(W). Data were obtained from farmers on the yield from their plots. The area of land under cultivation of each crop was extrapolated from the amount of seed sown (although the preferred method is to measure the area directly). The greatly increased replication that is possible using participatory methods produces a more accurate result than one derived from a smaller number of replications where area and yield is more accurately assessed by e.g., crop cutting. The lower reliability of extrapolated area and farmer-measured yields is more than compensated by the greater number of replicates that can be handled. Replication using conventional techniques is limited by the time-consuming visiting of widely dispersed plots to carry out labour-intensive crop cutting.

Results Obtained From Participatory Varietal Selection in KRIBP(W)

Rice

Participatory rural appraisals (PRA)

Ten rice landraces were identified in the PRAs, a probable underestimate, because landraces with almost identical names were assumed to be the same and only a sample of farmers was surveyed. Transplanted rice was much less important than direct-drilled rice. All of the landraces were early maturing and were of tall or medium plant height.

Search and procurement of rice cultivars

Four varieties were included in the 1992 trials because they were officially released in the project area and recommended for dryland farming, i.e., GR-3, GR-5, JR-75, and Poorva. However, they did not match the characteristics of the farmers' cultivars because they were dwarf or semi-dwarf cultivars. The remaining entry in the 1992 trial was Sathi-34-36, a recommended, tall cultivar.

An extensive search found 15 suitable released cultivars from six sources. The search process proved to be more difficult than anticipated. It was hard to find up-to-date published information on which cultivars are released, their major characteristics, and the agro-ecological system to which they are best adapted. Copies of the useful publications that do exist for rice (e.g., Roy, 1989) are not widely available. Access to unpublished information was essential and involved considerable time and costs to make personal visits. Nonetheless, wide searches were essential. If we had restricted the search to cultivars recommended by the official extension system then the cultivars most liked by farmers would not have been found.

Farmers' perceptions, rainy season 1992

The rainy-season trials were conducted in two villages in Gujarat in collaboration with a NGO, the Sadguru Water and Development Foundation, Dahod, Gujarat. The five cultivars tested were easily obtainable cultivars recommended for Madhya Pradesh and Gujarat. Rainfall was below average in 1992, and in the low-input conditions of the farmers' fields all of them, apart from Sathi-34-36, produced little or no grain. Farmers liked Sathi-34-36, an old variety that was released in 1955, and it was the only tall cultivar tested. The need can be seen to match the test cultivars to the local material for a character perceived to be important.

Farmers' perceptions, rainy season 1993

In 1993 farmers' perceptions of the five test cultivars they were given, the previously identified Sathi-34-36 and four new cultivars, were assessed by FGDs and HLQs in relation to their local landraces.

Nearly all farmers considered Kalinga III to be higher yielding than the local landrace (Fig. 12.1). Sathi-34-36 was felt to yield more than the local landrace by about half of the farmers. GR-3, the released and recommended cultivar, was perceived to be the lowest yielding entry in the trial by far (Fig. 12.1).

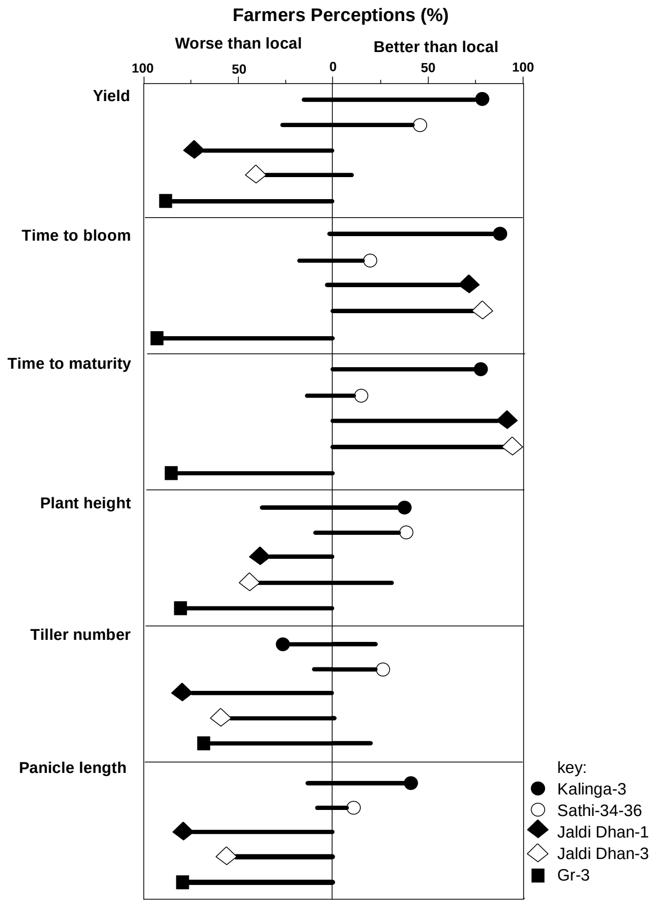

Fig. 12.1 Farmers perceptions of five rice cultivars evaluated in the rainy season of 1993. The farmers' perceptions as to whether the cultivar was better or worse than the local are indicated by the lines. The shorter the line for any cultivar the more farmers responded that the cultivar was the same as the local landrace.

It was known that farmers preferred earlier-maturing genotypes and, because they have high stover yield, tall genotypes. Nearly all the farmers perceived Kalinga III to be earlier than the local landrace, and Sathi-34-36 to be of a similar maturity (Fig. 12.1). GR-3 was late maturing and this was probably the cause of its low yield in the marginal agricultural environment of the project (Fig. 12.1). Farmers regarded Sathi-34-36 as taller than the local landrace and Kalinga III as being similar in height (Fig. 12.1). The low yield of GR-3 could be further explained by its apparent short height, which is a disadvantage in weedy, drought-prone environments (Fig. 12.1).

The degree of agreement of farmers' perceptions on Kalinga III, the most preferred cultivar, was assessed across the six villages in the study. The differences were highly significant for yield, time to bloom and maturity, and in all cases Kalinga III was superior to the local landrace. For yield, there was perfect agreement that Kalinga III was higher yielding in all villages in MP and Gujarat (Fig. 12.2). However, perceptions that Kalinga III was higher yielding than the local was far less marked in Rajasthan, but was always considered to be so by 50% or more of the farmers. Farmers' perceptions on time to bloom and time to maturity were in good agreement across the villages.

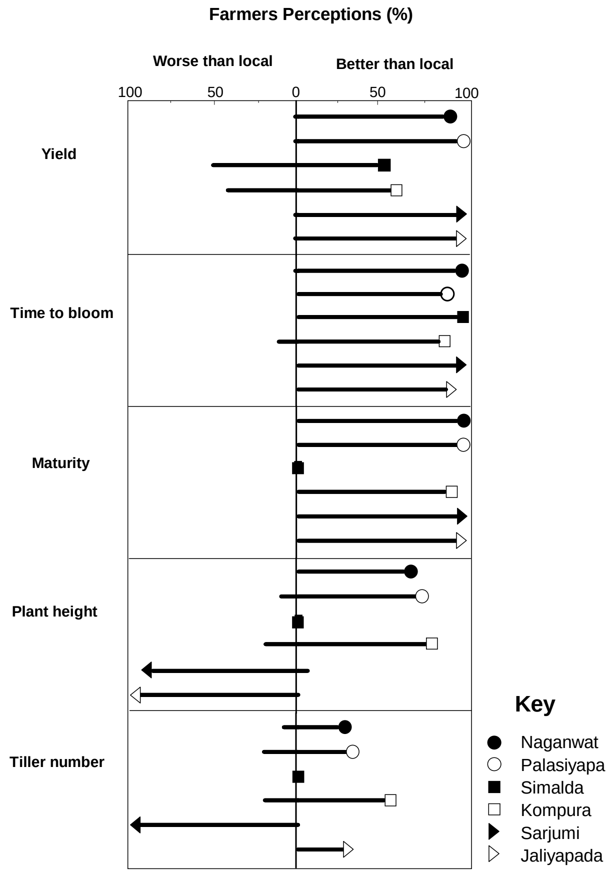

Fig. 12.2 Farmers perceptions of the rice cultivar Kalinga III evaluated during six villages in the rainy season of 1993. The farmers' perceptions as to whether the cultivar was better or worse than the local are indicated by the lines. The shorter the line for any cultivar the more farmers responded that the cultivar was the same as the local landrace.

Comparison of yield in rainy season 1994

The intention of the programme was to assess cultivars using farmers perception as the most reliable criteria. However, it soon became clear that if Kalinga III was to be released in the states of the project, (in order to qualify for subsidies and official promotion) yield data were required. Data on farmers' perceptions were not considered sufficient by release committees.

A participatory approach was used for estimating yields per area (*see* Box). In 1993, when there was below average rainfall and no yield data were taken, farmers perceived Kalinga III to be higher yielding than the local landrace. 1994 was an exceptionally wet year, but the paired yield comparisons of Kalinga III with the local landrace still showed that Kalinga III yielded 46% more (Table 12.2). Across the four villages its yield advantage varied from 15% to 84%. Of the 58 comparisons, Kalinga III yielded the same or more than the local in 44 of them (Fig. 12.3).

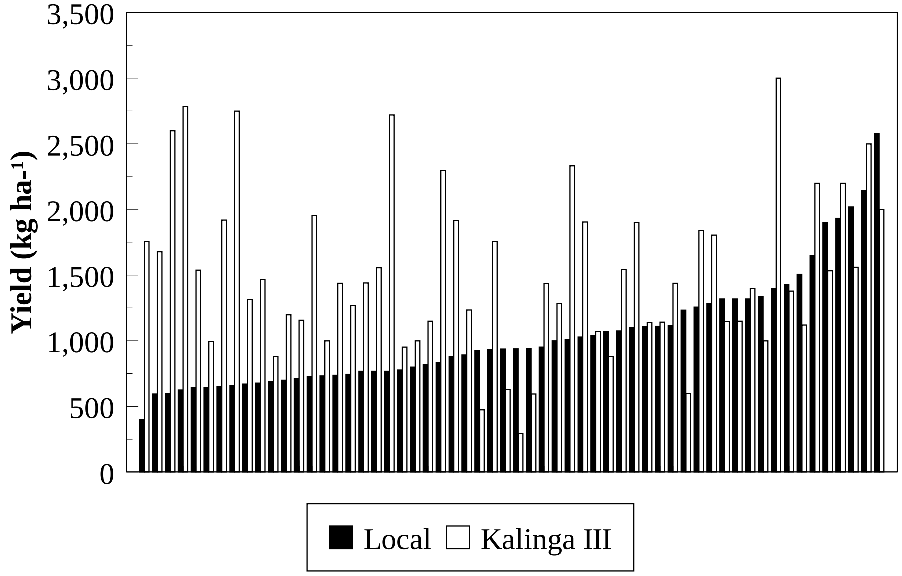

Fig. 12.3 Yield of Kalinga III and local landrace in 58 paired comparisons in four villages, rainy season 1994. The pairs have been placed in order on the x axis according to the increasing yield of the local landrace.

Table 12.2 Comparison of Kalinga III with local cultivars in FAMPAR trials in four villages during the rainy season 1993.

Village	Number of farmers	Yield (kg ha-1)		Yield of Kalinga III (% of local landraces)	t-value†
		Kalinga III	Locals		
Kompura (Raj)	31	1610	1036	155	4.4 **
Sadera (Raj)	5	1711	927	184	2.5
Sarjumi (Guj)	14	1342	1161	115	1.8 *
Palasiyapada (MP)	8	1373	929	147	1.3
Overall	**58**	**1521**	**1042**	**146**	**5.2 ****

† Paired t test between Kalinga III and local landraces

Confirmation of acceptability by seed sales

Subsequent sales of Kalinga III have confirmed its acceptability:

- In 1994, the acceptability of Kalinga III was confirmed by sales of 3.5 t seed at unsubsidised prices to farmers in over 20 villages. Seed sales were limited by seed supply as the demand could not be met fully. In villages where no seed was sold large areas were sown to Kalinga III from farmer-saved seed.
- In 1995, 1.7 t of seed was sold, since there were now large quantities of farmer-saved seed in the project villages. Two government agencies and 15 NGOs requested and were supplied with seed.
- In 1996, 4.0 t of seed was supplied to outside agencies and 12.0 t to both new and old project villages.

Chickpea

PRA and the search for chickpea cultivars

Only one local cultivar of chickpea was found to be grown, Dahod yellow. The search for chickpea cultivars was made through the chickpea breeders at the ICRISAT. They provided seed of four phenotypically diverse cultivars that were likely to be adapted to the project area.

Comparison of chickpea cultivars in rabi 1992/1993

Farmers were asked to compare the four test varieties with their local variety for many traits including degree of pest attack, crop maturity, seed size and colour, taste, and market value. Farmers preferences varied more across villages than was the case for rice so it was more difficult to assess the preferences of the farmers. There were trade-offs between traits. Some varieties had a lower yield but gave an earlier harvest with a higher market price. These trade-offs were difficult to assess as there was no overall agreement by the farmers on what trait they considered to be the most important.

From the farm walks, all farmers were aware of all the cultivars in the trials so they could make judgements on their overall preferences. Farmers were asked whether they would grow the cultivar they had tested for a second season and whether they would purchase seed of a different test cultivar. The latter question revealed much greater differences in farmers' preferences because there was a multiple choice amongst the cultivars the farmers had not previously grown and because purchasing seed was more onerous than replanting from farm-saved seed (Table 3.17). If seed purchase was involved a marked preference was shown for the cultivars that had a good combination of earliness and yield. When seed purchase was required, there was a 35-fold preference for ICCV 2, the most preferred cultivar, over ICCC 4 that was the recommended cultivar for the area. ICCV 2 and ICCV 88202 had most preferred combination of yield and earliness followed by ICCV 10 which was high yielding but late to mature. The cultivars ICCV 37 and ICCC 4 were markedly inferior to the local cultivar, Dahod yellow, because they flowered later but failed to yield more.

Table 12.3 Number of farmers participating in the 1992-1993 FAMPAR trials who said they would grow one of the test cultivars in the following year.

Question	Sample size†	Number of farmers that said they would grow the cultivar next year				
		ICCC 4	ICCV 37	ICCV 10	ICCV 88202	ICCV 2
Will you regrow your ‘own’‡ cultivar?	24	10	13	17	21	17
Will you grow another test cultivar?§	96	1	5	13	25	35
Total	120	11	18	30	46	52

† The number of farmers that could be asked this question: for any cultivar 24 had previously grown it and 96 would have not.
‡ Own = test cultivar they have already grown.
§ Assuming the seed would be purchased at an unsubsidised price.

Farmers preferred early cultivars because grain prices are higher early in the season and because farmers perceived that earlier-maturing cultivars would escape drought caused by receding soil moisture. The local cultivar had a more stable grain yield across the villages and sometimes yielded more than the test varieties. However, farmers still preferred the earlier of the test cultivars so yield is not the paramount consideration for farmer selection.

Maize

Maize is the staple diet of millions of people in the project area, but they have benefited little from the formal research and extension system. There has been no adoption of new maize cultivars and no evidence of any change in production technologies. PRAs in the project villages revealed that:

- There was a strong preference for white, rather than yellow, endosperm varieties.
- Farmers grow and prefer extra early and early-maturity cultivars that are better adapted to low-rainfall and low soil fertility.
- Farmers rarely purchase maize seeds, so they much prefer to grow composites rather than the hybrids. Also, they do not like hybrids because of their lateness and requirement for additional applied inputs.
- There was a marked preference for flint grain type over dent. Dents are perceived as more prone to field and storage pests. Women perceive that flint types allay hunger longer than the more quickly digested dents.
- Maize stover is the most important and the most preferred feed stock for their animals. Hence fodder quantity is important and tall cultivars are preferred.

In these exploratory PRAs the farmers described several landraces (Table 12.4).

Table 12.4 Maize landraces identified in PRAs.

Cultivar	Maturity (days)	Plant type	Grain type
Sathi Dholi†	70-75, (ready for eating as raw green cobs in 60)	Medium-tall, suitable for inter-cropping, drought tolerant. Low yielding with small cobs.	Flinty white, very hard seeds, small to medium grains.
Sathi Pilli†	As for Sathi Dholi	As Sathi Dholi.	Flinty yellow, very hard seeds, small to medium grains.
Dudh moger	95-100	Tall with broad dark green leaves, yields well, grown only when monsoon anticipated to be better than average. Grown on better land and soil types near the homesteads.	Dent white opaque, medium to large grains. Preferred for sweet taste and good cooking quality.
Nani ghangri	75-80	Tall plant with medium broad light green leaves, grown on average lands with average rains.	Flinty with off-white grains, translucent lustrous, small to medium grains.
Moti ghangri	80-85	Same as Nani ghangri.	Same as Nani ghangri .
Nani pilli	75-80	Same as Nani ghangri.	Flinty with yellow grains.
Moti pilli	80-85	Same as Nani ghangri.	Flinty with yellow grains, medium grains.

† Also known as Sameri

Table 12.5 The results of the search process for early white maize composites.

Cultivar	Duration (days)	Grain type	Plant type	Organisation of origin†	Release year‡	Where released	Years tested
Chandan Safed 2	70-75	White dent	Medium straight	JNKVV	1971	MP	1992,93,94
Gujarat Makka 1	83-85	White flint	Tall	GAU	1987	Guj	1992,93,94,95
Shweta	83-85	White flint	Tall	GB Pantnagar†	1983	UP	1992,93,94,95
D 822	80-85	White flint	Tall	GP Pantnagar	NR	-	1992,93
CHH 8	75-78	White semi-dent	Medium	JNKVV	NR	-	1994
CHH 9	85-90	White flint	Tall	JNKVV	NR	-	1994
CHH 13	90-95	White flint	Tall	JNKVV	NR	-	1994

† GB Pantnagar = Govind Vallabh Pant University of Agriculture and Technology (Uttar Pradesh)
‡ NR= Not Released, q = Year to be known

Search for maize cultivars

Based on the finding of PRAs, the project searched within and outside the project states early, white-grained composites. The following institutes were visited personally: the Maize Research Station, Godhra, Gujarat Agricultural University; the Regional Research Station, Chhindwara, JNKVV, Madhya Pradesh; the Regional Agricultural Research Stations at Banswara and Udaipur, Rajasthan Agricultural University; the G.B. Pantnagar University of Agriculture Science and Technology, Pantnagar, Uttar Pradesh; and the All India Coordinated Maize Improvement Project (AICMIP), New Delhi. The results of the search process carried out in 1992 and subsequent years revealed that there is a very restricted choice available for the early, white-grained composites (Table 12.5), probably because such composites are restricted to marginal areas and occupy a much smaller area than full maturity, yellow-grained varieties.

Results

In the first crop season of the project, *kharif* 1992, the trials were conducted in collaboration with a local NGO, Sadguru, in two neighbouring villages in Gujarat. Four new cultivars, Gujarat Makka 1, Shweta, Chandan Safad 2 and D 822 were each given to five farmers in both of the villages. Farm walks were organised and farmers' perceptions recorded. Although there were long intermittent dry spells, the farmer' perceived some of the new cultivars to be better than their local landraces. Gujarat Makka 1, selected from a local landrace Sameri, was the least preferred of the new entries because it was perceived to be no different from the local. Chandan Safed 2 was found to be low yielding, but its earliness and erect plant type was considered as advantageous for drought escape and for inter-cropping. Shweta and D 822 were perceived to be higher yielding by some farmers. It seemed possible that they only yielded more under favourable conditions. Discussion with farmers suggested that at least two of the new cultivars, Shweta and Chandan Safed 2, were liked, but there was a need for further testing.

In *kharif* 1993, in six project villages, using the same entries and design, farmers' perceptions in pre- and post-harvest FGDs were recorded. In this year, D 822 was rejected by farmers because of its low yield. Again the advantage of Shweta was not striking, but the seed demand for Shweta in the following seasons, *rabi* 1993-1994 and *kharif* 1994, suggests that Shweta has advantages. The supposition that it yields more than the local landraces in more favourable environments was confirmed by the increasing popularity of Shweta in the irrigated command areas of Sadguru villages and in the KRIBP(W) project villages. In more recent trials, farmers say in FGDs that they prefer Shweta for its better taste and cooking quality and its higher yield under better but well-drained conditions. The advantage of Shweta is much more apparent in the *rabi* than in the *kharif*.

Black gram

Black gram was found to be the most important pulse crop in the cropping system of the project area. The crop is grown both as a mixed crop or an inter-crop with maize and as a sole crop on many fields with poor soil fertility that have stony hilly patches. The exploratory PRAs revealed that:

- farmers grow two landraces for different reasons (Table 12.6);
- both of the landraces were found to be highly susceptible to powdery mildew and pod borer, and
- farmers have never seen or heard of any new disease-tolerant cultivars.

Table 12.6 Local landraces of black gram

Landrace	Maturity (days)	Grain type	Other characters
Telia	70-75	Shiny black, bold seeds	Spreading type, fetches higher market price as people in urban areas prefer shiny grains. Grown on better land for good yields. Susceptible to powdery mildew.
Kuvestya or Bhurya	75-80	Dull black, medium-bold seeds	Non-spreading type. Pods with globerulous hairy structures. Less shattering type, highly susceptible to powdery mildew. Fetches lower price. Mostly grown as mixed crop with maize.

A search for black gram cultivars.

A search was carried out in 1994 and 1995 for early maturing, disease-resistant cultivars, preferably with shiny black grains. The search was done using the information available with the project districts and the states, and referring to the *Handbook on Cultivars* (Tunwar and Singh, 1985). Pulse breeders were contacted in JNKVV, Indore, Madhya Pradesh; BARC, Trombey, Mumbai, Maharashtra; and the Regional Agricultural Research Station, Banswara, Rajasthan Agricultural University. Six cultivars were identified (Table 12.7).

Table 12.7 Black gram cultivars identified in the search

Cultivar	Duration (days)	Grain type	Plant type, disease reaction	Organisation of origin	Release detail	Year tested
T-9	80	Small light shining	Semi erect, highly susceptible to powdery mildew	CSA, Kanpur	National release, 1975	1994, 1995
TPU 4	80	Medium-bold, dull black	Spreading type, pod bearing in bunches, resistant to powdery mildew	BARC, Trombey, Mumbai	National release, 1993	1994, 1995
IU 8-6	75-80	Medium-bold, shiny black	Semi erect, field tolerance to powdery mildew	JNKVV, Indore, MP	NR†	1994, 1995
IU 1-19	80	Medium-bold, dull black	As IU 8-6	As IU 8-6	NR	1994, 1995
RBU 28	80	Small to medium, dull black	Spreading type semi-determinate	RARS, RAU, Banswara, Raj	NR	No seeds obtained
RBU 38	80-85	Medium, dull black	As RBU 28	As RBU 28	NR	No seeds obtained

† NR = Not released

Results

In *kharif* 1995, trials were conducted in three villages, one in each of Gujarat, MP and Rajasthan. Focus group discussions (FGDs) took place after farm walks in the villages.

Of the four varieties that were tested, IU 1-19 was the least preferred. Unlike the other test varieties, it had no advantage of earliness, as it flowered at the same time as the local varieties. Of the three remaining varieties, T-9 was the lowest yielding and had smaller pods than the local landraces. The two most preferred cultivars, TPU-4 and IU 8-6, were liked for their higher yield (the pods were born on bunches of 4-5 pods, whereas the local landrace -had only one or two pods per bunch). In the FGDs, all of the farmers commented on the lower pest attack in all of the test varieties (apart from T-9 in Gujarat, where it was reported to be susceptible). All of the new varieties were more resistant than the local to powdery mildew disease, but the farmers did not mention this in the FGDs as the disease incidence of powdery mildew was low in the local landraces in 1995. The higher yield of the new cultivars was attributed to better pest resistance and more pods. IU 8-6, overall, was the most preferred cultivar as it had a better grain colour than T-9. Neither T-9 nor IU 8-6 are recommended by any of the extension services in the three states in which the trials were conducted.

Discussion

From the initial PRAs it was found that there was no adoption of improved cultivars in any crop other than cotton. The PRAs revealed that the improved cultivars available on the market did not meet the farmers' needs. They had one or more undesirable traits, most commonly they took too long to mature and cereals often yielded too little straw. Many farmers believed that improved cultivars would give no benefit unless provided with additional inputs, such as fertiliser or irrigation, but the farmers had no access to them or they could not afford, or could not risk, their purchase. The perception that improved cultivars required higher inputs was due in part to the traditional "recommended package of practices" approach of scientists and extension workers.

In all crops, the PRAs in the villages proved to be a quick and effective method of identifying and characterising the landraces the farmers grew. From the results of the subsequent trials, it was clearly an essential first step in choosing which cultivars should be tested with farmers. Nonetheless, there are limitations as to what a PRA can reveal and the merits of collecting and growing out landraces have been discussed above.

Important features in the KRIBP approach

The approach for PVS used in KRIBP differed from Maurya *et al.* (1988) because most of the genotypes tested were released cultivars and not advanced lines. The released cultivars that were tested were not known in many parts of their area of adaptation because the domains in which they were recommended imperfectly defined and because they were inefficiently popularised. The important features of the research were:

- PRAs to identify the major characteristics of the local landraces. Cultivars obviously unacceptable for easily identified characters such as grain type, crop duration, and plant height could be avoided.
- Identification of suitable improved, released cultivars to provide a large ‘basket of choices’ (Chambers, 1989) to farmers.
- Testing in the most appropriate environment, the farmers' fields with unchanged farmer-management.
- Farmers and their families assessing all major farmer-relevant parameters, e.g., taste, cooking quality, market value, and not just the limited set of characteristics measured in plant breeders' trials.
- Assessment of farmer acceptability of cultivars by measuring adoption in subsequent seasons.

These results confirmed those of Maurya *et al.* (1988) that farmers can obtain considerably higher yields by growing different cultivars without changes in management. It means that the promotion of a recommended ‘package of practices’ can be counter productive, since it dissuades risk-averse farmers from trying new cultivars. It also persuades plant breeders to test cultivars under high levels of management that are atypical of resource-poor farmers’ fields.

PVS was effective and reliable for identifying appropriate cultivars for resource-poor farmers. Partnerships between breeders and NGOs would be a most effective way of carrying out PVS programmes. Wider adoption by both NGOs and governmental organisations of farmer-participatory methodology should result in rapid adoption of higher-yielding cultivars in marginal environments.

The PVS programmes have been carried out over a number of years, with several crops, and with many farmers. A general pattern has emerged showing that released, recommended cultivars are rarely preferred (Table 12.8). It indicated that some cultivars are being recommended outside of their area of their area of adaptation (for marginal areas when they are only appropriate for favourable environments), and that varieties that should be more widely recommended are recommended for too small an area.

Table 12.8 Cultivars identified by participatory varietal selection in the KRIBP project and performance of recommended cultivars

Crop	Performance of recommended cultivars	Cultivars tested† Rel.	Cultivars tested† Pre-rel.	Cultivars identified	Release location	Year of release
Rice	All recommended cultivars tried failed in farmers' fields‡.	9	7	Kalinga III Sathi-34-36	Orissa Gujarat	1983 1955
Maize (white)	Recommended cultivar not distinguished from local by farmers.	3	3	Shweta	U.P.	1980
Chickpea	One of the recommended cultivars, Dahod yellow, is the local cultivar. Other failed.	4	1	ICCV 2 ICCV 10 ICCV 88202	A.P. SZ§ Not rel.	1989 1992 Not rel.
Black gram	Recommended cultivar T-9 was less preferred. Others not tested as very old	2	2	TPU-4 IU 8-6	National Not rel.	1992 Not rel.

† Rel.=released cultivar and Pre-rel. = pre-released cultivar
‡ Except the old, landrace-derived variety Sathi-34-36
§ SZ = Southern Zone comprising A.P., southern M.P. and Tamil Nadu

Not all PVS programmes are equally successful in clearly identifying superior cultivars. In rice, black gram, and chickpea cultivars that were greatly preferred by farmers were identified. However, in maize the preferences are less striking, and Shweta was liked only for particular situations. This identifies the need for creating new material when none is available. This can also be done using participatory methods and these are discussed below.

Participatory Plant Breeding

Participatory plant breeding is a logical extension of participatory varietal selection. If it is desirable to involve farmers in selection of cultivars then there is no need to wait until there are finished products. Farmers can be involved in selecting among segregating material. However, the first recourse should be to PVS since PPB is more resource-consuming. PPB has to be used when PVS has been tried and failed, or when the search process has failed to identify any suitable candidate cultivars. PPB can also be used to build on the results of PVS, by using farmer-preferred cultivars, identified in PVS, as parents for participatory breeding programmes. Methods appropriate for PPB in rice are discussed by Sthapit *et al.* (1996) and general methods for PPB by Witcombe *et al*. (1996).

There are few examples of participatory plant breeding programmes and the methods they have used. Kornegay *et al*. (1996) carried out a PPB programme for common bean (*Phaseolus vulgaris*) in Colombia with three farmers from one district. Zimmerman (1996) used farmer visits early on in a common bean breeding programme, at three researcher-managed locations in Brazil. At the F_7 generation ten farmers were involved in testing the lines. Sthapit *et al*. (1995, 1996) carried out a PPB rice breeding programme in two villages in Nepal with 18 farmers. They used F_5 bulk families as the starting point. These were derived from seed harvested from F_4 families that were grown in land rented from a farmer. A variety, Machhapuchre-3, produced by this PPB programme was officially released in 1996 by the Variety Releasing and Registration Committee of Nepal.

In a collaborative programme with Dr SN Goyal of Main Maize Research Station, Godhra, Gujarat Agricultural University, a participatory breeding programme has been initiated for white-grained maize in the KRIBP development project. In the past, at least as far as India is concerned, efforts towards breeding white-grained maize have been largely, or entirely, dependent on the progeny of crosses between white-grained parents. However, since most maize breeding programmes have concentrated on yellow-grained maize, the diversity and yield potential of yellow maize cultivars is higher. It is, therefore, desirable that yellow-grained parents should be used when breeding white-grained maize. Grain colour is a highly heritable trait, and because of the Xenia effect the genotype of the pollen parent can be seen on the individual grains of a cob. Hence, it is easy to produce a pure white-grained population from crosses between yellow x white parents. Not only can superior yellow maize cultivars be used as parents, but great genetic variability can be produced because the yellow and white maize parents are genetically unrelated. The main features of this programme are the use of :

- a broad-based composite based on both yellow- and white-grained parents;
- locally-adapted parental material known to be acceptable to farmers;
- the testing of the acceptability of the breeding products with farmers as soon as sufficient seed is available, and
- the parallel testing of products with farmers and in official trials.

Varieties produced from this programme are performing extremely well in trials, and unfinished products have been tested with farmers and found to be highly acceptable.

Participatory rice breeding programmes are underway with Regional Agricultural Research Station, Banswara, Rajasthan Agricultural University and Regional Agricultural Research Station, Derol, Gujarat Agricultural University. In this programme:

- Crosses are used between Kalinga III, the most successful rice cultivar in the PVS programme in the KRIBP project, and a local landrace Nanisal. Kalinga III has also crossed to IR36 as an exotic parent with high yield potential and multiple disease and pest resistances.
- Early generation material grown on-station is selected by farmers.

The additional time required by PPB means that we are not yet able to present convincing experimental data to prove its effectiveness. Nonetheless, we are confident that participatory plant breeding will emulate or surpass the striking success of participatory varietal selection.

Acknowledgements

We would like to thank Dr JN Khare and Mr PS Sodhi of the KRIBP project. Without their unstinting efforts in managing the KRIBP project it would not have been possible to conduct the research in India reported here.