Farmers and Plant Breeders in Partnership

Second edition

Edited by
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Foreword

This second edition of Farmers and Plant Breeders in Partnership has undergone extensive revision since the first publication in 2001. This edition provides an up date on the DFID Plant Sciences Research Programme’s participatory research in Asia and Africa. In addition, some new topics are included in the sections describing the impact of the research on end users, the importance of screening for post-harvest traits and the potential role of molecular marker technology in participatory plant breeding. A common theme throughout the book is the importance of orientating plant breeding programmes towards the needs of the farmers, who are essentially the clients of the research. We describe how this is achieved by first understanding what farmers need, and then by developing programmes that will meet those requirements. One of the most powerful tools in achieving this is the testing of products from the breeding programmes with farmers, a process that considerably reduces the time taken between development of a new variety and its widespread adoption.

The work described is the result of partnerships between farmers and plant breeders. Of significance, is the diverse range of partnerships that have been involved, including both national and international organisations, government and non-government sectors, and organisations concerned with both research and extension. Only by mobilising a network of partners concerned with all aspects of delivering new varieties to farmers can real impact be made.

John R. Wilcosme and Clare M. Stirling

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Participating Institutes

ASA  Action for Social Advancement, Sahyog Nagar, Dausa, Gujarat 389 151, India.
BAU  Bharath Agricultural University, Karimnagar 505 010, India.
CAZS  Centre for Arid Zone Studies, University of Wales, Bangor, Gwynedd, UK.
CDF  UK Department for International Development Crop Protection Research Programme, Aylesford, Kent, UK.
CRI  Crops Research Institute, PO Box 3785, Kumasi, Ghana.
DADs  District Agricultural Development Offices of the Ministry of Agriculture, Nepal.
GVT(E)  Gram Vikas Trust (East), 280 Kanki Road, Near Pard Jauj Kirthi, Ranchi 834 008, Ranchi, India.
GVT(W)  Gram Vikas Trust (West), Western India Rainfed Farming Project, Bhuj 370 001, India.
ICRISAT  International Crops Research Institute for the Semi-Arid Tropics, Patancheru 502 324, Andhra Pradesh, India.
JIC  John Innes Centre, Norwich, Norfolk, UK.
JJIP  Local Initiatives for Biodiversity, Research and Development, PO Box 324, Bastar, Andhra Pradesh, India.
MPOU  Mahatma Pratap Agricultural and Technology University, Banswara 327 001, Rajasthan, India.
NRC  National Research Centre for Sericulture, Tamil Nadu 600 002, India.
NRC  National Research Centre for Sericulture, Rajendranagar, Hyderabad 500 016, Andhra Pradesh, India.
NRC  National Research Centre for Sericulture, Charitha, Kanpur, India.
PAC  Punjab Agricultural University, Ludhiana 141 004, Punjab, India.
PAC  Punjab Agricultural University, PO Box 22, Pathankot 147 001, Punjab, India.
Puk  Plant Environment Laboratory, Department of Agriculture, University of Reading, Reading, Berkshire, UK.
PAS  School of Agricultural and Forestry Sciences, University of Wales, Bangor, Gwynedd, UK.
SARI  Sardar Agricultural Research Institute, PO Box 52, Tamale, Ghana.
UAS  University of Agricultural Sciences, GKVK, Bangalore 560 065, Karnataka, India.

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Poor farmers in marginal areas continue to grow old varieties that are often low-yielding and susceptible to pests and diseases. They have had little exposure to new varieties and those that have been released are often not suitable for rainfed conditions on marginal lands.

Every season farmers sow their crops. They understand seeds and crop varieties and know how to use them. They are usually very willing to try new varieties, but not in India, Nepal and West Africa shows that formal plant breeding and varietal release systems are not truly serving farmers needs. In particular, resource-poor farmers in marginal areas benefit less from high-yielding varieties (HYVs) compared to farmers in more favourable regions.

In India, the percentage adoption by area of HYVs of rice was mapped for six states at a district level. In many districts the adoption of HYVs was below 50% and in these districts mean yields were also low (i.e., 1.1 t ha⁻¹) and only half that of districts with high adoption rates (Figure 1). These large differences in average yield cannot be explained solely in terms of genetic differences resulting from adoption or non-adoption of HYVs. The districts that had low adoption of HYVs also had the most marginal agricultural environments where farmers use less inputs.

Many farmers also grow old varieties or landraces, some released decades ago. This is because they seldom have access to modern technologies, such as new varieties, and one poorest farmers are often less able or willing to take risks and so are less likely to adopt new varieties. One means of addressing this problem is to place the seed of novel cultivars directly in the hands of the farmers. In this way, farmers have the opportunity to test new cultivars for themselves in their own fields.

By fostering collaboration between plant breeders and farmers, our work aims to provide even the poorest farmers with a chance to benefit from such technologies as new varieties. In West Africa, where many farmers are women, gender and social status play an important role in farmers' decisions on which varieties to grow. Participation can resolve issues relating to gender, social status, and social status in the context of the selection of a new variety. This can be done separately by gender, and the poor can be identified and then helped by giving them access to new varieties.

Farmers in developing countries are often less involved in the breeding, selecting, and testing of new varieties. Our participatory plant breeding programme involves farmers in all these processes in order to help identify or create varieties that suit local needs and conditions. We use two approaches: participatory varietal selection (PVS) and participatory plant breeding (PPB), the benefits of which can be applied to both marginal and high potential production systems (HPPs).

Participatory Varietal Selection (PVS)

PVS assumes that varieties exist that are better than those currently grown, but which farmers have not had the opportunity to test. In PVS, farmers are given varieties to test in their own fields. These varieties are chosen carefully. To save time and to ensure that seed is available, we use seed of cultivars that have already been released, not only from the target region but also from other regions or countries. A successful PVS programme has four phases:

i. participatory evaluation to identify farmers' needs in a cultivar,
ii. a search for suitable material to test with farmers,
iii. evaluation of its acceptability in farmers' fields, and
iv. wider dissemination of farmers' preferred cultivars.

One of the great strengths of PVS is that it is an extension and a research method. Varieties derived from PVS can rapidly spread from farmer to farmer. As well as exposing farmers to novel cultivars, PVS is effective in identifying locally adapted parental material and in identifying breeding goals - for example, early maturity - that assist the selection of complementary parents.

Most of the PVS programmes use a mother and baby trial system. The mother trial compares all the entries together in a farmer's field. In baby trials, farmers compare a single variety with the variety they have grown in the past.

Participatory Plant Breeding (PPB)

PPB is more powerful than PVS as it creates new variability rather than relying on existing varieties. In our PPB programme we exploit the results of PVS by using cultivars as parents of crosses. Weaknesses in cultivars are identified in the PVS programme so that cultivars can be crossed with varieties that have complementary traits to improve those weaknesses. A key PPB method is the collaborative participation of farmers who grow a bulk in their own fields and select amongst it. Using this collaborative breeding, it is possible to replicate the selections cost-effectively by giving seed of a particular bulk to many farmers. The selection is thus replicated across physical environments (different farmers' fields) and across farmers (who may have different selection strategies and select for different traits that best meet their needs). In other methods breeders consult farmers who may, for example, give opinions on material grown by breeders as research stations. One great advantage of PPB is that it is much faster than conventional breeding.
In conventional plant breeding few varieties ever make it to the stage of on-farm testing and even fewer are formally recommended and released. Therefore, in any one year farmers have access to a very limited choice of varieties. PVS gives farmers more choice by providing seed from a wide range of varieties that have already been released.

Participatory varietal selection (PVS) increases farmers’ varietal choice. In DFID-funded research, it has been successful in several countries and with many different crops (see opposite). We usually give participating farmers a choice from three to six varieties. However, a wider choice can be given when we produce many suitable lines in our participatory plant breeding programmes.

In Ghana, upland rice is grown by resource-poor farmers, often on sloping land, in drought-prone areas. Few varieties suitable for these upland conditions have been formally released and most farmers, particularly in the forest zone, still grow landraces of African rice (Oryza glaberima) or informally introduced varieties.

PVS programmes have been conducted in three locations in Ghana: in the forest zone at Berekum, in the transition zone at Afroman, and in the savanna zone at Nyimapa. These PVS programmes have all used nurseries in the first year and then distribution of seed to individual farmers in the second and subsequent years.

Approximately 100 varieties were selected for PVS from throughout the West African region along with high- and low-input conditions and evaluated by both men and women farmers. In addition, we conducted post-harvest assessments with farmers and market traders, because varietal characteristics such as harvestability and hard-setting quality without parboiling were important in determining varietal choice (see page 15).

Farmers selected a wide range of varieties and gave many different reasons for their choices (see Table 1). Both men and women farmers wanted varieties that were high-yielding and disease resistant. Disease resistance was wanted in the forest zone and drought tolerance (early maturity) in the savanna zone (Table 1). Women farmers also identified several post-harvest characteristics such as taste, aroma, ease of threshing and good milling quality without parboiling.

Several varieties were consistently selected by farmers in both low and high-input conditions (Figure 2). However, some varieties were chosen more frequently under low-input conditions and some under high-input conditions, indicating specific adaptation.

Table 1. Characteristics considered important in new upland rice varieties by male and female farmers in two agroecological zones in Ghana.

<table>
<thead>
<tr>
<th>Forest zone</th>
<th>Savannah zone</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Men</strong></td>
<td><strong>Women</strong></td>
</tr>
<tr>
<td>High yield</td>
<td>High yield</td>
</tr>
<tr>
<td>Supersize</td>
<td>Taste</td>
</tr>
<tr>
<td>Dark color</td>
<td>Early maturity</td>
</tr>
<tr>
<td>Well-natured</td>
<td>Aroma</td>
</tr>
<tr>
<td>Large grains</td>
<td></td>
</tr>
</tbody>
</table>
PVS uses farmers’ knowledge to identify useful varietal characteristics

PVS can provide valuable information to breeding programmes. It can identify general traits for adaptation to environmental conditions or to cropping systems. PVS can also identify specific traits or characteristics wanted by farmers in particular areas.

Varietal testing and release programmes are dominated by the need to increase yield by selecting varieties that perform well across many different environments. Hence breeding programmes traditionally concentrate on the traits most important for wide adaptation, e.g., stable grain yield and resistance to major pests and diseases. Farmers are rarely consulted about varietal characteristics and their ‘ideal’ plant type.

Individual farmers judge varieties by considering a wider range of traits. For example, farmers often want varieties that produce a lot of fodder, as well as grain, and that are easy to thresh.

PVS can identify general traits that glue adaptation to environmental conditions or to cropping systems (such as from short to long cycles for the crop to mature). In addition, PVS can identify specific traits or characteristics wanted by farmers in particular areas. Some of these important characteristics (e.g., ease of threshing) are reflected by the local names given to acceptable varieties in PVS trials (Table 2). Indeed, ease of threshing was found to be of great importance to the Nepalese and Ghanaian farmers, but this trait has never been measured in conventional breeding programmes.

<table>
<thead>
<tr>
<th>Cultivar name</th>
<th>Local name</th>
<th>Translation</th>
</tr>
</thead>
<tbody>
<tr>
<td>B54 A11</td>
<td>Lenwa</td>
<td>You’ll eat it (threshes easily)</td>
</tr>
<tr>
<td>IRI.12979-24-1</td>
<td>Lwanda</td>
<td>I will not pull.</td>
</tr>
<tr>
<td>W6B 340-8-0-13-4-8</td>
<td>Kama</td>
<td>Ramrohita ma</td>
</tr>
<tr>
<td>W6B 219-9-4-HB</td>
<td>Biteda</td>
<td>Is good to eat</td>
</tr>
<tr>
<td>W6B 160-264-HB</td>
<td>Adene</td>
<td>Sanshe</td>
</tr>
</tbody>
</table>

Table 2. Sample of some of the local names given by farmers in Todzi, near Hojo, to cultivars selected from PVS on upland rice in Ghana.

For example, under low-input conditions the two most frequently chosen varieties were the improved varieties WAB 36-54 and WAB 224-8 HB. Under high-input conditions the local landscape Kukulpala and variety CARD 170 were amongst those selected most often. This belies the oft-stated belief that improved varieties need more inputs. Farmers were clearly able to discriminate among a large number of varieties and identify varieties suitable for the different conditions that exist on their farms.

Six other varieties from the same PVS programme have also been adapted in the Hojo region and one variety (IRRI.12979-24-1) has been formally released through SARI (Savannah Agricultural Research Institute) for northern Ghana.

PVS trials on upland rice in Ghana gave farmers more choice than they had ever had. Farmers selected a wide range of varieties and a few proved consistently popular, because of their market value, seed quality and yield.

Figure 2. Farmer evaluation (combined data from male and female farmers) of rice varieties grown under high (clean weeding and fertilizer) and low (one weeding and no fertilizer) input conditions at Nyampala in the savanna zone of Ghana.

Upland rice field near Todzi, Volta Region, Ghana.