Better Choices for Rainfed Farming

J.R. Witcombe and J.P. Yadavendra
Joshi, A and JR Witcombe. 1996. Farmer participatory crop improvement. II. Participatory varietal selection, a case study in India. Experimental Agriculture 32: 461-477.


Foreword

PROF M S SWAMINATHAN
Chairman, National Commission on Farmers, Govt. of India
President, Pugwash Conferences on Science and World Affairs
Chairman, M S Swaminathan Research Foundation

This book "Cultivating Partnerships: Better Choices for Rainfed Farming" is a timely one since the Government of India is currently engaged in setting up a National Rainfed Area Authority. With the help of concrete examples of work done in the field, Drs Witcombe and Yadavendra have shown the value of Farmer and Scientist Collaboration. This has resulted in Participatory Varietal Selection procedures in a wide range of crops like maize, chickpea, blackgram, upland rice and horsegram. The other important principle adopted by the authors is the mainstreaming of pro-poor approaches in agricultural research and extension. Since good seed of the most appropriate crop and variety is a major constraint in dryland farming, the authors have shown how seed distribution networks can be organized.

In rainfed farming, the technologies recommended should be location and season specific. In most parts of India, rainfall distribution is highly skewed and much of the rain falls within a hundred hours in a year. Therefore, rainwater harvesting and efficient use become essential to ensure the stability and productivity of rainfed farming systems. Without the active participation of farm women and men in both the design and implementation of field programmes in research as well as knowledge management, it will be difficult to develop new technologies which are economically sound and environmentally sustainable. This is why I consider the contribution of Drs Witcombe and Yadavendra very important from the point of view of helping the proposed National Rainfed Area Authority to bring about a paradigm shift from patronage to partnership in all areas related to farming under rainfed conditions.

Improving the productivity, profitability and sustainability of rainfed farming holds the key to the eradication of hunger and poverty in such areas. Therefore, I hope this book will be not only read widely but also used for bringing about a pro-small farmer orientation to our research and extension programmes. The book contains the seeds for bringing a message of hope to over sixty percent of our rural population who earn their livelihood through rainfed farming.

Chennai
March 29, 2006

M.S. Swaminathan
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Chennai
March 29, 2006

M.S. Swaminathan

Gramin Vikas Trust, NOIDA, India.

Published by the Gramin Vikas Trust, Kribhco Bhavan, A-8-10, Sector 1, NOIDA 201301, Uttar Pradesh

Printed by Systems Vision, New Delhi.
We start with the success story of a better maize variety that, by yielding grain even under droughted and low fertility conditions, has brought new hope to poor farmers in western India. It is the successful outcome from the close collaboration of scientists and farmers.

The breeding programme that produced this maize variety, GM-6, was highly targeted to meet the needs of our clients, the resource-poor farmers of the hilly districts in adjoining areas of Gujarat, Madhya Pradesh (MP) and Rajasthan.

GM-6 maize variety is extra-early to mature and is proving to be a popular option for farmers in all of these three states (Figure 1). It matures about 7 days earlier than the earliest of the local varieties. It has a high yield because it has larger ears, and unlike local varieties, the grains fill to the tip. Farmers appreciate the good grain quality of this variety.

By working closely with farmers to identify suitable parents, by selecting for characteristics valued by the farmers, and by breeding and testing under farmers’ own management conditions, a new and improved variety acceptable to farmers was successfully and rapidly produced.
This publication describes more than a decade of research to aid the development efforts of GVT in two rainfed farming projects in western and eastern India. These development projects were funded by the Department for International Development (DFID) of the UK, KRIBHCO, and the Government of India. The need for farmer participation in development was recognised in these projects from their outset. GVT soon also realised that rainfed farming technologies suitable for the difficult areas in which it was working did not meet the needs of the client farmers. Research to develop suitable rainfed farming technologies became an important part of our work. To do this GVT built a unique partnership with State Agricultural Universities to carry out participatory research for the benefit of poor farmers in rainfed areas.

In this publication we present the results of this research. They produced positive outcomes that are benefiting the livelihoods of hundreds of thousands of poor farming households in six states of western and eastern India.

The participatory methods used here are widely applicable to all farming systems across India. We hope that this publication will stimulate others to use these approaches that have proven to be so effective in increasing the options available to farmers in some of the most difficult farming conditions in the country.

The results in this publication show the power of working closely with farmers to find out exactly which varieties are acceptable to them. At present in India, varieties are released and notified mainly on the basis of their high grain yield. We need to introduce a further criterion on acceptability to farmers.

NOIDA
March 22, 2006
The work described in this publication is from research projects that formed part of the Gramin Vikas Trust’s Rainfed Farming Projects in western and eastern India. These research projects were collaborations among many partner institutes. The development projects were funded by DFID India, KRIBHCO, and the Government of India. Much of the research was also supported by the DFID Plant Sciences Research Programme administered by CAZS Natural Resources, for the benefit of developing countries. The views expressed are not necessarily those of DFID.

The institutions that collaborated in the research were:

- **AAU** Anand Agricultural University, Anand 388110, Gujarat, India
- **ASA** Action for Social Advancement, Sahyog Nagar, Dahod, Gujarat 389 151, India
- **BAU** Birsa Agricultural University, Kanke, Ranchi 834 006, Jharkhand, India
- **CAZS-NR** CAZS Natural Resources, University of Wales, Bangor, Gwynedd, LL57 2UW, UK
- **GVT(E)** Gramin Vikas Trust (East), 280 Kanke Road, Near Pani Jaha Kothi, Ranchi 834 008, India
- **GVT(W)** Gramin Vikas Trust (West), West Indian Rainfed Farming Project, Bhopal 462 013, India
- **ICRISAT** International Crops Research Institute for the Semi-Arid Tropics, Patancheru 502 324, India
- **JNKVV** Jawahar Lal Nehru Krishi Vidyalaya, Indore 452001, Madhya Pradesh, India
- **KRIBHCO** Krishak Bharati Cooperative Limited, Noida 201301, Uttar Pradesh, India
- **MPUAT** Maharana Pratap University of Agricultural and Technology, Banskewar 327 001, Rajasthan, India
- **NAU** Navsari Agricultural University, Navsari 396445, Gujarat, India
- **SDAU** Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar 385506, Gujarat, India

We wish to thank the individual contributions of:

- SN Goyal, AN Metha, VP Patel and SV Sanghani of AAU.
- A Joshi and A Mondal of ASA.
- R Kumar, and DN Singh of BAU.
- A Mottram, CM Stirling and DS Virk of CAZS-NR.
- A Prasad, SC Prasad, BS Raghuvanshi, SS Rana, KS Sandhu, R Sharma, and SK Yadav of GVT.
- M Billore, NV Deshpande, A Gupta, R Parmar, VP Rajput, DK Sharma and HC Singh of JNKVV.
- GS Ameta, P Choudhary, SK Kaushik, R Pandya, P Rokadiya, LK Sharma, DP Saini and GP Vishwakarma of MPUAT.
- NB Patel and SBS Tikka of SDAU.

Photos by JR Witcombe unless otherwise credited. Cover picture by A. Mottram, CAZS-NR.
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Growing new varieties produced by modern plant breeding is an attractive option for farmers. Good varieties can yield more grain with the only cost to the farmers being the extra effort of harvesting the increase. However, many poor farmers in marginal areas have benefited little from new varieties but continue to grow lower-yielding landraces or old varieties that are often more susceptible to pests and diseases. They have had little opportunity to try released varieties and, when they do, they have usually found them unsuitable for rainfed, low fertility fields. These problems were solved by farmers and scientists working more closely together.

When GVT began working, more than a decade ago, for poor farmers in difficult, rainfed environments it was quickly found that formal plant breeding and varietal release systems had hardly begun to meet farmers’ needs. In western India, in the hilly adjoining districts of Gujarat, MP and Rajasthan it was difficult to find any farmer that was growing a variety produced by modern plant breeding. The same was found in the rainfed farming regions of eastern India. In all these areas, farmers continue to cultivate local landraces that have been grown by the farming community for generations. Most are low-yielding and susceptible to disease (Figure 2).

Farmers seldom had access to modern technologies, such as new varieties, and would find it difficult to afford the risk of purchasing seed of untried new varieties. In a process called participatory varietal selection (PVS) we improve access to new varieties. We provide farmers with a carefully selected choice of cultivars and reduce their risks as they do not have to purchase the new seed in order to try it. Farmers then test the new cultivars for themselves in their own fields. Scientists benefit from the knowledge of farmers; every season farmers sow their crops; they understand seeds and crop varieties, and appreciate the opportunity to try new varieties.

By fostering collaboration between plant breeders and farmers, our work aims to provide even the poorest farmers with a chance to benefit from improved technologies such as new varieties. Participatory research can resolve issues relating to gender or wealth, by involving men and women, both rich and poor. Evaluations and discussions can be conducted separately by gender and the poor can be identified and then helped by giving them seed to try in their own fields.

Apart from PVS, we also employ highly client-oriented breeding (COB) to produce new varieties tailored to the needs of the client farmers. Farmers in developing countries are often insufficiently involved in the breeding, selecting and testing of new varieties. Our client-oriented plant breeding programmes involve farmers in these processes to help identify or create varieties that suit local needs and conditions.

In COB, plant breeders and farmers learn from each other. Breeders have a broad knowledge of available genetic resources and of appropriate breeding methods. Farmers contribute local knowledge and test varieties under local conditions. Involving farmers speeds up the process of varietal adoption and increases the varietal diversity in farmers’ fields.

It is important to note that the benefits of PVS and COB are not restricted just to marginal farming systems but also apply to more productive ones. Some of the results we report below are from intensive irrigated production systems.

Why did we collaborate with farmers?

Collaborating with farmers. Testing rice cooking and eating qualities.

Figure 2. Local landraces are low yielding (a landrace maize, left) and susceptible to diseases (powdery mildew on a local blackgram landrace, right).
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One way of increasing the adoption of new varieties is to help farmers test for themselves a wide range of novel cultivars in their own fields. This process is termed Participatory Varietal Selection (PVS).

In PVS, the cultivars should be selected carefully to match the traits that farmers require. To do this we ask farmers what qualities are required in the traits that are important to them. They may, for example, specify that any new variety of rice must be early maturing and of a non-dwarf plant height so that fodder yield is adequate.

We have used already-released cultivars, not only from the target region but from other regions or countries. In India, there are many varieties that have been released and widely grown only in a single state, yet have the potential to be useful in others. Using already-released cultivars saves time because sufficient seed is usually readily available. We have found that the varieties farmers prefer the most are almost invariably imports from other regions rather than those recommended for the area (see box below).

We also use PVS to immediately test new varieties produced from our breeding programmes.

A successful participatory varietal selection programme has four phases:
1. Participatory evaluation to identify farmers’ needs in a cultivar;
2. A search for suitable varieties to test with farmers;
3. Experimentation on their acceptability in farmers’ fields;
4. Wider dissemination of the farmer-preferred cultivars.

One of the great strengths of PVS is that it is both an extension and a research method. Varieties tested in PVS, if acceptable, can rapidly spread from farmer to farmer.

Most of the PVS programmes in the GVT projects in India have used a mother and baby trial system. The mother trials are used to compare all the entries together in a farmer’s field (Figure 3). They are researcher-designed but farmer-managed. Each trial is a single replicate as it has only one plot of each variety. However, the trials are replicated across villages and across farmers within each village. They not only serve as demonstration plots or focal points for discussions, but provide quantitative, analysable data on yield.

In baby trials, farmers compare a single variety (or sometimes two varieties) with the variety they have grown in the past. By giving different varieties to different farmers all of the promising new varieties from the mother trials can be tested in the baby trials.

The varieties below are ones that farmers preferred in the PVS trials and several of them have subsequently been released. At the time of the participatory trials nearly all of them were either unreleased advanced lines or varieties that were not recommended for the areas where the PVS trials took place.

Rainfed maize: Shweta and ZM 421 in western India
Chickpea: ICCV 88202 (Pratap Chana 1), ICCV 2 and KAK 2 in western India
Blackgram: IU8-6 (JU-8-6) in western India
Upland rice: Kalinga III in western and eastern India
Horsegram: AK-42 in western India

Figure 3. Part of a mother trial of upland rice in Rajasthan. Farmers are visiting the trial to compare all of the entries, three of which can be seen here (a late flowering dwarf entry on the left, an early flowering Ashoka variety middle, and a tall, late flowering entry can just be seen on the right).
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### Successful PVS in western India

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The centralised plant breeding techniques that produced the Green Revolution gave impressive results in the more favourable agricultural environments. They have been less effective for low-resource farmers who cultivate poorly productive land.

In comparison to centralized breeding, farmer participatory approaches in plant breeding result in a better orientation to the needs of the client farmers. In the past, such approaches have been described by the activity of involving farmers – participatory plant breeding (PPB). We now prefer to use a term that explains the purpose of involving farmers – highly client-oriented breeding (COB).

Each stage of COB is designed to better account for the needs of the clients:

1. The new variety is specifically designed to have the combination of traits that the client farmers desire.
2. The parents are very carefully chosen on the basis of having the potential to produce this desired combination. At least one is locally adopted by farmers.
3. The selection in the segregating generations is done in environments that closely match the fields of the client farmers.
4. The results of this selection, new varieties, are immediately tested with the client farmers in PVS trials.

COB is more powerful than PVS alone because it creates new variability rather than relying on existing varieties. In our COB, we use varieties selected by farmers from PVS trials as parents of crosses because they are adapted and acceptable. Farmers sometimes identify specific weaknesses in a variety; these can be eliminated by crossing it with a parent chosen for its complementary strengths. One great advantage of COB is that it is much faster than conventional breeding because new varieties are immediately tested with farmers.

VS and COB put seed directly in the hands of participating farmers and our studies show that given access to seed, poor farmers will adopt new varieties as rapidly as wealthier ones.

The resources available to farmers can be a very important factor in their adoption of varieties. Resource-poor farmers may have restricted access to new varieties and may be less willing to invest in, or risk, growing new varieties. However, our studies in irrigated wheat in Gujarat show that, given choice and access to seed, resource-poor farmers will adopt new varieties as rapidly as do better-off farmers (Figure 4).

In Jharkhand, eastern India, farmers who cultivate upland rice on low-fertility, sloping soils continue to grow low-yielding landraces that are susceptible to disease and pests. As a result of COB, two new improved rice varieties, Ashoka 200F and Ashoka 228 have been produced for upland conditions. The size of landholding is a clear reflection of what the farmers can grow.
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Successful COB in western and eastern India

Rainfed maize: Variety GM-6 in western India. Originally released in Gujarat and now recommended in Rajasthan and Madhya Pradesh as well. BVM-2 in eastern India.

Upland rice: Varieties Ashoka 200F (BVD 109) and Ashoka 228 (BVD 110). Originally released in Jharkhand (eastern India). Ashoka 200F is now also recommended in Gujarat, MP and Rajasthan and Ashoka 228 in MP.

Reaching out to the poorest farmers

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COB has produced varieties for rainfed farming systems where there are many more resource-poor farmers than in more favoured environments.

Our COB programmes for maize have targeted resource-poor farmers on marginal lands where farmers favour early-maturing varieties that can escape terminal drought. COB has proved highly successful in producing varieties that are superior to those currently available.

Maize is the most important crop for farmers’ livelihoods in Gujarat, Madhya Pradesh and Rajasthan in GVT’s western Indian rainfed farming project where it covers over 70% of the agricultural land in the kharif (rainy) season. It is grown by the indigenous tribal people in this season as a staple food crop for home consumption. Average yields are low because of low fertility and drought (Figure 6) so most households are not self sufficient in maize. Even so, grain is often sold to meet cash requirements. The crop residue is used as an animal fodder as well as a source of fuel. In eastern India, maize is the second most important crop after rice.

In western India, before project interventions, nearly 100% of the maize area was occupied by low-yielding landrace varieties (mainly white-grained maize). We gave maize farmers new varieties to try in a PVS programme. The farmers did not markedly prefer any of them to their local ones.
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COB has produced varieties for rainfed farming systems where there are many more resource-poor farmers than in more favoured environments.

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Maize is the most important crop for farmers’ livelihoods in Gujarat, Madhya Pradesh and Rajasthan in GVT’s western Indian rainfed farming project where it covers over 70% of the agricultural land in the kharif (rainy) season. It is grown by the indigenous tribal people in this season as a staple food crop for home consumption. Average yields are low because of low fertility and drought (Figure 6) so most households are not self-sufficient in maize. Even so, grain is often sold to meet cash requirements. The crop residue is used as an animal fodder as well as a source of fuel. In eastern India, maize is the second most important crop after rice.

In western India, before project interventions, nearly 100% of the maize area was occupied by low-yielding landrace varieties (mainly white-grained maize). We gave maize farmers new varieties to try in a PVS programme. The farmers did not markedly prefer any of them to their local ones.

Figure 5. The percentage of the rice land area devoted to the new Ashoka varieties versus the total cultivated land of each household in three eastern India states. The numbers above the bars indicate the number of households in each category of landholding size.

Figure 6. A typical example of a low-yielding, drought-stressed maize field.
However, some of the varieties had specific traits that the farmers wanted, so in a COB programme we crossed six of them to produce a composite population. We included white- and yellow-grained types to increase genetic diversity: three were white-grained and three were yellow-grained. We made the initial selections from this population based on characteristics identified by farmers, and at later stages farmers selected for themselves in populations we grew. We reselected for white-grained types, the preferred grain colour of the farmers, from the genetically mixed grain colours of the population. Three of the most promising of the white-grained varieties produced from the population were assessed both on-station and in participatory trials.

GM-6, described at the beginning of this publication, was one of these three promising varieties. GM-6 is becoming increasingly popular with farmers in Gujarat, Madhya Pradesh and Rajasthan. Using very similar approaches in eastern India a yellow-grained variety, BVM-2, was bred from crosses made among yellow- and white-grained varieties. It was released in Jharkhand state in 2003 as BVM-2.

By using PVS to identify suitable parents, by selecting for characteristics valued by the farmers in environments that matched the farmers’ fields, and by testing the new varieties under farmers’ own conditions, we rapidly produced improved varieties acceptable to farmers.

The PVS programme has continued using new introductions such as ZM-421, a white-grained variety we introduced from CIMMYT, Zimbabwe. Both GM-6 from our COB programme and ZM-421 were tested in baby trials. Farmers found both varieties to be high yielding, but ZM-421 more so because of its later maturity that was also associated with higher fodder yield (Figure 7). Farmers’ options are increased as they can grow GM-6 on the majority of their fields and ZM-421 on more favourable land with deeper, more fertile soils.

By working closely with farmers we studied the acceptance of the new maize variety GM-6. Most farmers who have had access to GM-6 seed adopt it and then grow it on a large proportion of their maize land. Farmers benefit from an increased grain yield and the demand for seed of this variety is high and increasing.

GM-6 was bred in Gujarat and first released in that state in 2001. Subsequently, from the convincing results of mother, baby and on-station trials it was recommended for cultivation in parts of Rajasthan in 2004 and of Madhya Pradesh in 2005. The formal demand for the seed is increasing. For example, in 2006 in Gujarat, more than 200 t of seed of the variety was demanded by the State Department of Agriculture.

Most farmers given access to seed of GM-6 adopted this variety even though a significant minority of farmers only grew it for a single year (Figure 8). In the first year, some farmers did not prefer the variety while others, even though they liked it, had not saved sufficient seed to grow it again. Once farmers had grown it for a second time, all were convinced of its advantages, and all had sufficient seed to grow it again. They did so on an increasing proportion of their land.

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Figure 7. Summary of 130 farmers’ perceptions for five traits of two maize varieties, GM-6 and ZM-421, relative to the local checks. The length of the bars indicate the strength of opinion as data for ‘the varieties are the same’ are not shown; for example, all farmers reported that there was no difference in market price between ZM-421 and the local variety.

Figure 8. The adoption of GM-6 by a total of 121 farmers who had first been given seed in three years, either 2001, 2002 or 2003. Adoption is shown as a percentage of farmers and as a proportion of the maize land they devoted to this variety.
However, some of the varieties had specific traits that the farmers wanted, so in a COB programme we crossed six of them to produce a composite population. We included white- and yellow-grained types to increase genetic diversity: three were white-grained and three were yellow-grained. We made the initial selections from this population based on characteristics identified by farmers, and at later stages farmers selected for themselves in populations we grew. We reselected for white-grained types, the preferred grain colour of the farmers, from the genetically mixed grain colours of the population. Three of the most promising of the white-grained varieties produced from the population were assessed both on-station and in participatory trials.

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Impact of maize varieties from COB

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Impact of rainfed upland rice varieties from COB

We conducted surveys in three states of eastern India and three states of western India to assess the acceptability of the new Ashoka rice varieties released from our COB programme. Farmers much preferred the new varieties and 97% of those interviewed intended to grow them again the following year. The new varieties are giving substantial improvements on farmers’ livelihoods.

Most farmers, from both eastern and western India, found that the new varieties were better than the local varieties for important traits (Figures 9 and 10). They were earlier, higher-yielding, and fetched a higher market price. Only in western India did farmers report that Ashoka 200F generally produced less straw, reflecting the higher straw yield of the later-maturing local varieties in this region.

The new varieties had a significant effect on income and contribute significantly to the improvement of livelihoods of poor farmers in marginal upland areas. In group interviews with farmers from eastern India the advantages of earliness, drought-tolerance, higher yield and better grain quality became clear (Figure 12).

Figure 9. Farmers’ perceptions of Ashoka 200F rice variety in comparison to local cultivars. Based on a survey of 57 households sampled over three states in western India (Gujarat, Madhya Pradesh and Rajasthan) in 2004.

Figure 12. The high acceptability of the varieties was reflected in their high adoption by farmers. By 2001, the year of their official release, farmers who had earlier been given seed had already adopted the varieties on significant areas. In western India, studies on adoption showed that nearly all farmers who had tried Ashoka 200F or Ashoka 228 continued to cultivate them and did so on more of their rice land (Figure 11). A declining proportion of farmers grew Kalinga III because they replaced it with the Ashoka varieties.

Each year more seed of the Ashoka varieties has been produced and demand for seed of these varieties is growing. By early 2006, requests to GVT for seed from State Department of Agriculture, development projects, NGOs and the private sector were already in excess of 400 t. Since total demand is known to be higher, seed production for 2006 by GVT is planned to exceed 500 t.
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![Figure 9. Farmers’ perceptions of Ashoka 200F rice variety in comparison to local cultivars. Based on a survey of 57 households sampled over three states in western India (Gujarat, Madhya Pradesh and Rajasthan) in 2004.](image)


Corresponding farmers (%)

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Ashoka 200F in a mother trial in Rajasthan, 2002.
Horsegram is a neglected crop but it is a nutritious legume that grows well in rainfed uplands. By working closely with farmers a new intercropping system, maize with horsegram, is finding acceptance with farmers. A PVS programme identified new varieties of horsegram that were overwhelmingly better than local varieties.

Horsegram is a locally important grain legume in some localities of western India such as Alirajpur, MP and Kushalgarh, Rajasthan. It is grown for home consumption, for sale as a cash crop, and is sometimes used as poultry feed. There has been no adoption of improved varieties and farmers cultivate landrace varieties almost invariably as a sole crop. All the landraces have indeterminate flowering and hence indeterminate growth habit and most are late-maturing.

Horsegram has potential as an intercrop with maize. We supplied seed of an improved horsegram variety to farmers and suggested how they could cultivate it with maize. We interviewed 22 farmers from Rajasthan and Madhya Pradesh (MP) who had tried this cropping system in 2003. All of the farmers reported that the horsegram intercrop reduced the problem of weeds, inter-cultivations were reduced and, in some cases, weedings were also fewer. The reductions were greater in Rajasthan where the weed problem was more severe because of more favourable rainfall. Most farmers reported that the yield of maize was not affected and all farmers intended to continue with horsegram as a crop, usually as an intercrop but also as a sole crop (Figure 13). Some farmers who saw the trials were impressed and obtained seed to try for themselves (Figure 14).

Figure 14. Farmer Tehar Chand, Patada village, Kushalgarh, Rajasthan with his crop of maize intercropped with horsegram, 2003. He saw this trial in neighbouring Mahuda village in 2002 and obtained horsegram seed from a village farmer.

The grain yield and other attributes of the new varieties in the PVS trials were outstanding. The highest yielding entry, AK-42 yielded 60% more than the local variety in mother trials and 40% more than the local variety in baby trials. Two varieties performed the best, AK-21 and AK-42. Both were higher yielding, and earlier maturing than the local variety and both had superior grain quality and higher market price. To find out which of the two was really the best, farmers grew these two varieties side by side in their own fields along with their best local variety and all 71 farmers were asked their preferences (Table 1). The local variety was never preferred for any trait. AK-42 was significantly preferred for all traits when the number of responses ‘AK-42 is best’ was compared to the number for ‘AK-21 is best’.

Table 1

<table>
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<tr>
<th>Question</th>
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<tr>
<td>Earlier maturity</td>
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Number of farmers with opinion.

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Agronomists, engineers and farmers – the two-wheeled tractor

Participatory research is not just for improved varieties or relatively simple agronomic interventions. We have used participatory research to test the two-wheeled tractor with farmer self-help groups. Some of the results were unexpected and could only be found from participatory research.

Mechanisation has been a key to progress in agricultural development in favourable areas. In marginal areas the cost of a four-wheeled tractor is prohibitive for all but the most prosperous farming households. The two-wheeled tractor is cheaper, has become highly popular in China, Bangladesh and Nepal, and is now manufactured in India.

We tested this innovation in collaboration with farmers in a self-help group. The two-wheeled tractor was tried with a range of implements such as the rotary tiller, tine cultivator, trailer, water pump, and electricity generator. All of the attachments, apart from the tine cultivator were liked by farmers.

Farmer groups report that the water pump attachment to the two-wheeled tractor is more effective for pumping water than the common 5 hp diesel pump set (Figure 15).

Like any attachment to the two-wheeled tractor it is much more easily transported so it can be used more widely in the village. Hence, the villagers were able to expand the area under irrigated crops and, where perennial water was available, they have cultivated three crops a year. In this case, the tractor produced the opposite of what was commonly feared; it increased labour demand because the increased cropped area reduced out-migration from the village in the dry season.

The trailer attachment allows farmers to sell their produce at a higher price by transporting it to the nearest market town. One household sold 700 kg of cotton in a single day at a higher price than normally achieved. The net benefit was nearly Rs. 1700. Normally to sell this amount of produce, the woman of the household has to make 28 trips by bus, one per day, with a load of 25 kg each time. Hence, apart from achieving a higher price, the savings in time and labour were considerable.

A surprising finding of the participatory research was the success of the electricity generator attachment. The group soon realised that it was profitable to hire this out for marriage ceremonies. Income was generated within the village rather than spent on paying merchants in the local town for the hire of kerosene petromax lights.

The economics of the two-wheeled tractor, even in marginal agricultural environments, is robust and the capital costs can be repaid in 2-3 years. The two-wheeled tractor can also be used to accelerate the construction of bunds, tanks and nallah plugs in soil and water conservation work.
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Blackgram is an important legume in western India. Farmers were growing local landraces of blackgram that were highly disease susceptible and low yielding. A PVS programme quickly identified new varieties and as a result of the participatory research IU8-6 was recommended for cultivation in MP. It was used as a parent in a COB programme and this has produced an outstanding new variety.

Blackgram is the most important short-duration grain legume in the project area in western India. It is grown for home consumption and as a cash crop. Because of its importance as a source of cash, the market value of the grain is particularly important. The crop residue is used as fodder, although the fodder yields are not very high. Farmers cultivate low value, landrace varieties that are susceptible to disease (Figure 2) and most have small, dull seeds.

Farmers found two varieties in a PVS programme, TPU 4 and IU8-6 (later named as JU-8-6), that they liked more than the local landraces because of their higher yield. Of these they preferred JU-8-6 for its superior grain quality (Figure 16) and its early maturity that matched the local varieties. JU-8-6 was released in MP in 2004, on the strength of this participatory research.

Following the principles of highly client-oriented breeding, knowledge from PVS trials were utilised to choose the parent varieties TPU 4 and JU-8-6. These were crossed and a large population produced. A line derived from this cross, IVU 486, had the highest yield and largest grains of any entry in the mother and baby blackgram trials in MP. It has yet to complete sufficient years of testing to qualify for release, but it is well accepted in mother and baby trials.

Chickpea is the most important legume crop in the rabi (post-rainy) season in western India. Farmers were growing local landraces or a very old variety, Dahod Yellow. A PVS programme quickly identified new desi and kabuli chickpea varieties that farmers preferred. The local desi variety, Dahod Yellow, was crossed with a kabuli variety ICCV 2 identified in the PVS programme in a highly client-oriented breeding programme. Both kabuli and desi types from this cross are now in advanced trials.

Chickpea is the most important rabi legume crop in all the three states in western India in which GVT is working. It is grown for local consumption as well as a cash crop. The crop residue is used as animal feed. Farmers cultivate Dahod Yellow, a very old variety, that is of too long a duration to be adapted to the shallow, rainfed soils of our client farmers. Our agronomic research showed that soaking the chickpea seeds overnight in water, called seed priming, and then surface drying them before sowing led to better crop establishment, earlier maturity and higher yields.

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Blackgram is the most important short-duration grain legume in the project area in western India. It is grown for home consumption and as a cash crop. Because of its importance as a source of cash, the market value of the grain is particularly important. The crop residue is used as fodder, although the fodder yields are not very high. Farmers cultivate low value, landrace varieties that are susceptible to disease (Figure 2) and most have small, dull seeds.

Farmers found two varieties in a PVS programme, TPU 4 and IU8-6 (later named as JU-8-6), that they liked more than the local landraces because of their higher yield. Of these they preferred JU-8-6 for its superior grain quality (Figure 16) and its early maturity that matched the local varieties. JU-8-6 was released in MP in 2004, on the strength of this participatory research.

Following the principles of highly client-oriented breeding, knowledge from PVS trials were utilised to choose the parent varieties TPU 4 and JU-8-6. These were crossed and a large population produced. A line derived from this cross, IVU 486, had the highest yield and largest grains of any entry in the mother and baby blackgram trials in MP. It has yet to complete sufficient years of testing to qualify for release, but it is well accepted in mother and baby trials.

Figure 16. The shiny black grains of JU-8-6 that fetch a higher market price.

Chickpea is the most important legume crop in the rabi (post-rainy) season in western India. Farmers were growing local landraces or a very old variety, Dahod Yellow. A PVS programme quickly identified new desi and kabuli chickpea varieties that farmers preferred. The local desi variety, Dahod Yellow, was crossed with a kabuli variety ICCV 2 identified in the PVS programme in a highly client-oriented breeding programme. Both kabuli and desi types from this cross are now in advanced trials.

Chickpea is the most important rabi legume crop in all the three states in western India in which GVT is working. It is grown for local consumption as well as a cash crop. The crop residue is used as animal feed. Farmers cultivate Dahod Yellow, a very old variety, that is of too long a duration to be adapted to the shallow, rainfed soils of our client farmers. Our agronomic research showed that soaking the chickpea seeds overnight in water, called seed priming, and then surface drying them before sowing led to better crop establishment, earlier maturity and higher yields.

Participatory varietal selection (PVS) identified new varieties such as the Kabuli ICCV 2 and KAK 2 and the desi ICCV 88202 (Figure 17). All were extremely early matur-
Seed distribution networks

Most farmers in marginal areas do not buy seed regularly but instead use seed saved from the previous harvest, or obtain seed from other farmers. Farmer-to-farmer spread of seed in informal seed dissemination networks is the most important mechanism in the spread of new varieties. Formal seed production is also important, but government organisations begin to demand seed of a new variety only several years after it is first officially recommended. GVT has accelerated this process by facilitating seed sales or undertaking its own seed production and sale programmes.

The first variety to be identified in our PVS programme was rice variety Kalinga III. Following the introduction of this variety, the rate of spread from village to village from farmer seed dissemination was rapid (Figure 18). Friends and relatives carried Kalinga III seed mainly to nearby villages within 10 km distance but occasionally to far off ones. Kalinga III spread, from the three source villages that were studied, to over 100 villages in an area of several thousand km² from 1994 to 1997. More recent studies in eastern and western India on Ashoka 200F and Ashoka 228 have confirmed how seed of upland rice varieties spreads from farmer to farmer.

Although farmer-to-farmer seed supply is generally effective it is not perfect. In severe drought years seed production on-farm declines yet it is subsequent to such drought years that the seed demand is the highest. This can result in a slowing of the rate that a new variety is adopted. In an inbred crop, such as rice, the genetic purity of the variety is relatively easy to maintain. However, this is more difficult in out-breeding crops such as maize. The farmer needs to replace his or her seed stock every 3 to 4 years and large quantities of seed are required to do this.

With these problems in mind, GVT supported self-help groups to produce seed of maize (Figure 19). To help make the groups sustainable, the groups were responsible for marketing the seed they produced. However, the experience of the self-help groups was not encouraging. To directly help poorer farmers, the seed production was in GVT project villages where farmers had small landholdings and limited access to irrigation water. This meant that to get sufficient contiguous area for the maize crop there were many members in the self-help group. They also lacked commercial experience and charged too little for the seed. Lack of irrigation water led to highly varying amounts of seed production. Low seed production demotivated the groups as the overheads in organising the enterprise remained high but the returns were smaller. It also reduced the cash reserves required to keep seed until the next planting season. To get more assured seed supply, GVT will shift the activities of supporting self-help, groups. Seed growers will be located in more favourable areas that have assured supplies of irrigation water in the post-rainy season. This allows the harvest to be sold immediately by the groups for the rainy-season crop. This approach is in line with GVT’s experience in eastern India, where self-help groups with irrigated land have been more successful.

GVT is also involved in more formal seed production activities. It has, for example, contracted seed production with farmers and sold the seed to other agencies. Several hundred tonnes of seed of the two Ashoka varieties have been produced and sold in eastern India.

GVT also acts as an intermediary for seed production and sales of varieties from the PVS and COB programmes. It has arranged for seed producers to supply seed directly to NGO projects such as those of Catholic Relief Services (CRS) in MP, and Action for Social Advancement (ASA) in Chhattisgarh.

Such formal seed production and supply can raise the awareness of the varieties with government agencies. State Department of Agriculture have budgets to purchase and distribute large amounts of seed of new varieties and the sooner this is done the faster a variety can become popular.

Figure 18. Documented spread of Kalinga III from three case study villages over the period 1994 to 1997 where K=Kompura, G=Gamana and B=Bijori villages.

Figure 19. Grower group at village Padlasodia, Sajjangarh, Banswara District, Rajasthan, September 2003. In the background is one of the fields that comprise a10 ha block of GM-6 grown by the group.
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Cultivating Partnerships

Better Choices for Rainfed Farming

J.R. Witcombe and J.P. Yadavendra
The Gramin Vikas Trust (GVT) is an independent legal entity established by Krishi Bharati Cooperative Limited (KRIBHCO) - Department of Fertilizers, Government of India. It receives assistance and support from KRIBHCO and the Department for International Development - UK. It was established in the year 1999. Its goal is to develop, implement and disseminate effective, equitable and sustainable participatory policies and programmes for reducing rural poverty in the rainfed areas of India. It acts as a catalyst to enable the socially and economically disadvantaged rural and tribal communities to improve their livelihoods on a sustainable basis, especially those in resource-poor rainfed areas. It has several hundred professional staff that are managing a variety of development projects in eastern and western India.
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