Participatory Research and Gender Analysis

Crossing Perspectives
Farmers and Scientists in Participatory Plant Breeding

Preface

1. Introduction
When Strangers Become Allies

- Beyond the Green Revolution
- Two solitudes
- Toward a revolution in relevance
- Efficiency and impact
- Equity and people power
- Two Marias
- Case 1
- Case 2

2. Stare of the art
Two approaches converge

- From Ice Age to Computer Age
- Formal-led and farmer-led breeding
- The environment of participatory plant breeding
- Crop development factors
- A shared challenge
- Case 3
- Case 4
- Case 5
- Case 6

3. Achievements and Impact
Closing the Gap

- Understanding farmers' preferences
- Genetic diversity: The farmer's guardian angel
- Decentralization and devolution
- Cases of impact
- Reaching the poor, reaching the women
- Case 7
- Case 8
- Case 9

4. Future Directions
The Need to Tackle Emerging Issues

New questions and a forum for debating the
Case 10

Selected Tools

Further Reading
Forthcoming publications from the PRGA Program
Acronyms
Acknowledgments

The Consultative Group on International Agricultural Research (CGIAR) works to promote food security, poverty eradication, and the sound management of natural resources throughout the developing world.

In recent years the CGIAR has embarked on a series of systemwide programs, each of which channels the energies of international centers and national agencies (including research institutes, nongovernment organizations, universities, and the private sector) into a global research endeavor on a particular theme that is central to sustainable agriculture.

The purpose of the CGIAR Program on Participatory Research and Gender Analysis for Technology Development and Institutional Innovation (PRGA Program) is to assess and develop methodologies and organizational innovations for gender-sensitive participatory research and to operationalize their use in plant breeding and in crop and natural resource management.

The PRGA Program is cosponsored by the International Center for Tropical Agriculture (CIAT), which serves as the convening center, and by the International Maize and Wheat Improvement Center (CIMMYT), International Center for Agricultural Research in the Dry Areas (ICARDA), and International Rice Research Institute (IRRI).

PRGA Program activities are funded by the Australian Centre for International Agricultural Research (ACIAR), Canada's International Development Research Centre (IDRC), the Ford Foundation, and the governments of Denmark, Germany, Italy, Japan, the Netherlands, New Zealand, Norway, Switzerland, and the United Kingdom.

The Program's members include international agricultural research centers, national agricultural research systems, nongovernment organizations, and universities around the world.

Introduction
When Strangers Become Allies

Beyond the Green Revolution

The key ingredient in participatory plant breeding is a systematic inclusion of farmers´knowledge, skills, and preferences.

Modern plant breeding stands among the greatest scientific and human success stories of all time. The Green Revolution it triggered just a few decades ago prevented mass famine and altered farming and dietary habits around the world. Yet the fruits of agricultural innovation bypassed hundreds of millions of farmers in developing countries. Why have so many of these women and men, often shoe-horned into tiny subsistence-scale holdings on marginal land, been so reluctant to plant promising new crop varieties? And why have so many rejected them outright?

For more than two decades, these questions have haunted scientists, government planners, extension workers, development agents, donors, and others with a stake in crop research and agricultural development. But they have also stimulated the creation of a novel and promising set of research methods collectively known as participatory plant breeding (PPB). The key ingredient in PPB is a systematic inclusion of farmers' knowledge, skills, and preferences. This involves much more than an occasional consultation between scientists and farmers. It means that these two groups—often strangers to each other, separated by different world views, lifestyles, and training—become allies, working side by side.

Apart from purely humanitarian reasons, like preventing famine and fighting poverty, why should people in the richer countries care about small farmers in the developing world? And why should they be concerned about PPB?

The simple answer is that our planet is getting «smaller.» The scale and intensity of world agriculture are clearly altering the earth's landscape, atmosphere, biodiversity, and ecological balance. What people, rich or poor, do in one location affects others and their surroundings thousands of kilometers away. To expect the relatively small community of national and international agricultural scientists to single-handedly find socially and environmentally sustainable solutions to feeding billions of people is unrealistic. The diverse knowledge and resources of the world's farmers must be harnessed for the task. PPB is one way to do it.

This publication presents the farmer-centered logic behind PPB, current practices, the considerable impact to date, and new directions. From the outset it should be noted that PPB is broadly defined here. It includes not just the actual mixing of plant genes to produce new traits but all the joint efforts of farmers and trained researchers to improve and move germplasm into the field. This reflects the growing need for a holistic, impact-oriented approach to agricultural research and development, one that abhors results sitting on a shelf collecting dust.

We also introduce readers to some of the people behind the idea and some of the beneficiaries—women and men farmers and researchers working for a more productive and sustainable agriculture, based on care for the environment and greater human dignity through the power of innovation and cooperation.

Much of the information comes from the discussions and research of the Plant Breeding Working Group of the Program on Participatory Research and Gender Analysis (PRGA Program). Sponsored by the Consultative Group on International Agricutural Research (CGIAR), the PRGA Program is a global effort, involving four international research centers and scientists from many other organizations and countries. Its work includes a preliminary inventory of about 70 PPB experiences from around the world. These experiences demonstrate that PPB methods are helping many publicly funded breeding programs focus more sharply on farmers' needs and deliver products that offer them tangible benefits. Examples abound in the international research community:

- The West Africa Rice Development Association (WARDA) has expanded PPB work to 17 countries.

- The Ethiopian Institute of Agricultural Research (IAR) and Cameroon's Institute of Agricultural Research for Development (IARD) are among various African programs now using PPB methods.

- The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is applying PPB in India as well as eastern and southern Africa,

- The Indian Agricultural Research Council (ICAR) and in Nepal the National Maize Research Program of the Nepal Agricultural Research Council (NARC) as well as the nongovernment organization (NGO) Local Initiatives for Biodiversity, Research and Development (LI-BIRD) are also engaged in outstanding PPB work.

- The International Center for Research in the Dry Areas (ICARDA) is applying PPB in Morocco, Tunisia, and Yemen.

- PPB approaches are now included in the African and Latin American bean research networks coordinated by the International Center for Tropical Agriculture (CIAT).

- CIAT has also extended the approach to major cassava-growing areas of Colombia, Brazil, and Ecuador. Particularly noteworthy is the pioneering work carried out by the Colombian Corporation for Agricultural Research (CORPOICA), the Brazilian Agricultural Research Enterprise (Embrapa) in the country's Northeast, and by the National Institute of Agricultural Research (INIAP) in Ecuador.

- NGOs and private foundations, such as the Deccan Development Society (DDS) in India, the South-East Asia Regional Institute for Community Education (SEARICE) in the Philippines, CARE in Sierra Leone, the Relief Society of Tigray (REST) in Ethiopia, Projects in Alternative Agriculture (PTA) in Brazil, the Institute for Development and Social Action (IDEAS) in Costa Rica, and the Foundation for the Promotion and Study of Andean Products (Fundación PROINPA) in Bolivia, are active in seed multiplication and conservation as well as in the development of new varieties through PPB.

This publication presents the farmer-centered behind PPB, current practices, the considerable impact to date, and new directions.

Two solitudes

This publication presents the farmer-centered behind PPB, current practices, the considerable impact to date, and new directions.

Modern or "conventional" plant breeding has produced remarkable successes over the past century. New technology packages, based on high-yielding varieties, have worked extremely well on the fertile lands and in the stable growing environments they were designed for. Commercial farming geared to markets requiring uniform products is typical of such areas.

Yet conventional breeding has been largely unable to address the crop needs of the world's roughly 1.5 billion poor people who depend on agriculture in harsh marginal environments. In many cases subsistence or semisubsistence farmers cannot afford new seed and fertilizer packages. What they need are varieties that respond well to their highly specific and often difficult growing conditions but which do not require expensive inputs.

One thing conventional plant breeders have repeatedly aimed for is broad adaptability—the quality of a plant to give a high average yield over a range of growing zones and years. There are often good reasons for taking this approach. Unfortunately, genetic material that yields well in one growing environment but poorly in another tends to be eliminated fairly early from the breeder's gene pool. Yet this may be exactly what farmers in some areas need.

Too often, breeders have been unaware of the detailed preferences and needs of target farmers. In many instances farmers' only invited contribution to conventional scientific breeding has been to evaluate a few experimental varieties just before their official release to the public. Poor adoption rates show that such token gestures are too little, too late. They suggest that farmers and conventional breeders have been coexisting as «two solitudes» rather than working as real partners.

Toward a revolution in relevance

"This has to do with bringing the farmer out of the field and into the screen houses, labs, and meeting rooms as a real partner in research".

PPB began to take shape in the early 1980s. Its approach to crop development is quite different from the one described above. PPB does, of course, rely on conventional plant genetics, plant pathology, and economics. But it combines these with anthropology, sociology, farmer know-how, and the principles and tools of market research and product development that are commonly used in the private sector.

PPB covers the full range of genetic improvement activities: setting breeding goals, creating genetic variability, selecting within variable populations, evaluating experimental varieties, releasing and popularizing new varieties, and producing seed. Farmers can take part in any of these phases and in varying degrees. Thus, many types of interactions between farmers and researchers are possible. «This has to do with bringing the farmer out of the field and into the screen houses, labs, and meeting rooms as a real partner in research,» says Jacqueline Ashby, coordinator of the global PRGA Program.

PPB brings together formal breeders, farmers, and sometimes other users, such as processors, middle men, and consumers. This cooperation can take place at whatever stage of the breeding process their particular expertise can make for a better, more acceptable end product.

In effect, the overriding goal of PPB is relevance for users. In practice, Ashby says, other motives, objectives, and subobjectives also come into play with PPB, depending on the organizations involved. For example, large-scale breeding programs conducted by international or national public-sector organizations may be particularly interested in building new genetic traits into a crop. For them PPB may be a way to boost efficiency while cutting research costs.

NGOs and grassroots organizations involved in participatory breeding often have a quite different focus. They may want to conserve and extend plant genetic diversity within the local landscape, affirm local people's rights and control over those genetic resources, or improve the technical expertise of farmer-breeders. Other groups may be keen to develop specialty varieties for niche markets—in response to demand for organically grown products, for example. Or in the event of a disaster, like a hurricane or war, relief agencies may use PPB as a tool for repairing a country's agricultural base, beginning with seed production and distribution to those hit hardest.

Efficiency and impact

By making crop improvement research more relevant to users' needs, does PPB make this work more effective? Apparently so. The approach has shown strong potential for improving both efficiency and impact over conventional breeding in several ways.

First, preliminary studies indicate that PPB may cut research costs. With this approach farmers and scientists share key tasks, thus reducing some of the costs of on-farm trials that are normally borne by the formal research system. One analysis of conventional versus participatory variety evaluation revealed that for participatory trials the cost per data point was US$0.50, compared to $0.80 for conventional trials. The former cost less because farmers carried out much of the on-farm trial management and data collection. Vicente Novoa, director general of Ecuador's National Institute of Agricultural Research (INIAP), notes that cost savings were one of the many benefits he saw when INIAP started to implement participatory research methods. «Farmers do a lot of the field work.» he says. «With a small amount of training, they can collect data and carry out evaluations.»

Although the costs of PPB have been analyzed on a small scale, cost information is still scant. Some breeding activities could actually cost the formal research sector more. For example, producing large quantities of seed of new genetic material for farmers to evaluate on-farm may drive expenditures up, particularly if PPB covers large groups of farmers or large areas comprising a mosaic of diverse user groups and varied micro-environments. How PPB affects research costs is the topic of a major impact assessment being carried out by the PRGA Program's Plant Breeding Working Group.

Second, PPB leads to more accurate identification of varieties that farmers prefer and that are adapted to local conditions. (It can even allow farmers to incorporate their own superior selections or landraces into new genetic material.) One reason for PPB's greater accuracy in identifying and meeting the requirements of specific client groups, such as poor women, is that it carefully differentiates among users, especially through gender analysis. In doing so it can also convey valuable feedback on farmers' needs, preferences, and dislikes to formal breeders. ICRISAT's experience in working with pearl millet farmers in Rajasthan, India, illustrates this point particularly well (see Case 1).

A third advantage of PPB over conventional breeding is that it consistently leads to faster release and dissemination of locally accepted varieties. Since trials are conducted on-farm, farmers are the first to see the results. When they find a variety they like, they further test it on their own and immediately start multiplying and distributing seed. Groups of participating farmers are often quite capable of handling these tasks at the local level, as demonstrated by the CIALs in Latin America (see Case 2) and SEARICE in Asia.

Fourth, PPB offers formal research programs a way to help farmer-breeders—who are specialists in collecting, selecting, recombining, conserving, and exchanging planting material—acquire the knowledge and germplasm they need for better plant breeding. In the process PPB can also stimulate farm communities to conserve and enhance their own local genetic resources. This is money in the bank, so to speak—resources for future crop research and development, participatory or otherwise.

Equity and people power

PPB is particulary effective in targeting poor rural women, who are key players in managing plant genetic resources.

In addition to making research more efficient, PPB strives to give various user groups easier access to modern crop varieties. But who exactly must participate in breeding to ensure that target groups receive the intended benefits? PPB attempts to answer this deceptively simple question through user-group differentiation, which is equivalent to the practice of segmenting markets in market research.

When fighting poverty is the overriding aim of a PPB program, user differentiation can help plant breeding efforts zero in on «invisible» groups, especially the ones who seldom have the chance to articulate their needs. These may include poor semisubsistence growers, small-scale crop processing workers, and even those who scavenge farmers' fields for grain missed during harvest (called «gleaners»). Once identified, representatives of these groups can participate at various stages in the breeding process.

PPB is particularly effective in targeting poor rural women, who are key players in managing plant genetic resources. In addition to growing crops, they often take part in postharvest processing and saving seed. They are also responsible for children's nutrition. Women can play an especially important role in plant breeding when its objectives need to take into account the many purposes that a single crop may serve in the rural household. For many crops neither men nor the market at large will generally know which varietal characteristics are most important. That is why poor rural women must occupy a special place in PPB.

Because it is sensitive to equity issues, PPB can be a powerful tool for agricultural rehabilitation and disaster relief intended to reach women and children—the most vulnerable disaster victims. In times of crisis (brought on by war, political upheaval, drought, or flooding, for example), rural people may be forced to consume their own seeds and other planting materials just to survive. It is therefore crucial that poor farmers, particularly those in marginal environments, gain access to suitable planting material as quickly as possible. The international Seeds of Hope programs have demonstrated how PPB can help provide effective seed relief.

In order to enjoy equitable access to exotic and local crop varieties, farmers need to gain control over germplasm. It is especially important that they be self-reliant in seed production. These are often explicit aims of PPB, which helps accomplish both by moving experimental germplasm into farmers' fields.

Two Marias

**"Thanks to the maize, we also have fattening chickens and pigs.
We mix maize with the pig feed that we buy at the store so it will go further"**

CROSSING PERSPECTIVES
FARMERS AND SCIENTISTS IN PARTICIPATORY PLANT BREEDING

The best way to get a feel for PPB and its impact is to meet some of the farmers involved. In this case both happen to be named Maria. One has been a direct contributor to PPB in Africa, the other a beneficiary of PPB in Latin America.

Maria Kaherero is a Namibian farmer who began an experiment with several kinds of pearl millet in 1989. One variety she used was Okashana-1, which matures early, tolerates drought, and has large grains and good threshing qualities. Okashana-1 was first made available to farmers in 1989 after a variety ranking exercise at Okashana Agricultural Center in northern Namibia. More than 100 farmers participated through the initiative of an NGO, the Rossing Foundation.

After Namibia attained independence in 1990, the new government invited ICRISAT to help initiate a pearl millet breeding program and to assist in multiplying Okashana-1. Prior to independence the country had no research program for its traditional cereal crops. Building on the Rossing Foundation's work, ICRISAT scientists provided for closer farmer involvement in the work of the new national breeding program.

With active government promotion, Okashana-1 became the standard against which farmers like Maria Kaherero could compare other varieties. But the new variety was not perfect. Its long stalks made it vulnerable to being knocked down by strong winds, and its seeds were susceptible to insect damage.

Maria planted Okashana-1 alongside local pearl millet varieties to allow cross-pollination, a step she repeated over four growing seasons. The resulting outcrosses, which had larger heads and thicker stalks, captured scientists' attention. In 1992 plant breeders visited her farm to select from her outcrosses.

Meanwhile, in another variety ranking exercise at two nurseries, 200 farmers chose 30 varieties out of 150 selected by the breeder and planted at Mahenene Research Station in northern Namibia. The purpose was to seek farmers' opinions about the relative importance of various millet traits. The varieties selected by farmers were then crossed with Kaherero's plants, and generations were rapidly advanced at nurseries in northern Namibia and at an ICRISAT site in Zimbabwe.

After three seasons a new composite population was finally developed. Incorporating the traits that farmers preferred, it outperformed both the farmers' local varieties as well as other composite populations developed through conventional breeding. This composite, named Maria Kaherero Composite, or MKC, has since become a genetic pillar of Namibia's national breeding program.

An ocean and a continent away, in southwestern Colombia, María Ilia Campo lives with her husband Máximo in the small community of El Diviso. In 1990 the community's local agricultural research committee, or CIAL, began a participatory research program with advice from scientists. This led to the introduction of two superior maize varieties, which have profoundly changed the couple's lives.

The community decided to concentrate on this versatile subsistence crop because of its importance for food security. In the past, farmers at El Diviso had commonly planted a tall maize variety, sowing it at low density. The variety produced only one ear per plant, however, and did not respond well to fertilizer. It was also slow to mature, allowing only a single crop per year. Plants often fell over in high winds just before harvest.

Among the varieties that farmers selected in their own trials were some experimental materials developed by the national agricultural research institute, CORPOICA, using germplasm from the International Maize and Wheat Improvement Center (CIMMYT). The CIAL also selected and improved local material obtained from farmer-breeders in a neighboring community. The farmers at El Diviso observed that the short maize varieties among the breeders' materials were susceptible to damage by animals. They selected instead varieties of medium height, which stand up in high winds and produce three ears per plant instead of just one. These varieties also respond well to fertilizer and mature quickly, enabling farmers to grow two crops per year.

Thus, long before CORPOICA officially released its varieties, the farmers at El Diviso had already multiplied and distributed seed of their selections, including the improved local variety. CORPOICA's seed has yet to be offered at the local agricultural bank, which is the main distributor of new varieties.

The El Diviso CIAL was so successful in producing high-quality seed that extension agents contracted the farmers to supply seed for a credit program. The CIAL began producing seed and selling it to local farmers, other communities, and extension agencies, enabling nearby communities to obtain and multiply the new varieties.

Overall, the new varieties have boosted local maize production by nearly 50 percent, generating tangible benefits for María and others. «When I got married,» she says, «I cooked, cleaned the house, and took care of the children. Máximo had to work as a day laborer on a commercial farm 3 days a week, and the other 2 days he worked on my father's farm.» Now, María and her husband have their own farm, and Máximo no longer has to work for other farmers. They plant maize as well as beans, coffee, tomatoes, and a little sugarcane. They no longer have to buy maize, since their own harvests provide enough seed for future crops and plenty of grain to make a kind of bread called *arepas* and maize soup.

«Thanks to the maize, we also have fattening chickens and pigs,» says María. «We mix maize with the pig feed that we buy at the store so it will go further. And we use the chicken manure to fertilize our tomatoes and beans.»

Other farmers have also cashed in on the CIAL's work. Before, just two or three families out of 100 in El Diviso had pigs, largely because most could not afford to buy feed. Now, 15 families have pigs as well as chickens. Originally, only 10 families grew maize, compared to 50 families today.

This story of the two Marias demonstrates the importance of tapping local knowledge and preferences when introducing and testing new genetic material. It also underscores the need to ensure that farmers have a plentiful and timely local seed supply. As illustrated in this publication, those lessons are now being applied in rural communities throughout the developing world.

Case 1

Pearl millet farmers shift an international center's research agenda.

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is working closely with farmers to improve pearl millets for the desert margin region of Rajasthan, India. Recent research involving interviews and visits with farmers has yielded a more detailed understanding of how farmers manage genetic resources. This, in turn, has helped ICRISAT researchers better interpret earlier results and has prompted them to shift research strategies and further develop PPB activities.

Researchers closely examined the farmers' perspective, including their production aims, ways of coping with large variations in rainfall, and strategies for managing pearl millet seed. The scientists also investigated important social factors, including village conditions and the division of farm responsibilities, especially tasks related to seed, by gender.

Here are just a few of the many observations and insights gained from the interviews and visits:

- Farmers in the drier areas—where annual rainfall is below 400 millimeters—do not really distinguish between *varieties* of pearl millet but between *plant types*. Different grain and straw qualities, for example, are associated with these different plant types.
- Farmers with larger parcels of good land produce and store their own seed, usually for more than one season. After harvest they select seed based on the panicles (grain-bearing heads). The selections tend to cover a wide range of plant types.
- Farmers want to diversify their seed lots as they diversify growing conditions on their farms through the use of manure, soil conservation measures, and the management of trees and shrubs in their fields.
- Poor farmers rarely maintain their own seeds. At sowing time they depend on relatives, richer farmers, or purchases from companies for their seed supply.
- The soil on land owned by poor farmers is normally of poor quality. It is often sandy, steeply sloped, and deficient in nitrogen and phosphorus.

- Poor farmers, especially women, find it increasingly difficult to obtain pure seed of the local varieties that are well adapted to their poor soils.

- Women are responsible for maintaining food and seed grain. They also prepare the seed mixtures at the time of sowing and do most of the work at harvest, including selection of panicles for seed.

How did such detailed information on farmers' preferences influence ICRISAT's pearl millet breeding program? Profoundly.Earlier on-farm work by ICRISAT had shown that preferences for varietal traits differ markedly not only among farmers but also among members of the same family. Many preferred traits are incompatible, making it impossible for breeders to combine them into a single variety. New information about farmers' reasoning and habits helped researchers resolve this dilemma.

For example, once they understood that farmers like to grow mixtures of plant types and actively select diverse seed, researchers were able to solve the problem of incompatible preferences. Rather than try to develop a variety that meets all requirements, ICRISAT breeders began identifying potential components of pearl millet mixtures for farmers.

A second shift in the orientation of the pearl millet breeding program responded to a need that farmers clearly expressed on several occasions. In western Rajasthan even well-off farmers wanted varieties adapted to poor soils, mainly as a way of bolstering food security. ICRISAT scientists thus started to develop breeding populations whose plant type is especially suited for those conditions. Among other things, the plants need to be disease-resistant, flower early, have thin stems, and give good grain yields under a range of difficult growing conditions.

The breeding populations involved in this work are composed mostly of superior landraces that originated in Rajasthan and are conserved in the gene bank at ICRISAT. To mimic target growing conditions, breeders have carried out progeny testing only in Rajasthan and have appropriately altered their management of soil fertility at the research stations. Only small amounts of mineral fertilizer were used, primarily to reduce experimental error. Researchers have also been preparing test fields depleted of nitrogen and phosphorus to better simulate farmers' conditions.

Initial feedback from farmers in the villages where the original interviews took place indicated that the new populations more closely fit farmers' requirements. But further work is probably needed to improve the germplasm's adaptation to low soil fertility.

Two other ICRISAT activities reflect an improved understanding of pearl millet farmers' needs and preferences. First, researchers are helping Grameen Vikas Vigyan Samiti, a local NGO, identify an appropriate local variety for seed multiplication in its target villages to ensure that poor farmers have a good supply of seed in case of an emergency.

Second, ICRISAT began a detailed study of farmers' management of pearl millet genetic resources across a wider area of Rajasthan, plus an assessment of their use of modern germplasm in seed lots. These efforts will underpin strategies for in situ conservation of local pearl millets, thus protecting a valuable food resource.

Case 2.

Farmer research committees in Latin America: An idea takes off.

Parts of Latin America have witnessed a veritable boom in farmer-led PPB in recent years, with major benefits for poor producers. Much of this activity centers on a new kind of miniorganization called a CIAL, the Spanish acronym for «local agricultural research committee.» While some CIALs experiment with cultural practices and inputs like fertilizers, at least half of CIAL-based research projects have concentrated on selecting improved crop varieties. In many cases the committees have served as channels for providing feedback to breeders on local preferences and test results.

A CIAL is a local volunteer research service, owned and managed by a rural community. By linking farmers with formal researchers, it increases the capacity of local communities to convey their needs and demands to public research services. The CIAL is accountable to the local community, which sets the committee's research priorities.

A CIAL normally consists of four farmers chosen by the community because of their interest in and aptitude for experimentation, as well as other skills and qualities, such as leadership, ability to communicate, honesty, and organizational capacity. The committee draws on the formal research expertise of government organizations, universities, and NGOs. CIAT too has provided the CIAL movement with both technical and organizational support and has trained other institutions in CIAL formation.

The CIAL approach to participatory research originated in Colombia in 1990 with strong impetus from CIAT. Consistent funding from the Kellogg Foundation has helped the concept evolve and flourish. More than 250 CIALs are now operating in Colombia and seven other countries of the region: Bolivia, Brazil, Ecuador, El Salvador, Guatemala, Honduras, and Nicaragua. In March 1998, CORPOICA, Colombia's national agricultural research institute, announced plans to extend the CIAL participatory model to its work throughout the country.

While many CIALs began after an initial push from outside organizations like CIAT, they quickly became farmer-led operations. And as the idea spread among small rural communities in Latin America, the impetus for many new CIALs came from the farmers themselves.

In the first 4 years of CIAL development, farmer-researchers managed the testing of about 1,000 varieties of beans, maize, peas, groundnuts, fruits, and vegetables. A major spin-off has been the establishment of small seed enterprises led by CIALs.

To date, more than 10,000 farmers have bought seed from CIALs. For one growing season, these sales were estimated to have generated gross income of over US$2.5 million. In addition, it has been estimated that the labor costs of a CIAL-managed experiment are 60 percent lower than those for a similar trial run by a government extension agent.

In 1998, CIAT scientists followed up on a study that had been conducted a decade earlier by a rural sociologist on farmer experimentation in Colombia's Cauca Department. Four communities covered by the 1988 study had gone on to form CIALs. The new assessment compared those communities with four others from the original study group that had not formed CIALs. It showed an increase in farmer experimentation with new varieties of crop species already under cultivation and of new species altogether. Farmers in communities with CIALs experimented more actively than those without. For example, about half the farmers interviewed in communities with CIALs were conducting experiments with new crop species, compared to 35 percent in communities without CIALs.

These results suggest that CIALs do more than give communities better access to external research resources and enable small numbers of farmers to innovate. The presence of these committees has a multiplier effect on agricultural experimentation in the community at large. In other words farmers not only learn from one another about promising new crop varieties and species, but they also «learn how to learn» from each other. The catalyst for this process is organized participatory research.

2. Stare of the art
Two approaches converge

Today, scientific plant breeding is a highly organized enterprise. It is based on an understanding of the principles of heredity and on standardized, replicable experimental techniques.

From Ice Age to Computer Age

Human beings have been domesticating wild plants and improving them as food sources for about 10,000 years, since just after the last ice age. Neolithic farmers were probably the first to begin saving the best seed from the best plants at harvest.

On many occasions natural mutations and crosses between species have also produced plants with new traits that farmers liked. So, farmers have saved seed from such naturally generated superior plants for sowing future crops. The intricate dance between human and natural selection over the centuries has given us the many and diverse species of plants that today feed and clothe the world, nourish livestock, and fuel kitchen stoves. Farmers continue to breed their own varieties, in parallel with scientists, and they currently produce more seed than agribusiness.

In the mid-1800s, the work of an Austrian monk, Gregor Mendel, revolutionized our understanding of how plants and other living things inherit biophysical traits. But his findings were not fully appreciated and applied until the beginning of the 20th century.

Today, scientific plant breeding, both public and private, is a highly organized enterprise. It is based on an understanding of the principles of heredity (much improved since Mendel's time) and on standardized, replicable experimental techniques. Computer technology has greatly boosted both the sophistication and speed of statistical analysis of results. Meanwhile, the tools of biotechnology, such as tissue culture and molecular marker applications, have cut research time and extended the biological reach of plant breeders into the new world of transgenic organisms.

Formal-led and farmer-led breeding

As an approach to agricultural research, PPB is young but growing quickly. The PRGA Program has inventoried about 70 examples, largely in developing countries, and these can be divided into two general approaches, «formal-led» and «farmer-led.»

Most plant breeding programs include a broad range of genetic improvement activities in which farmers and researchers can interact in a number of different ways. Among these activities are: setting breeding goals, creating genetic variability, selecting within variable populations, evaluating experimental varieties (often termed «participatory variety selection,» or PVS), releasing and popularizing new varieties, and producing seed.

The degree and type of interaction often depends on the activity and the type of knowledge it involves. The adjacent table summarizes the different task-sharing arrangements among farmers and scientists in four breeding approaches.

In formal-led PPB, farmers take part in crop breeding and seed supply activities initiated and organized by trained agricultural scientists from research organizations or other formal institutions. In farmer-led PPB, farmers' own systems of crop development, long in existence or newly initiated by local communities, receive support from external agents, such as trained researchers, development officers, and paraprofessionals. The main distinction has to do with who is in the driver's seat.

Comparison of four breeding approaches:
conventional scientific breeding, formal-led PPB, farmer-led PPB, and traditional farmer breeding

	Conventional scientific breeding	Formal-led PPB	Farmer-led PPB	Traditional farmer breeding
Main goals	• Productivity increase (quality/quantity)	• Productivity increase • Biodiversity enhancement	• Productivity increase • Conservation	• Maintenance of germplasm • Improvement of
seed (and germplasm) building	• Self-reliance • Wide adaptation of germplasm	• Local adaptation of germplasm (although wide adaptation may be an outcome)	• • Local adaptation of germplasm (although wide adaptation may be an outcome)	Farmer skill
Germplasm	• MVs • Finished materials on-farm	• Primarily MVs • Some FVs • Stabilized and variable materials on-farm	• Both MVs and FVs, depending on goals • Stabilized and variable materials on-farm	• Locally available materials, from neighbors and markets
Participants in:				
• Definition of objectives and breeding strategy	B	J	J	F
• Selection of parents/crosses	B	J	J	F
• Selection from segregating populations	B	J	J	F
• Screening advanced lines on-station	B	J	J	F
• Adaptive on-farm testing		B	F	F F
• Validation	J	F	F	F
Organization a communities sometimes on a single farm	• Centralized • single community,	• Decentralized Work with individual	• Decentralized • Work with groups of farmers farmers	• Decentralized, in • Work with
Variety release but “blessing” “blessing”	Formal informal approval or	Formal	No formal release but informal	No formal release approval or
Seed diffusion	Formal	Formal and local	Local	Local

MVs = modern varieties, FVs = farmer varieties, B = breeders, F = farmers, and J = breeders and farmers jointly.

Formal-led PPB also differs from farmer-led PPB in three other ways. First, agricultural research agencies that initiate participatory research normally have a mandate to apply the results beyond the participating farmers or communities. Farmer-led PPB, in contrast, tends to have a local focus. Second, formal-led PPB is usually linked to the formal system for releasing varieties and producing certified seed, while farmer-led initiatives handle these tasks informally.

Finally, formal-led PPB often aims to improve the efficiency of conventional breeding—for example, by showing researchers how to better account for the crop traits that interest farmers. Farmer-led PPB, while conveying results to the community, is not obliged to provide feedback to scientific institutions. Thus, formal-led PPB does not just involve research on crop varieties but often seeks as well to improve the research process.

For the most part, formal-led PPB has the same overriding goal as conventional scientific plant breeding, namely to increase crop productivity. Other objectives are to cut the costs of research and development, generate new knowledge, enhance the conservation of plant genetic diversity, and improve farmers' skills.

The work of INIAP in Ecuador, ICARDA in Syria, and CIAT with the Rwandan Institute of Agricultural Science (ISAR) provides examples of formal-led PPB conducted by one national and two international research organizations, respectively (**see Cases 3, 4 5**).

Two typical aims of farmer-led PPB are conservation of genetic diversity and germplasm improvement. In some cases farmer-led breeding aims to expand crop options or promote self-reliance in both plant breeding and control of the seed supply. An example of this is the Sustainable Agriculture and Village Extension (SAVE) Project in Sierra Leone (**see Case 6**).

Farmer-led PPB programs are neither as numerous as formal-led programs nor as well documented. They have a wider mix of goals but are more narrowly focused on farmers' own systems of breeding and seed selection (**see Case 7**).

The two PPB approaches, though distinct, have much to offer one other. For example, many formal-led programs, by working with farmer-led groups, can better link increased genetic diversity with higher yields. Likewise, through alliances with formal-led programs, farmer-led groups should be able to achieve broad geographical coverage. Not surprisingly, as the two approaches mature, they are beginning to converge.

The environment of participatory plant breeding

It is helpful to examine PPB experiences in relation to the kinds of physical and economic

Farmer-led breeding often aims to expand producers´crop options or promote self reliance in both breeding and control of the seed supply

environments where they take place. The physical environment, or target agroecosystem, may be unfavorable, variable, and risk-prone or, at the opposite extreme, favorable, uniform, and easy to control. As for the economic environment, subsistence production may predominate, with farmers choosing crop species and varieties mainly according to their own needs and preferences. Or in contrast, crop production may be driven largely by demand from urban consumers and commercial processors. The latter tend to demand product uniformity and a narrow range of grain, taste, and cooking types.

Participatory plant breeding programs work in a variety of agroecological and economic contexts. But they tend to be concentrated in marginal, essentially subsistence production environments—for example, in eastern India, Syria, and high-altitude Nepal.

Surprisingly, though, growing numbers of PPB programs are now taking place in more agroecologically favorable locations, where crop production is market-driven, as in irrigated areas of the Philippines. Two motives underlie this trend. First, some PPB programs are looking to increase varietal diversity in areas where crop production is marked by genetic uniformity. And second, NGOs involved in PPB are hoping to give farmers more control over breeding, specifically in rice programs of several Asian countries.

Both formal-led and farmer-led PPB can conceivably operate in any agroecological or economic environment. However, most formal-led work has taken place in marginal lands, where conventional breeding has not fully addressed producers' needs. Formal-led PPB also tends to be applied where traditional subsistence crops are being transformed into marketable commodities subject to new quality standards. This prompts farmers to seek special processing traits to meet market demands. In parts of Latin America, for example, some PPB work aims to develop cassava varieties characterized by high starch content for industrial markets.

Farmer-led PPB programs, while spanning all types of production zones, often lie between the economic and physical extremes.

Crop development factors

Most formal-led work has taken place in marginal lands, where conventional breeding has not fully addressed producer´s needs.

In addition to examining the economic and physical contexts of PPB, the PRGA Program has mapped these activities according to two sets of factors related to crop development. One is the research stage at which the participatory collaboration began. The other is the plant propagation method involved: vegetative, open pollination, or self-pollination.

As for the research stage, PPB programs are often divided into those working with genetically variable, or «segregating,» plant populations (early stage) and those dealing with stabilized lines (later stage). To this classification we can add two other research stages. First, farmers could be usefully involved from the outset in the strategic planning of a research program (though so far the Plant Breeding Working Group of the PRGA Program has found no such cases). And second, once new varieties have been developed, farmers can take charge of the multiplication and distribution of seed or other planting material.

The Working Group has found cases of PPB in all three of the categories defined according to method of crop propagation. While most programs work with stabilized materials of self-pollinated crops, a significant and increasing number deal with segregating populations.

A handful of PPB programs have successfully introduced their germplasm into the formal seed sector (in India and Nepal, for example) but without resolving the issue of farmers' property rights. In addition, some programs—working with beans in Rwanda and with beans, cassava, and maize in Colombia, for example—have supported groups of farmers who are undertaking seed multiplication for their communities. But few programs have tried to unite variety development with widespread diffusion of seed.

A shared challenge

Farmer participation in plant breeding need not be restricted to the final, testing stages of research.

CROSSING PERSPECTIVES
FARMERS AND SCIENTISTS IN PARTICIPATORY PLANT BREEDING

At what stages in plant breeding (in the broadest sense), can farmers and formal breeders first join forces? PPB specialists point to several activities in which this collaboration can begin:

- Defining the plant type that the formal or farmer-breeders will develop
- Characterizing the physical environment in which the crop will be cultivated.
- Identifying specific client groups and representatives as well as the plant traits they prefer
- Selecting parent materials and making crosses
- Selecting promising plants at early generations (that is, in segregating populations), when traits are not yet fixed
- Screening advanced lines for traits that interest farmers, such as cooking time, starchiness, storability, ease of harvest, and so onMonitoring the performance of experimental varieties through on-farm evaluations at multiple locations
- Multiplying and distributing seed
- Sharing information about new varieties.

As the list shows, farmer participation in plant breeding need not be restricted to the final, testing stages of research. Under a rice project in Nepal, for example (see Case 8 on page 36), farmers worked successfully with relatively early generations of genetic material.

PPB signals a major shift in the standard division of labor between crop scientists and their clients, particularly when it begins at the earlier stages of research. This is not to say that farmers or other users need take part in every single breeding task or stage. PPB experience reveals that some tasks demand scientific expertise, while others require knowledge that only farmers possess. Still others demand close interaction between the two groups. A careful division of labor, tailored to the setting, can improve the efficiency of the whole process from plant breeding to variety adoption and thus prevent research from straying down blind alleys.

An instructive example of this shift in the division of labor comes from the PPB work of CIAT plant pathologist Elizabeth Alvarez with cassava in the Colombian Amazon. Based on pictographic sheets and field visits, her research team worked with indigenous women farmers to identify the most important problem of this staple crop. In this case it turned out to be a root rot disease

In disease-affected *chagras* (small plots of burned rainforest planted with cassava and other crops), scientists identified local races of the pathogen and then inoculated plants in the greenhouse with these to select disease-tolerant genotypes. Out of 430 genotypes from Brazil, Colombia, Ecuador, and Venezuela, eight were selected for tolerance, not just to local races of the pathogen but also to those from different cassava growing regions of Colombia.

Indigenous women then took the lead, evaluating and harvesting the resistant cultivars in four different communities to find varieties adapted to local conditions and characterized by high yields and starch content under traditional crop production practices. «The women are so happy and so proud to be selecting varieties themselves,» Alvarez says.

Subsequent work, carried out by Brazilian cassava breeder Wania Fukuda and her colleagues at Embrapa Cassava and Tropical Fruits in cooperation with CIAT used the same approach to work with farmers in 50 communities in the state of Sergipe. Scientists identified cassava varieties resistant to the root rot that was turning tubers into useless, foul-smelling mush. The farmers then did field testing and selection to ensure that the varieties were adapted to local conditions and suited for the production of *farinha*, a processed form of cassava used in many traditional dishes. This division of labor ensured that the final selection of varieties incorporated the knowledge of both the scientists and the local farmers.

Participatory plant breedinf signals a major shift in the standard division of labor between crop scientists and their clients.

Case 3

Making the potato breeder's work easier in Ecuador

It is early March and potato plants are flowering in Santa Marta de Cuba, a small Andean community in Ecuador's northernmost province of Carchi. Today, a lively group of farmers, agricultural technicians, and students has gathered in a field to evaluate potato clones.

Potatoes are an important crop for this country's small farmers, who grow them both for consumption at home and for the market.

After an organizer briefly reviews the research conducted to date and describes the activity planned for the day, an enthusiastic participant yells: «¡*Vamos investigando*!» («Let's go research!»). The group then sets out to judge and select from the clones that they themselves identified in the previous cycle of research. This exercise takes place at two stages in the growing season: flowering and harvest. The aim is to identify for release one or two clones that satisfy the greatest number of criteria set by participants.

The root and tuber program of Ecuador's National Institute of Agricultural Research (INIAP) has been using participatory breeding methods since the beginning of the 1990s. Before, scientists had developed varieties for release according to their own perceptions of what was suitable, with little or no input from the farmers themselves. Rates of adoption were disappointing.

«The use of these methodologies constitutes a fundamental change in our attitude,» says Héctor Andrade, who leads INIAP's potato research. «Because we were trained as scientists, we didn't think we needed to consult with anyone about our results.» Now Andrade and his team are convinced that user participation in breeding not only guarantees higher adoption rates but also reduces the time it takes to develop suitable varieties.

Perhaps the most striking example of INIAP's recent success with PPB was the release in 1995 of FRIPAPA. This potato variety combines the disease resistance and high yield of previously released materials with the taste and texture found in native varieties and required by the fried- potato industry.

The research project collected data on the selection criteria of farmers and processors and forged ahead with clones that best matched the quality preferences of these two groups. Negotiations with a processing firm ran parallel with the breeding program.

The resulting agreement guaranteed a market and price for the new potato variety. Today, 200 hectares of FRIPAPA are planted in northern Ecuador for seed production. The new variety is expected to capture half of the national market for frying potatoes.

INIAP has been organizing participatory clone selections, like the one at Santa Marta de Cuba, in different parts of the country. The Institute now relies on a national network of potato clone evaluators consisting of 12 groups. Farmers are routinely invited to the research station at Santa Catalina, Pichincha, to select clones for further testing on their own farms.

Participatory breeding is also proving valuable to INIAP's research on other crops. «Working with farmers makes my job a lot easier, because I have some certainty about the characteristics I'm selecting for,» says Oswaldo Chicaiza, a breeder in INIAP's cereals program. «While participatory breeding is initially more costly than conventional breeding, « he says, «it soon becomes cheaper because the farmers themselves can do a lot.»

The INIAP potato program is an example and a resource for other institutions interested in using participatory breeding methods, including NGOs. In fact, farmers are now asking the Institute to apply the same approach with other crops.

Case 4

Syrian barley growers and their powers of selection

Over the years farmer adoption of new barley varieties in Syria's drylands has been extremely low. And this has been a great source of frustration for researchers at the International Center for Agricultural Research in the Dry Areas

(ICARDA).

«I realized I was going to get nowhere,» says ICARDA scientist Salvatore Ceccarelli. He is referring to conventional breeding for unfavorable areas, where few farmers can afford fertilizers and other inputs.

Instead, they need varieties that are adapted to harsh growing conditions and match their preferences. «Participatory plant breeding was a logical conclusion in the evolution of my thinking.»

Some researchers, admits Ceccarelli, are skeptical about farmer participation in varietal selection, especially when it involves numerous early-generation lines. They believe, for example, that farmers may be unable to visually distinguish varieties that give high grain and straw yields from those with low yields. «My data prove that this is not true,» he says.

In 1996 plant breeders embarked on a project to test whether PPB could become a permanent feature of a program serving low-input agriculture in difficult environments. While identifying suitable barley germplasm with farmer participation, the project also compares PPB with conventional breeding methods.

Researchers examined the results of farmer participatory work in nine communities and at two research stations, using 200 experimental barley lines plus eight of the farmers' varieties. In some communities as many as 10 neighboring farmers were invited to take part in the selection done in a «host» farmer's plot.

Each host farmer selected the best lines from both his own experimental plot and from plots at the research stations. Independently, a professional breeder also selected from the host farmers' plots and the station plots. «We made sure the breeder didn't talk to the farmer when he went to the farmers' fields to make his selection,» says Ceccarelli. At the same time, the research team, which included two social scientists, gathered information about farmer selection criteria and preferences. Syrian extension agents helped with the field work. Measurements of grain and straw yield were used as an independent check on the participants' judgments of those factors.

In each subsequent growing season, the farmers' and breeders' selections were grown on-farm and on-station, and the parallel screening by farmers and breeders continued. Farmers are so interested in the results that they have asked ICARDA to retain the elite barley lines at the research station just in case something goes wrong with their own seed production and they need a source of clean seed.

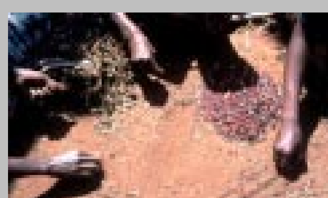
The project is now in its third and last year, and a second phase, involving more farmers, is being planned. A major aim is to speed the diffusion of barley lines selected by farmers during the first phase. Meanwhile, ICARDA scientists, together with breeders in the national programs of Tunisia, Morocco, and Yemen, are running similar comparative PPB studies with barley and lentil farmers.

Early results from the work in Syria show that farmer selections, based on diverse criteria, perform as well and sometimes better than those of the professional breeders. The results also show that farmers are unintimidated by the task of screening large numbers of early generation lines and can contribute to the selection of desirable traits.

Participating farmers began producing seed from a few of their own best selections after the project's second growing season. «We anticipated that the initial signs of adoption would appear at the end of the project,» says Ceccarelli. «But it's happening earlier.»

Case 5

Institutional issues in participatory bean evaluation in Rwanda



Rwandan farmers are extraordinarily adept at managing local bean diversity. Nationwide they grow about 550 different varieties. Farmers plant mixtures of varieties, adjusting them according to the particular soil type and crop association.

Despite this clear preference for bean diversity, the Rwandan Institute of Agricultural Science (ISAR) has employed a selection sequence, based on Western models, that sharply narrowed the range of cultivars on offer. About 200 entries were screened, but only two to five entered on-farm trials—the sole means for clients to provide feedback.

In 1988-1990, ISAR and the International Center for Tropical Agriculture (CIAT) undertook a PPB program that drew on farmers' experience early in the selection process. During the program's first phase, women bean experts evaluated 15 bean cultivars in trials conducted at an experiment station two to four seasons before on-farm testing. The on-station evaluations revealed that women select bush beans according to attributes that a formal breeding program would not easily anticipate.

On-farm trials further demonstrated that farmers are able to transfer results from the experiment station to their own plots at home. Thus, the varieties farmers selected outyielded their own checks by an average of up to 38 percent, while the breeders' choices in the same region showed no significant gain. Farmers adopted 21 new varieties in the program's first 2 years, as many as ISAR had released in the previous 25 years.

The program's first phase was very research-oriented, with a strong emphasis on precise technical results. The experience highlighted farmers' ability and eagerness to screen large numbers of varieties at an early stage in crop improvement. The program also heralded the potential benefits of farmer participation, which included better, more diverse crop production and significant savings in the costs of on-station research.

During a second phase, participants screened a broader range of cultivars even earlier, evaluating 80-100 entries in on-station trials five to seven seasons before conventional on-farm testing. From 1990 to1993, farmers screened a trial that generally contained about 80 lines. A CIAT pathologist screened the trial earlier than usual to eliminate entries that were highly susceptible to major diseases. In the first two seasons alone, farmers selected 26 varieties from community-managed trials for further testing at home.

In its second phase, the program sought ways of encouraging communities to choose their own expert representatives and of devolving much of the on-farm testing to the farmers themselves. This was based on the assumption that rural communities should have the right to select their own delegates to screen new cultivars on-station and that they should also control how the 20 to 25 varieties selected are subsequently tested in rural areas. Such an approach, targeting germplasm to many diverse locations, is practical only if it is decentralized, with rural communities bearing most of the local costs.

From early 1990 onwards, the women bean experts who came to the experiment station represented three types of local groups: (1) farmer research groups supported by an NGO, (2) self-organized groups of farmers interested in research, and (3) groups from administrative units referred to as *communes*. The cultivars women selected were managed in various types of community plots.

The NGO served several hundred farmers, and the commune units potentially reached up to 6,000 households. (Hence, the program reached a potential total of 27,000 households, or about 135,000 people). Normally, 30 to 50 farmers were invited to review each community plot. One or two of the varieties selected were given to each evaluator at harvest for testing at home in subsequent seasons.

The PPB program's second phase yielded important insights into institutional concerns. Ironically, turning over the choice of farmer representatives to the communities, along with the responsibility for local testing, did not always best serve the interests of women bean experts. In Rwanda human relationships at the local level are governed by strict hierarchies, in which women fall near the bottom of the heap, regardless of their class or ethnic group. «Women have no race» says a local proverb. Whatever power they have derives from their relationships with significant male others—brothers, fathers, and so forth.

Local power structures, particularly male hierarchies, distorted the PPB process at several key points. Researchers suspected that some of the «experts» selected to screen on-station trials were neither well informed nor particularly representative of community interests. One community, for example, was represented by the sister of the government agronomist and the wife of the sector head. The fact that the men were important officials apparently made farmer experts of their female relations. Power proved inseparable from knowledge.

Another concern was that key individuals reneged on their obligations to the community at the final stage of the work. In some cases the community plot had been laid, the variety evaluations completed, and the data collected, but seed of selected varieties was never distributed for farmers to evaluate further in their own plots.

Working through administrative structures offers many advantages. These units are nationwide, cross agroecological zones, and potentially encompass all of a country's farmers. Local governments have land and can mandate decentralized selection of varieties. Often, however, local administrators are more interested in control than service. Even so, given these officials' substantial strengths, PPB researchers in Rwanda hoped to find ways of obtaining better collaboration from them.

The PPB experiment tended to thrive when the women bean experts had some control and when a true sense of community prevailed. One women's cooperative was particularly well organized and serious about the research.

The group sent real experts to the experiment station, who chose varieties for subsequent testing in the plots of designated group members. The cooperative as a whole decided which varieties to multiply, which to discard, and which to test further. The cooperative had already multiplied more than a ton of seed when other communities were just getting started.

Scientists often view PPB programs as technical experiments, aimed at answering questions about farmers' expertise. For example, can they effectively screen segregating populations? Yet some of the greatest challenges lie in identifying appropriate institutional forms for PPB. Within the CGIAR system, institution building has focused principally on national institutions, helping them to become more client-oriented, for example. An equal, if not greater, challenge lies at the community level: how to identify or help create organizations that represent the full range of farmer interests and that can serve as partners of a receptive formal research sector.

The major findings on institutional issues of the Rwandan PPB program's second phase can be summarized as follows:

- Where varietal preferences differ even among neighboring farm communities, participatory selection has to be coupled early on with decentralized seed multiplication.
- To expand a participatory selection program, formal sector researchers must work in partnership with organized groups of farmers, rather than individuals, to share the costs and responsibilities of decentralized variety development.
- Working through community institutions does not guarantee that community needs are met. Local power structures—male hierarchies, for example—can undermine the fundamental premises of a participatory program. The challenge is to identify local organizations that represent the whole range of farmer interests and can serve as research partners.
- To work with farmer groups requires some means of feeding information «forward» to rural communities as well as delivering feedback from them to the formal research sector.

Case 6.

”Creative play” in Sierra Leone's farmer clubs

When farmers gain better access to diverse new planting materials, they can demonstrate a remarkable ability to experiment creatively and share results enthusiastically among themselves. That is one of the lessons of a recent participatory breeding project in Sierra Leone. Called Sustainable Agriculture and Village Extension (SAVE), the project centered on farmer screening and multiplication of new varieties.

It worked on the assumption that farmer participation in breeding is limited not by a lack of interest or skill but by poor access to new germplasm. Though launched by CARE, an international NGO, and funded by a mining company, the project was run by participating farmers.

The farmers organized themselves into clubs, which distributed small packages of planting material. Members chose from among 54 varieties of rice, cassava, sweet potato, oil palm, mango, and maize. From 750 farmers in 1990, the project's first year, the number of participants swelled to 4,500 people in 75 villages by 1995, when the project came to a close.

Farmers were encouraged to conduct «creative play» experiments, using new germplasm to fill gaps in their farming systems. So farmers could find their own solutions, CARE staff intentionally avoided offering them extension advice. They did, however, organize field days and workshops, in which farmers from different villages could share their experience and results. The events proved highly popular as a way for club representatives to present their evaluation methods and observations to other farmers.

At least 18 varieties had been identified and adopted by the end of the project. The most notable success was an early maturing sweet potato, which helped fill a food gap in the hungry season.

Putting farmers in charge of the project promoted local empowerment. But in some instances, decisions about club membership and seed distribution were slightly biased in favor of particular families and villages. In a later phase, SAVE paid more attention to equitable participation, especially that of women, and to providing seed of vegetable crops.

The project did not measure systematically the extent to which planting material was disseminated from recipient members to other farmers. Even so, distribution was rapid in some cases. In general, though, the small amount of materials distributed, while benefiting many farmers, slowed distribution, since farmers needed at least one growing season to multiply enough seed for exchange. Vegetatively propagated crops like cassava and sweet potato spread more quickly than seed crops like rice, since farmers could exchange cuttings from the first crop.

3. Achievements and Impact
Closing the Gap

Small-scale farmers in developing countries nearly always have a clear idea of what they want in a new crop variety.

Understanding farmers' preferences

Women´s preferences for specific plant traits are an excellent weathervane for steering breeders in the direction of poverty alleviation.

In its quest for research relevance, PPB gives a central place to local knowledge and preferences. Small-scale farmers in developing countries nearly always have a clear idea of what they want in a new crop variety. And that idea is usually complex. It may involve dozens of quality traits or combinations of traits, often linked to the multiple end uses of a crop. Yield is just one among many factors. In a program in Peru, for example, an inventory of farmers' criteria for evaluating potatoes included 39 different elements. In Tanzania bean growers drew on over 40 criteria.

Yet to many conventional breeders, farmer preferences may seem idiosyncratic or even frivolous if the rationale behind them is not clear. A major strength of PPB is that it places great value on recording and systematizing farmers' extensive knowledge of plant varietal traits and their local value. Such information, presented from the farmer's point of view, no longer appears confusing or mysterious to breeders. It becomes a key input in the basic plant design (or «ideotype») and selection of genetic material.

The value of early maturing varieties demonstrates the point. Breeders do not usually include earliness as a factor in the design of plant ideotypes, because it tends to be associated with lower yields. But from the viewpoint of small farmers with very little land, earliness makes sense. It allows them to get varied produce off their land quickly—which is crucial if their food supply from the previous crop is running low. Recognizing the validity of farmers' preferences for early maturing varieties has been a key ingredient in the success of breeding programs for poor maize farmers in eastern Africa and poor cassava farmers in semiarid areas of Latin America.

While farmers have strong preferences for, and opinions on, particular traits, these vary widely among individuals, within farmer groups, and between men and women. Eva Weltzien Rattunde, a researcher with ICRISAT, has seen such differences in her PPB work with pearl millet farmers in Rajasthan, India (**see Case 1**). «Across the whole region, women farmers expressed more concern for grain yield and grain stability than men,» she says. «Men tend to value the yield of stover, used as animal fodder, more highly than do women.»

At one point in her research, Weltzien and her colleagues brought a large, genetically varied set of pearl millet panicles (seed-bearing heads) from the research station to be evaluated by a group of farmers. The participants were asked to pick out all the heads they thought were potentially useful as seed. The next day the researchers drove to another village to consult a second group, which happened to consist of low-caste women farmers.

«Approaching the village, we realized that we had forgotten to bring the box containing the set of test panicles. The only panicles left with us in the car were those that the other farmers had rejected as not useful for sowing, plus a few other panicles that did represent a fairly good range of millet variability. We decided to work with this material rather than waste the day.»

The results of the discussion with the women surprised the researchers. «The only types of panicles they were interested in sowing were panicles that the other farmers had discarded, ones that were very small and had small grains and very thin stems,» recalls Weltzien. «They were certain this type of millet would be the most productive in their fields. In this case the needs of the two groups did not even overlap!»

Plant breeding is slow—it typically takes 10 to 15 years from initial planning of the varietal ideotype to final adoption of a new variety by large numbers of growers. And since PPB is a young field, it may take some years before its full potential becomes clear.

During its short history, though, PPB has brought a useful but sobering realization to formal plant breeders around the developing world: the conventional «one size fits all» approach to plant design does not sit well with millions of poor farmers cultivating marginal land under tough growing conditions. Formal breeders' historically narrow focus on uniform crop varieties that yield well across many growing environments is at odds with farmers' preferences for a diversity of other crop traits.

Demonstrating this gap between the thinking of formal breeders and that of farmers has been one of PPB's key achievements. Early PPB studies showed that simply adapting existing Green Revolution technologies to the conditions of small-scale, mixed farming might not work. Farmers repeatedly rejected plant breeders' prerelease materials or ranked them lower than their own local varieties.

CIAT bean research in the 1970s demonstrated the rift between farmers' and breeders' perceptions. At that time bean breeders were selecting for high yield, a trait associated with small grain size. Over time the grains of the best-performing varieties tended to become smaller. In contrast, farmers in the South American Andes consistently selected for large grains. The reason was simple: large grains were preferred in the local diet and thus commanded a higher price in the market.

A key contribution of PPB and other early attempts to orient research more to clients' needs was that it underscored—indeed, validated—the logic behind farmers' choices and preferences. This helped conventional plant breeders see that farmers' rejection of modern high-yielding varieties was not irrational. Rather, it simply reflected a complex set of underlying objectives quite different from their own.

In addition to high yields, farmers look for many other traits in crop varieties. Here are a few examples of farmers' selection criteria, which the PRGA's Plant Breeding Working Group has compiled from PPB cases:

- Yield stability
- Steady food supply over the year
- Straw and residue quality
- Early maturity (which usually means lower yields)
- Grain and tuber size
- StorabilityEase of processing, threshing, pounding, and dehuling
- Crop marketability
- Seed quality and size
- Tolerance to stresses (environmental, weeds, animals)
- Cooking time
- Digestability, nutritional value, taste, and texture
- Medicinal qualities
- Suitability for alternate purposes, such as mulching, construction, and crafts
- Starch content
- Adequacy for ceremonial use.

Not surprisingly, these criteria have a strong gender dimension. Women favor labor-saving attributes and secondary uses of crops as well as early maturity to avoid seasonal hunger. Since these preferences are strongly associated with low-income households, women's preferences for specific plant traits are an excellent weathervane for steering breeders work in the direction of poverty alleviation.

Genetic diversity: The farmer's guardian angel

PPB has helped conventional breeders appreciate the importance of risk management in farmers' varietal preferences. Genetic diversity, both within a single crop and in the number of species planted, is one hedge against the frightening prospect of ending up with little or nothing to eat at the end of a difficult growing season (see Case 5).

Landraces, the product of farmer breeding, are often a mixture of slightly different genetic lines rather than pure varieties. Some lines are better adapted to specific environmental niches than others or are better suited to particular uses in the farm household. Called «population buffering,» this strategy for managing plant genetic diversity helps ensure yield stability under variable growing conditions. It is the constant protective companion of small farmers, a mechanism they have relied on for thousands of years.

Experience with PPB also suggests that, when farmers manage risk through strategies other than maintenance of genetic diversity, they may end up contributing to genetic erosion. Farmers who use pesticides and fertilizers, for example, may select heavily for specific traits required by the market without running much risk of crop failure. While this makes their production more profitable, it also narrows the genetic base of the crop.

There is nothing inherently conservationist about farmer breeding or farmer participation in breeding. Even so, cooperation between farmers and scientists is providing valuable insights about how they can both do a better job of improving productivity while conserving plant genetic diversity.

Decentralization and devolution.

Genetic diversity, both within a single crop and in the number of species planted, in one hedge against the frightening prospect of ending up with little or nothing to eat at the end of a difficult growing season.

Positive experience with PPB is encouraging public-sector breeding programs to decentralize their operations and devolve tasks to farmers.

Decentralization alone does not guarantee farmer participation. Even if plant breeders work in plots leased or borrowed from farmers, they may still pursue a conventional «pipeline» approach to varietal development and release.

To open the way for genunie farmer participation, breeders must devolve much of the adaptive testing to them. And channels of communication must be created, so farmers can provide feedback to plant breeders on research results. These steps can improve the efficiency of germplasm selection for difficult environments, as illustrated by the experience of the CIALs in Latin America (**Case 2**) and the work of womens' cooperatives in Rwanda (**Case 5**).

To decentralize and devolve breeding activities, formal-led programs need to train farmers in plant genetics, breeding techniques, and pollination control. That was the approach taken by Cornell University in Honduras and by ICRISAT in Namibia, and their experience has shown that such training increases the impact of research. Training of farmers could prove highly valuable for plant breeding, in much the same way that «farmer field schools» have boosted the impact of integrated pest management (IPM) research. Much remains to be done in this area.

Cases of impact

Most of the PPB programs inventoried by the PRGA Program are no more than 5 years old and still operate on a rather small scale. In the early stages of these programs, farmers, researchers, and development workers have needed time to learn how to work as a team, agreeing on goals, division of labor, organizational arrangements for crossing and screening at multiple sites, and ways to make the needs of marginalized people central to the breeding strategy.

The 10 cases described in this publication illustrate vividly how and where PPB is making its mark. Some programs have successfully developed or selected improved varieties for marginal environments, such as the high hills of Nepal (**Case 8**) and Northeast Brazil. Where PPB programs have concentrated on increasing yields and enhancing varietal diversity, farmers have rapidly adopted the resulting genetic materials, notably in Ecuador (**Case 3**) and Colombia (**Case 9**). In a remarkably short time, PPB programs have reoriented breeding strategies, shortened varietal testing time, and sharply reduced the incidence of rejected varieties, for example, in India (**Case 1**), Rwanda (**Case 5**), and Syria (**Case 4**).

The PRGA Program now has under way a major study to assess systematically the impact of these and other approaches to PPB. The study examines how breeding materials perform when managed by conventional means, compared with a participatory approach. The work of IRRI and ICAR in eastern India and of ICARDA in Syria are among the cases included in the study.

Reaching the poor, reaching the women

Just women´s preferences and roles may differ from men´s the perspectives of the poor in general often differ from those of the "average" farmer.

In the long run PPB programs will be judged largely by how well they address the needs of the poor, particularly women. Reaching out to poor women is more than charitable. It can make for better science and more cost-effective plant breeding, because women occupy such a central place in developing-country agriculture.

As plant breeders, women domesticate wild species, select germplasm, and save seed in small-farm production systems. Often, they bear primary responsibility for maintaining and reproducing the world's landraces of crops such as beans, cassava, fonio, bambara groundnuts, millets, and many minor species.

In Rwanda, for example, women are the true experts on beans, proudly serving as the guardians of this crop's wide genetic diversity. Veneranda Mukondoli is one of the country's women bean experts. Several years ago she came down with malaria just when it was time to help prescreen germplasm at a local research station. Her husband offered to fill in for her. «You must be kidding,» Mukondoli told him with a smile. «I'll send our young daughter first. What do you know about beans?»

Female expertise benefits not just women but entire communities. Women bean experts in Rwanda selected a pool of 21 distinct bean varieties that met the quality requirements of diverse community groups. These varieties also outperformed the breeders' choices, on average, when judged by women's selection criteria. Maria Kaherero, the Namibian pearl millet breeder we met earlier, has made a similar contribution to agriculture in her country.

Women's participation in breeding thus has clear benefits. But not involving women is more than just a missed opportunity—it may actually be harmful. According to a study in Gambia, men's rice production systems have come to be based almost exclusively on exotic high-yielding rice varieties, whereas women have continued to grow a variety indigenous to West Africa. The wholesale adoption of newer varieties by men has marginalized women's production and led to the transfer of some rice lands into the hands of men. Overburdened by an intensive double-cropping regime, women eventually withdrew their labor from rice production.

Just as women's preferences and roles may differ from men's, the perspectives of the poor in general often differ from those of the «average» farmer. A review of about 40 formal-led PPB programs underscored these differences. For example, as mentioned earlier, poor farmers often prefer early maturing varieties to stave off seasonal hunger. As one Syrian barley farmer put it, «it's acceptable to produce less if the crop is earlier.» Poorer farmers also tend to evaluate crop varieties in terms of their suitability for multiple uses—as animal fodder, mulch, or construction material, for example. In

Rajasthan, India, poor farmers assign roughly the same priority to pearl millet stover as they do to the grain. Programs that want to target poor farmers would thus do well to consider using PPB.

The review of cases also documented some of the farmer-sensitive strategies that PPB researchers have employed. Testing under low-input conditions, emphasizing early maturing varieties, selecting varieties in light of the multiple uses of crops, and using varietal diversity to help stabilize production are just a few of the ways in which PPB is helping satisfy the needs of poor people.

Case 7

Empowering indigenous people in the Himalayas

Over the last two centuries, the indigenous peoples of the eastern Himalayas have been subjected to powerful, external forces of social and economic change. Like their counterparts in other regions, they are now struggling to reassert their cultural identity by rejuvenating ancestral customs and practices, especially the cultivation of traditional crops.

Within this setting a group of researchers established the Eastern Himalayan Network in 1994 to support indigenous communities in Bhutan, two states of India (Sikkim and Nagaland), and eastern Nepal. The network aims to strengthen local institutions, particularly their capacity for research, leadership, and community organization. Network researchers see farmer-led breeding as a powerful tool for social progress and empowerment. With support from Canada's International Development Research Centre (IDRC), they are working on issues of gender and ethnicity and on the management of biodiversity in agriculture.

Agrobiodiversity research conducted by Nepali farmers has highlighted the value of training farmers in plant breeding and selection as well as in seed storage and exchange. According to its director, Barun Gurung, the network is well prepared to provide training in seed storage and exchange. But for assistance in finding a scientist to teach Nepali farmers techniques for breeding traditional crops, Gurung has called on the Plant Breeding Working Group of the PRGA Program.

The communities targeted by the network are among the poorest in the eastern Himalayas. Most farm households are headed by women. The men often leave home for long periods in search of paid work in the towns. Farms generally occupy steep, marginal lands, on which some indigenous people grow traditional crops, such as buckwheat, barley, maize, and upland rice, and harvest forest products.

Historically, these staple cereals figured prominently both in the diet and rituals of indigenous people. Then, with the introduction and spread of lowland white rice, such crops gradually came to be seen as symbols of poverty and low status. But now the pendulum is swinging in the other direction, as indigenous communities return to the cultivation of crops that nourished their forebears.

Why introduce farmer-led breeding under these circumstances? There are two key reasons, says Gurung. First, most farmers in this area of Nepal are physically isolated from other communities and from research and extension services. Often, there are no access roads, and the nearest air strip may be several days' walk away. Thus, farmers' only path toward improved livelihoods may lie in planning and directing their own local agricultural development, with

Case 8

Farmers work with early generation germplasm in Nepal

In the high hills of Nepal, two major enemies threaten rice production, chilling injury and sheath brown rot. These problems significantly limit the area that farmers can plant and make for a short growing season. Unfortunately, farmers have had few resistant varieties to choose from. Of the 40 or so rice cultivars released by Nepal's rice research program, only two have proved suitable for altitudes above 1,500 meters. And screening of international cold-tolerant materials has failed to identify productive varieties.

In search of alternatives, the Lumle Agricultural Research Centre (LARC) decided in 1993 to work directly with farmers in testing fifth-generation rice lines. The research was carried out in collaboration with the UK's Department for International Development (DFID).

Plant breeder Bhuwon Sthapit realized that involving farmers at such an early stage deviated from conventional practice. But he was also conscious of several conditions that demanded a drastic change. First, LARC did not have enough land and other resources to carry out the breeding on an experiment station. Second, researchers knew that with centralized testing they would be unable to account for farmers' highly variable farming systems and management practices. Third, adoption of released rice varieties had so far been disappointingly low. Finally, researchers were concerned that to promote genetically uniform varieties would erode the genetic diversity in farmers' fields.

The PPB program yielded promising results in just 2 years. Two rice populations, selected independently by farmers at two sites, gave unusually high yields, even in researcher-managed trials. The entries also showed good resistance to sheath brown rot and chilling, and farmers judged their straw yield to be better than that of local varieties. Both rice populations spread quickly, and the lines were entered in the formal testing system in anticipation of official release.

The program's success, researchers believe, has hinged on finding farmers with the necessary expertise in varietal selection and on identifying a problem that is highly relevant to the local community.

Case 9

Switching to participatory cassava breeding in Colombia

The Colombian Corporation for Agricultural Research (CORPOICA) was created during 1993 in a reorganization of the Colombian Agriculture Research Institute (ICA). The experience of ICA and CORPOICA with cassava improvement from 1983 to the present illustrates how a national program can successfully negotiate the transition from conventional breeding to PPB. The shift has resulted in more acceptable cassava varieties, which farmers are adopting more quickly, and in the application of PPB to other crops.

In 1986 plant breeder Antonio José López realized that the cassava clones he had selected through conventional breeding were quite different from the local varieties. The farmers' varieties, for example, while not as high yielding as the ICA clones, produced more dry matter. Moreover, the ICA varieties were not being adopted aggressively by Colombian farmers.

Following a rapid rural appraisal, López concluded that the breeding and selection method had to be altered to better capture the farmers' perspective. Over the next 3 years, ICA worked with CIAT, which is headquartered in Colombia, to design a method for including farmers in cassava research. Among the outcomes were a field guide for farmer participation, a glossary of terminology used by local producers, and a data analysis program written and adapted for use on hand calculators in the field.

From promising cassava lines provided by the International Center for Tropical Agriculture (CIAT), López chose 10 candidates for evaluation by farmers in northern Colombia. These were planted on 60 farms. In the end the participating farmers selected three of the improved lines, two of which were released as new varieties: ICA-Costeña (1990) and ICA-Negrita (1991). The third line (CM 3555-6), though high yielding and producing good-quality cassava, turned out not to be to the farmers' liking because of its color. Nonetheless, López saw its potential for industrial uses and kept it mind for possible future release.

The participatory approach helped bridge a communication gap between farmers and researchers, allowing farmer selection criteria to be systematically recorded and translated into concrete research objectives. For example, farmers' preference for «hard roots» was seen as a preference for roots with over 35 percent dry matter. Apart from leading to the official release of the two new varieties, the project also gave participating farmers the chance to work directly with diverse experimental genetic material. It thus promoted early adoption and sharing of the materials the farmers liked.

For ICA the participatory approach provided a bonus. Cost analysis showed that

4. Future Directions
The Need to Tackle Emerging Issues

The plant Breeding Working Group of the PRGA Program is a major international forum for sharing PPB expirience and for addressing emerging issues.

New questions and a forum for debating them

Until now practitioners of PPB have tended to ask «first-generation» questions about their work. A major one is whether PPB is doing essentially what conventional breeding does but faster and cheaper and with a greater range of users reaping the benefits. The answer is a qualified «yes,» particularly where difficult and variable growing environments demand decentralization of breeding and variety testing. But PPB may also accomplish more than conventional breeding, for example, by building farmers' capacities to lead more efficient plant breeding independently of public sector agricultural bureaucracies.

The Plant Breeding Working Group of the PRGA Program is a major international forum for sharing PPB experience and for addressing these emerging issues. It brings together about 150 PPB practitioners from Africa, Asia, Europe, and the Americas. Its members include plant breeders, economists, sociologists, and development workers from national and international agricultural research institutes, universities, NGOs, and other organizations.

The Working Group operates both informally and formally. Much of its discussion takes place through private correspondence and electronic mail on the PBG listserve, supplemented by occasional seminars and other meetings. The Group has commissioned state-of-the-art reviews of PPB work as well as issue papers on topics like PPB and biotechnology, property rights in collaborative research, and institutional arrangements for PPB (some of these papers are included in the reading list).

One of the Working Group's first products was *Guidelines for Developing Participatory Plant Breeding Programs.* This short publication gives an overview of the steps in designing both formal-led and farmer-led research programs. It covers a wide range of topics—from collecting background information, setting objectives, and identifying participants to division of labor, germplasm evaluation, and seed system issues. A second, larger work now in progress (to be entitled *Farmers' Voices*) will put the spotlight on farmer-breeders around the world and on their need for support. As one of the editors put it, «this will give farmers a global voice in their own words.»

To promote comparative experimentation with new PPB methods, the Working Group also operates a small-grants program. The maximum amount is US$35,000 per year for up to 2 years. Recipients must fund at least half the work and collaborate with other institutions, including groups of farmers. As of 1999, 10 projects had been approved for PPB work on barley, lentils, maize, cassava, yam, potato, and beans in Latin America, Asia, and Africa.

While offering grants for innovative research, the Plant Breeding Working Group of the PRGA Program also solicits donor funds to tackle emerging issues. In March 1999 funding was approved for a study on property rights in collaboration between farmers and formal researchers. Working Group coordinator Louise Sperling calls it a «think paper.»

«While the technical issues of PPB are moving ahead, the social, ethical, and legal issues are lagging behind,» says Sperling. «People generally recognize the role of farmers in managing and improving germplasm. There's heavy farmer input, sometimes even to conventional breeding. They articulate preferences, share technical evaluations, provide land and labor for experiments, and contribute their landraces to the germplasm pool. But there's no agreement yet on how to compensate farmers, directly or indirectly. We have to find workable, practical strategies for real sharing and break down the barriers of mistrust.»

Even when farmers have contributed directly or indirectly to the development of new varieties, they do not always have the opportunity to grow these on their own land or to save and exchange the seed. The problem is not just that farmers must purchase seed of legally protected varieties every cropping season instead of sowing their own seed saved from an earlier crop. And it is not just that the seed is too expensive for farmers to afford. The problem is also one of limited access. Materials developed by national programs and by the farmers themselves in their own communities are often simply not distributed in certain areas.Another barrier to the protection of farmers' germplasm property rights is the definition of legally protectable plant varieties under international breeders' rights agreements. Varieties need to be «distinct, uniform, and stable.» Many PPB programs serving poor farmers attempt to meet specialized needs in variable micro-environments. This work often centers on nonuniform, variable germplasm populations, which do not qualify for protection, even if the end result constitutes a creative solution.

The 1-year property rights study mentioned above will draw on the expertise of lawyers, ethicists, and sociologists. It aims to provide members of the Plant Breeding Working Group with ethical and legal guidance as well as an account of current best practices. Group coordinator Louise Sperling hopes that it will also have a wider impact on the international community. «We hope to move the property issue forward. The bottom line is to ensure that plant breeders, both farmers and scientists, and their respective communities have access to the necessary germplasm. But the debate is going to be heated.»

As the field of PPB matures, it must address a host of second-generation questions, many of which are politically charged. For example, what are the best ways for trained researchers to support farmer-driven programs? How should the issue of property rights be resolved when farmers and formal breeders develop varieties together? And how can farmers' rights be protected?

As PPB projects move beyond their initial phases, they will need to explore ways of measuring impact and costs. Practitioners will need to consider how they can meet dual or triple goals simultaneously—for example, increasing production, promoting biodiversity, and reaching the disadvantaged? How can minor crops be improved? And what is the place of biotechnology in PPB?

At another level, how can PPB programs be expanded equitably and cost-effectively, given the huge amount of work involved in maintaining close contacts with large numbers of farmers in many communities? (For an interesting example of how this last issue is being addressed in West Africa, see Case 10) Also, what is the appropriate level of public versus private sector (farmer) investment in such programs? Finally, and perhaps most important, how can PPB contribute to the elimination of poverty in the developing world during the 21st century?

As in any new endeavor, the questions abound. Fortunately, many of them are being tackled, as growing numbers of people experiment with PPB methods. This approach has emerged in response to an urgent need to develop improved varieties that are better suited to a wide range of specific environments and to the particular needs of different groups, including the poorest people. Burgeoning interest in PPB throughout the developing world reflects a new understanding that, by working together, farmers and scientists can produce better, more acceptable results than either group can deliver on its own.

Case 10

Extending participatory research methods in West Africa

In West Africa 4.1 million hectares of land are sown to rice annually. More than 70 percent of this area is upland or rainfed lowlands, cultivated mainly by small farmrs, who rely largely on family labor and have limited access to inputs. In these systems crop production depends heavily on land and labor productivity plus the genetic potential of the rice variety. The rate of adoption of improved rice varieties remains low.

In 1996 scientists from the West Africa Rice Development Association (WARDA) developed participatory variety selection (PVS) and breeding approaches to evaluate and develop new varieties adapted to the heterogeneous production conditions of the rainfed rice-producing ecologies.

In the first year, farmers evaluate and select among 60 diverse varieties—ranging from local selections and traditional types to «interspecifics» —planted on a central village plot. Interspecifics, or interspecific hybrid progeny, are stable lines derived from WARDA's breakthrough technology of crossing African rice (*Oryza glaberrima*) with Asian rice (*O. sativa*). Evaluations are done at four stages and cover plant architecture, agronomic, and morphological traits as well as grain quality, and processing and culinary characteristics. In the second year, farmers are given seed of the varieties they selected to cultivate on their own farms in comparison with their traditional varieties. WARDA field staff visit the farmers at different stages to record farmers' preferences. At the end of the season, and in anticipation of the third and final year, farmers' willingness to pay for seed is assessed to estimate technology demand. In the third year, farmers are sold seed of the varieties they wish to grow on the basis of their evaluations in the first 2 years.

In early 1997 a description of this approach and preliminary findings from the first year of activities in northern Côte d'Ivoire were presented to a meeting of national rice scientists. This elicited strong interest from other national partners, so WARDA held a formal workshop on participatory methods, with particular emphasis on rice improvement, for participants from 10 West African countries in 1998. Many participants returned to their home countries to train other scientists. Widespread interest in the approach also led WARDA to develop a «scaling-up» strategy that is in place today.

The scaling-up process consists of four components. First, through training courses scientists are introduced to several alternative participatory research approaches that can be adapted to various production circumstances. The course covers methods for establishing an environment that is conducive to farmer-researcher interaction, stimulating discussion, refining farmer responses, compiling information from semistructured or open-ended evaluations, and interpreting results. Classroom training is followed by a field practical to test the methods.

Second, trainees and their institutions are invited to submit research proposals on participatory rice improvement that are appropriate for their targeted ecology and national resources. No single project design or structure is advocated. Participants are encouraged to select from those discussed during the training or to develop a design that is suited to their capacity and ecology of interest.

Third, WARDA scientists provide assistance in field protocol development, visits to country sites, organization and evaluation of research data, and preparation and presentation of research results.

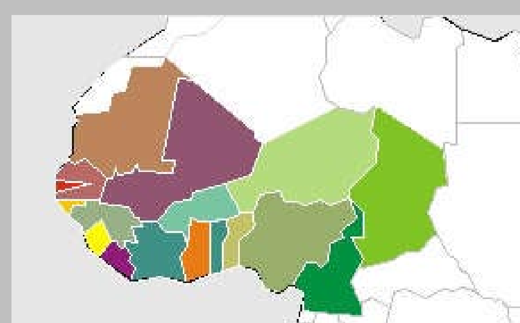
Finally, each institution is required to provide a scientific report on its findings and to present these results before a plenary of regional scientists. A financial report is also required in order for the research team to receive subsequent funding.

In 1999, WARDA conducted its second training course in participatory approaches to rice improvement. This time the participants included scientists from the remaining seven countries in the region as well as representatives from local nongovernment organizations, United Nations Volunteers, and Japanese

Overseas Cooperative Volunteers. At the end of this training, the participants from the 1998 program assisted the new trainees in planning and developing field research activities, thus capitalizing on national insights and experience. This assistance was provided in addition to that offered by WARDA, the PRGA Program, and the training resource people. Once an acceptable research design was developed, small grants were provided to cover the variable costs of implementing the experiment. All participating countries were required to share the costs of the research project.

This procedure for extending participatory methods to national counterparts has generated enthusiastic demand both for the methods and the opportunity to develop, with farmers, more productive cultivars for the region's upland and rainfed lowland rice-producing areas. So far, one breeder and one social scientist from all 17 WARDA member states have received training in participatory methods and are implementing participatory variety selection and breeding projects in their countries. WARDA will continue working to further strengthen regional capacity in participatory methods.

Member countries of the West Africa Rice Development Association (WARDA).



1. Benin
2. Burkina Faso
3. Cameroon
4. Chad
5. Cote d´Ivoire
6. Gambia
7. Ghana
8. Guinea
9. Guinea-Bissau
10. Liberia
11. Malí
12. Mauritania
13. Niger
14. Nigeria
15. Senegal
16. Sierra Leone
17. Togo

Selected Tools

Ashby JA. 1990. Evaluating technology with farmers: a handbook. Centro Internacional de Agricultura Tropical, IPRA Project: Cali, Colombia. 95 p. (Spanish, French)

Damotharan M. 1996. Show me, tell me, explain me. Video produced by Ulrich Roth for ICRISAT. Andhra Pradesh, India.

Gómez F; Bueso F; Reconco R; Hughes-Hallett P; Bentley J; Smith M. 1995. Manual de mejoramiento y conservación del maíz criollo con pequeños agricultores. Publi AG-9504. CITESGRAN, Programa CIIFAD/Zamorano, Proyecto LUPE SRN/AID. Tegucigalpa, Honduras. 37 p.

Guerrero MP; Ashby JA; Gracia T. 1993. Farmer evaluations of technology: preference ranking. Instructional Unit no. 2. Centro Internacional de Agricultura Tropical, IPRA: Cali, Colombia. 129 p.

International Crops Research Institute for the Semi-Arid Tropics. 1991. Participatory research with women farmers. 1 videocasete (VHS) 30 min + booklet (synopsis of the 30-min video: 2 p.). ICRISAT: Hyderabad, India.

IPRA Project. 1997. Didactic video on CIALs committees for local agricultural research. 1 videocasete (VHS) 43:20 min. CIAT: Cali, Colombia.

Plant Breeding Working Group/ PRGA Program. 1999. Guidelines for participatory plant breeding Working Document no. 1. Program on Participatory Research and Gender Analysis: Cali, Colombia.

Further Reading

Alvarez E. 1998. Participatory farm surveys. Mitú (Vaupés). In: Bellotti AC; Alvarez E; Calvert L; Calatayud PA; Ospina B; Anderson P. 1998. IPM for a safer environment: integrated pest management in major agroecosystems in the Americas. CIAT: Cali, Colombia.

Andrade H; Cuesta X. 1997. The role of the user in selecting and releasing potato varieties in Ecuador. In: New frontiers in participatory research and gender analysis: proc. International Seminar on Participatory Research and Gender Analysis for Technology Development, Sept 9-14, 1996. p 181-189. CIAT: Cali, Colombia.

Arunachalam, V, ed. 1998. Participatory plant improvement: proc. Workshop on Farmer Participatory Methods in Research and Development for Semi-Arid Tropics organised by M.S. Swaminathan Research Foundation and the International Crops Research Institute for Semi-Arid Tropics held October 27-28, 1998. MSSRF: Chennai, India.

Ashby JA; García T; Guerrero MP; Patiño CA; Quirós CA; Roa JI. 1997. Supporting local farmer research committees. In: van Veldhuizen L; Waters-Bayer A; Ramírez R; Johnson DA; Thompson J, eds. Farmers' research in practice: lessons from the field. Intermediate Technology Publications: London, UK.

Beltrán JA. 1993. Evaluación de generaciones segregantes de frijol (*Phaseolus vulgaris* L.) en campos de agricultores, en contraste a la realizada en estación experimental. Universidad Nacional de Colombia, Facultad de Ciencias Agropecuarias: Palmira, Colombia. 64 p.

Berg T. 1996. Dynamic management of plant genetic resources: potential of grass-roots movements. Studies in plant genetic resources, no. 1. Plant Production and Protection Division, Food and Agriculture Organization of the United Nations (FAO): Rome, Italy.

Ceccarelli S; Bailey E; Grando S; Tutwiler R. 1998. Descentralized participatory plant breeding: a link between formal plant breeding and small farmers. ICARDA: Aleppo, Syria.

Defoer T; Kamara A; de Groote H. 1997. Gender and variety selection: farmers' assessment of local maize varieties in southern Mali. Afr Crop Sci J 5(1):65-76.

Eyzaguirre P; Iwanaga M, eds. 1996. Participatory plant breeding: proc. Workshop on Participatory Plant Breeding, 26-29 July 1995, Wageningen, Netherlands. IPGRI: Rome, Italy.

Fukuda WM; Magalhães JA; Cavacanti J; Pina PR; Tavares JA; Iglesias C; Hernández LA; Montenegro EE. 1997. Pesquisa participativa e melhoramento de mandioca: Uma experiência no semi-árido do nordeste do Brasil. Documento no. 73. Embrapa-CNPMF: Cruz das Almas, Brasil.

Hardon J. 1995. Participatory plant breeding. In: Issues in Plant Genetic Resources no. 3. IPGRI: Rome, Italy. 15 p.

Haugerud A; Collinson MP. 1990. Plant genes and people: improving the relevance of plant breeding in Africa. Exp Agric 26:341-362.

McGuire S; Manicad G; Sperling L. 1999. Working Document no.2. Technical and institutional issues in participatory plant breeding: done from the perspective of farmer plant breeding. Program on Participatory Research and Gender Analysis: Cali, Colombia.

Monyo ES; Ipinge SA; Heinrich GM; Lechner WR. 1997. Farmer participatory research in practice: experiences with pearl millet farmers in Namibia. Paper presented at the SADC/ ICRISAT Regional Workshop on Farmer Participatory Research Approaches, 7-11 July 1997, Harare, Zimbabwe.

Sperling L; Loevinsohn ME; Ntabomvura B. 1993. Rethinking the farmer's role in plant breeding: local bean experts and on-station selection in Rwanda. Exp Agric 29:509-519.

Sperling L; Loevinsohn ME, eds. 1996. Using diversity: enhancing and maintaining genetic resources on-farm. IDRC: New Delhi, India.

Sthapit BR; Joshi KD; Witcombe JR. 1996. Farmer participatory crop improvement, III. Participatory plant breeding, a case study for rice in Nepal. Exp Agric 32(4):479-496.

Thiele G; Gardner G; Torrez R; Gabriel J. 1997. Farmer involvement in selecting new varieties: potatoes in Bolivia. Exp Agric 33(3):275-290.

Weltzien RE; Whitaker ML; Rattunde HFW; Dhamotharan M; Anders MM. 1998. Participatory approaches in pearl millet. In: Witcombe JR; Virk DS; Farrington J, eds. Choice of seed: making the most of new varieties for small farmers. Oxford IBH and Intermediate Technology Publications: New Delhi, India.

Witcombe JR; Petre R; Jones S; Joshi A. 1999 Farmer participatory crop improvement, IV. The spread and impact of a rice variety identified by participatory varietal selection. Exp Agric 35(4).

Zeigler RS. 1997. Implementing farmer participatory plant breeding: a research management perspective. In: New frontiers in participatory research and gender analysis: proc. International Seminar on Participatory Research and Gender Analysis for Technology Development, Sept 9-14, 1996. CIAT: Cali, Colombia.

Forthcoming publications from the PRGA Program

In 1999

Hecht S. 1999? Social issues in participatory plant breeding: a report to the CGIAR Gender Working Group. Working Document no.5, Program on Participatory Research and Gender Analysis: Cali, Colombia.

Weltzien E; Smith M; Meitzner L; Sperling L. 1999? Technical and institutional issues in formally-led participatory plant breeding. Working Document no.3, Program on Participatory Research and Gender Analysis: Cali, Colombia.

Thro AM; Spillane C. 1999? Biotechnology-assisted participatory plant breeding in developing countries. Working Document no.4, Program on Participatory Research and Gender Analysis: Cali, Colombia.

In 2000

Ashby JA; Sperling L, eds. 2000? Participatory plant breeding and rural development. Program on Participatory Research and Gender Analysis: Cali, Colombia.

Dalton T; Lilja N; Jones M. 2000? Extending participatory research methods in West Africa. In: Ashby JA; Sperling L, eds. Participatory plant breeding and rural development. Program on Participatory Research and Gender Analysis: Cali, Colombia.

Friis-Hansen E; Sthapit B, eds. 2000? Guidelines on participatory methodologies for conservation and use of plant genetic resources. IPGRI/CDR/PRGA Program Technical Bulletin. Rome, Italy.

Iglesias CA; Hernández LA. 2000? Scaling up participatory plant breeding as part of an international program. In: Ashby JA; Sperling L, eds. Participatory plant breeding and rural development. Program on Participatory Research and Gender Analysis: Cali, Colombia.

Acronyms

ACIAR Australian Centre for International Agricultural Research

CGIAR Consultative Group on International Agricultural Research

CIAL Local agricultural research committee, Colombia

CIAT International Center for Tropical Agriculture, Colombia

CIMMYT International Maize and Wheat Improvement Center, Mexico

CORPOICA Corporación Colombiana de Investigación Agropecuaria (Colombian Corporation for Agricultural Research), Colombia

DFID Department for International Development, UK

Embrapa Empresa Brasileira de Pesquisa Agropecuaria (Brazilian Agricultural Research Enterprise), Brazil

ICA Instituto Colombiano Agropecuario (Colombian Agricultural Research Institute), Colombia

ICARDA International Center for Agricultural Research in the Dry Areas, Syria

ICRISAT International Crops Research Institute for the Semi-Arid Tropics, India

IDRC International Development Research Centre, Canada

INIAP Instituto Nacional de Investigaciones Agropecuarias (National Institute for Agricultural Research), Ecuador

IPGRI International Plant Genetic Resources Institute, Italy

IPM Integrated pest management

IRRI International Rice Research Institute, the Philippines

ISAR Institut des Sciences Agronomiques du Rwanda (Rwandan Institute of Agricultural Science)

LARC Lumle Agricultural Research Centre, Nepal

MKC Maria Kaherero Composite, variety of pearl millet, Namibia

NGO Nongovernment organization

PPB Participatory plant breeding

PRGA CGIAR Systemwide Program on Partcipatory Research and Gender Analysis for Technology Development and Institutional Innovation

PTA Projects in Alternative Agriculture, Brazil

PVS Participatory Variety Selection

SAVE Sustainable Agriculture and Village Extension, CARE program, Sierra Leone

WARDA West Africa Rice Development Association, Côte d'Ivoire

Acknowledgments

The PRGA Program gratefully acknowledges the people listed below, who provided useful information for the preparation of this publication, either through interviews or written reports.

Interviews:

- Elizabeth Alvarez, Plant Pathologist, CIAT, Colombia
- Héctor Andrade, Potato Breeder, INIAP, Ecuador
- Jacqueline Ashby, PRGA Program Coordinator
- María Ilia Campo, CIAL El Diviso, Cauca, Colombia
- Salvatore Ceccarelli, Barley Breeder, ICARDA, Syria
- Oswaldo Chicaiza, Program Leader – Barley, Wheat, Quinoa, Maize, INIAP, Ecuador
- Barun Gurung, Director, Eastern Himalayan Network, Nepal
- Antonio López, Cassava Breeder, CORPOICA, Colombia
- Vicente Novoa, Director General, INIAP, Ecuador
- José Ignacio Roa, Participatory Research Specialist, Participatory Research Project, CIAT, Colombia
- Louise Sperling, Facilitator of Plant Breeding Working Group, PRGA Program
- Buhwon Sthapit, Senior Rice Breeder, IPGRI
- Eva Weltzien Rattunde, Principal Scientist, Sorghum Breeding and Genetic Resources, ICRISAT, Mali

Written reports:

Jacqueline Ashby, PRGA Program Coordinator
Emmanuel Monyo, Senior Scientist (Breeding), SADC/ICRISAT, Zimbabwe
Louise Sperling, Facilitator of Plant Breeding Working Group, PRGA Program

Thanks also to:
Guy Manners, WARDA, Côte d'Ivoire.
Elizabeth Páez, CIAT, Colombia

Writing: Gerry Toomey and Nadine Saad

Editing: Nathan Russell and Gladys Rodríguez

Photos: CIAT files—ii, 19, 32-33 (middle), 37, 38;
Salvetore Ceccarelli—23, 24, 28; Briggitte Courtois—6, 18;
Barun Gurung—inside front cover, 36; Julio C. Martínez—2 (right), 39; Emmanuel Monyo—8;
Luis Fernando Pino—4, 14, 15, 20, 22, 29, 30-31 (middle), inside back cover; José Ignacio Roa—9, 12, 13;
Nathan Russell—front cover, 1, 3, 6-7 (middle), 7, 21, 25, 27, 32, 34, 35, 40, 41; Louise Sperling—2 (left), 16, 26;
WARDA files—43;
Eva Weltzien-Rattunde—10, 11, 30,