Participatory Approaches to Plant Breeding and Selection

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The centralized plant breeding of the Green Revolution has yielded results in the more favourable agricultural environments. Most low-resource farmers in marginal areas, however, have not benefited from these varieties. As an alternative for these areas, farmer participatory approaches are being adopted in selection and breeding of better adapted varieties. Because of the good results, these approaches are now spreading to more favourable environments, and the international agricultural research system has shown interest.

In the 1960s, the Green Revolution in many developing countries saw a dramatic improvement of the production of staple cereals that did much to increase food production. The increase in food production resulted from the adoption by many farmers of high yielding wheat and rice cultivars. Following from these successes, national and international breeding programmes targeted the breeding and popularization of a few varieties as their major goal. Breeders did not see a need to involve farmers because the required major characteristics of the new varieties were well defined: dwarf plant height to prevent lodging and increase the proportion of grain in the plant; the ability to flower in about the same period of time whatever the latitude and time of sowing; and post-harvest qualities that satisfied many consumers.
In addition, despite very different socio-economic circumstances, developing countries adopted from the USA and Europe a regulatory framework designed to release few, widely adapted cultivars for intensive, mechanized, monoculture cropping systems. In developed countries, farmers were regarded only as growers and not as direct consumers, because grain was rarely consumed on farm but was sold to industrialized food processors. To set breeding objectives for grain quality, the grain purchasers, rather than the farmers, were consulted. These purchasers were also the arbiters of the post-harvest traits of newly finished products.

Even after release, extension services did not need to involve farmers in a very "hands on" way. The literate farming community was completely aware, through printed media, of the availability and characteristics of new cultivars. Farmers could rely on varieties performing in their fields in the way described in promotional literature because of the similarity between the management of the crop on research stations and on farms.

Decades after the Green Revolution it became apparent that the application of this non-participatory Northern model in developing countries did not satisfy the needs of farmers in more marginal agricultural environments.

Participatory varietal selection

Although production increased greatly in favourable agricultural environments, production was stagnant or increased only slowly in marginal areas. Most farmers in these areas have not adopted new cultivars in favour of their local landraces. Maybe farmers did not have access to varieties that were adapted to less favourable conditions, and perhaps recommended varieties did not have the attributes, such as high straw yield, that low-resource farmers needed, or did not appear as productive as expected.

In the 1980s, to encourage the adoption of higher yielding varieties by low-resource farmers, scientists initiated farmer participatory research in plant breeding in several countries. All of this research was devoted to the latter stage of the plant breeding process: the selection among finished, or nearly finished, varieties. These *participatory varietal selection* (PVS) programmes have several characteristics in common. The needs of farmers are identified by discovering what crops and varieties they grow, and what traits they consider important. Scientists select new varieties that have the traits that farmers desire and that match the farmers' landraces for important characters such as maturity, plant height and seed type. Farmers visit research stations to select material from the wide range of varieties in breeders' trials. Whatever method is used to select the varieties, once selected they are given to farmers to grow alongside their local varieties with traditional management. Instead of complex trial designs, farmers are the unit of replication and each farmer grows one, or few, of the new varieties. However, in every village, each of the new varieties is grown by at least one farmer.

Evaluation methods are also participatory. The participating farmers visit all of the plots of all of the new varieties. They can then make judgements, as a group, on the relative value of the new varieties. Additionally, in many programmes, yield per unit area is assessed to provide data for variety release committees and to test the agreement between farmers' perceptions of yield and quantitative yield data.

More simple, informal methods for PVS have also been used. Small quantities of seed of named varieties are distributed to farmers, but no instructions are given on how to grow them, and no attempt is made to undertake formal evaluation of their relative performance. Instead, adoption rates are monitored after several seasons to see which varieties prove to be most popular with farmers. For a more rapid evaluation, informal discussions with farmers after a single season will identify highly preferred varieties.

PVS programmes have been described from many countries, including Colombia, India, Namibia, Nepal, and Rwanda, in grain legumes, rice, pearl millet and maize. The effectiveness of the programmes is demonstrated by the fact that the yield increases attributable to the adoption of new cultivars have been substantial.

Lessons from participatory selection
From the experience with PVS, a number of lessons emerge:

Trade-off between traits. Farmers evaluate varieties for multiple traits, and do not place an overriding emphasis on grain yield. For example, farmers trade off early maturity against yield, and yield from crop residues, such as straw, against grain yield. Hence, the most preferred varieties are often not amongst those selected by breeders for grain yield alone.

Many traits important to farmers are evaluated. Despite scepticism scientists may have about the reliability of farmers' data, farmers are the ultimate judges of any new cultivar. Farmers often consider traits that plant breeders have not thought important or cannot measure satisfactorily. Farmers, particularly women, can give detailed information on post-harvest traits such as grain milling characteristics, taste, and the ability of the cooked grain once eaten to delay the onset of hunger. Farmers can describe the market value of the grain and how it differs from that of the local varieties. It is feasible for a plant breeder to evaluate many of these traits without farmers, but it will be more expensive and cannot provide data on how the traits trade off against each other.

Research leads rapidly to extension. New genetic material reaches farmers' hands earlier when participatory methods are used. Preferred varieties then spread quickly from farmer to farmer.
The spread of new varieties can be promoted in other ways that involve farmers' participation. However, sometimes less participatory approaches are required such as the contracting of local farmers to multiply the seed. To promote the varieties, local distribution channels can be used such as *Non Governmental Organizations* (NGOs), seed merchants, and cooperative societies. In India and Nepal, networking among NGOs has been a most effective method for scaling up the seed distribution of preferred varieties.

Criticisms of the approach
Despite these advantages, a number of criticisms of these participatory methods are commonly proffered by scientists who have not used them.

Firstly, some scientists claim that participatory approaches by extension services are already being used. However, although traditional extension methods can involve farmers, they often rely on demonstrations of a few recommended varieties, grown by extension workers with a recommended package of practices. When farmers receive trials to grow themselves, they are instructed to adopt the same package of practices, and usually are given a very restricted choice of only one or two varieties. Usually, the package of practices is beyond the limited resources of farmers in marginal areas.

Secondly, it is said that PVS entails an unnecessary risk to farmers. Breeders, however, can help to control risk, by testing material in disease nurseries before giving it to farmers. Farmers manage risk exceptionally well, and their risk avoidance strategies become more sophisticated the fewer resources they have. Low-resource farmers never

grow a new variety on a large area the first time they cultivate it, and rarely grow it on their best land. Only after the first season will they grow a very promising variety on better land as a pure stand. A less preferred variety may be grown as a pure stand on poorer land, mixed with seed of a local variety, intercropped with other species, or not grown at all. Several seasons of evaluation pass before farmers grow a new variety on much of their land.

Additionally, the risk is not one-sided. In mistakenly attempting to protect farmers from themselves by limiting their access to new varieties there is a risk that the enormous economic benefits offered by new varieties may be foregone. If farmers are not given new varieties then old varieties remain under cultivation longer and become more susceptible to evolving pathogens.

Thirdly, some may question the reliability of results. The lack of credence given by scientists to farmers' perceptions is a result of training in scientific methods that use formal statistical designs and objectively obtained quantitative data such as yield per unit area. For example, breeders and release committees like to have yield data from randomized-block-design of varietal trials. However, data on farmers' perceptions are just as valid, can also be replicated across farms, across villages and across years. Studies have shown a remarkable consistency in farmers' perceptions, a consistency that is often lacking in the results from more formal replicated designs.

Fourthly, criticisms are made that farmers may reject varieties after one season of testing. However, in formal trials, entries are always rejected after a single year's testing in a multilocational trial, no matter how atypical the season. Farmers can make judgements that are not permitted in a formal trial. For example, a variety that has not yielded well may be tried for a second season because farmers have logical explanations for its poor performance. It may be a low yielding, short duration variety that farmers have grown in a wet year, but they assume that in a drought year it will have an advantage.

Fifthly, many scientists worry about the costs of involving farmers. To maximise the effectiveness of a non-participatory approach, research station sites for varietal trials are chosen for the availability of good infrastructure and fertile, uniform land. In a participatory approach, farmers must also be carefully chosen. For example, it will be more effective and cheaper to select villages and farmers with the help of a local NGO that has already built up a rapport with local communities.

The cost of not employing farmers must also be considered. Not employing participatory approaches is extremely expensive if it results in a breeding programme that fails to produce varieties that farmers adopt.
Concerns are unfounded that the site-specific nature of participatory research means that the research has to be repeated an uneconomic number of times in many villages. All evidence, so far, indicates that varieties identified by farmers are adapted to much larger areas than a few villages. This is unsurprising, because a single village, unless extraordinarily unique, will represent an agro-ecosystem that could occupy a very large area.

Participatory approaches in more favourable environments

Studies on the adoption of varieties by farmers in high potential areas have shown, surprisingly, that farmers are growing very old varieties. This is not because new varieties are not superior, but because the popularization of new varieties is inefficient. Participatory methods for marginal areas can be adapted to the socio-economic environment of more favourable production systems in developing countries and used to speed up varietal replacement. It is simpler to offer farmers in high potential areas many new varieties as more varieties are bred for these areas than for marginal ones. Classical extension approaches can be adapted easily to provide farmers with more choice. In high potential areas, farmer-managed demonstrations of many varieties are simpler to organize when farmers are literate and have large, uniform fields. Many farmers will see demonstrations of varieties when they are grown by the side of a much-used road. Signboards naming the varieties are more useful to literate farming communities. In marginal areas, however, the literacy level is often low. Nevertheless, farmers would still grow small plots of the experimental varieties on their own fields, alongside their regular crops.

There is a huge potential to increase yields by reducing the average age of the cultivars grown in high potential areas. The more recently released the varieties that farmers grow are, the more advantage they take of the genetic gains made in breeding programmes. Recently the *Overseas Development Administration* (ODA) has funded projects in India and Nepal, to test the hypothesis that PVS will be effective in increasing production in high potential areas.

Participatory plant breeding

As argued, the involvement of farmers in the selection of finished products is very cost-effective. When participatory varietal selection succeeds, the farmer-preferred cultivars are the ideal parents for a *participatory plant breeding* (PPB) programme.

Two types of PPB programmes can be distinguished: consultative and collaborative. In consultative programmes, farmers are consulted at every stage to set goals and choose parents that are entirely appropriate. In collaborative programmes, farmers grow the early, variable generations and select the best plants amongst them on their own fields. The choice of consultative or collaborative methods will depend on the crop and the availability of resources.

Collaborative breeding programmes have been reported for rice in Nepal, and for beans in Colombia and Brazil. In Colombia, a comparison has been made between farmers' and breeders' selections. It was concluded that breeders tend to select for yield and stress tolerance while farmers place greater emphasis on quality traits.

Consultative methods can be easily incorporated into decentralized breeding programmes targeted at specific environments. Breeders consult farmers to chose parents that can be both landraces and modern varieties. Farmers are also consulted to incorporate appropriate traits in the selection targets and farmers visit the breeders' research plots and comment on the new material. In consultative breeding, once finished products are available collaborative research is employed. Farmers, perhaps

those that have been consulted earlier, evaluate the finished products in their own fields. However, in collaborative programmes, there is no discontinuity between the end of breeding new products and the start of selection amongst finished products.

Intellectual property rights

In developing countries, plant breeding in the public sector is seldom a profit-making activity. Public sector plant breeders rarely make financial gains from their released products. This is unlikely to change if plant breeders rights are introduced. Hence the issue of how to reward farmers is not complicated by a need to divide profits. Farmers participating in breeding programmes benefit from early access to new material, gain recognition from the community, and learn new techniques. In Nepal, farmers involved in PPB have gained all of these benefits, and have sold seed of the new variety at a higher price than the local landrace.

The issue of *intellectual property rights* (IPR) makes PPB more complicated for private companies. Profits and IPRs need to be shared between farmers and breeders. Moreover, competitors could gain access to new genetic material that is grown openly in farmers' fields. No doubt private sector companies could find ways of surmounting these problems, but it does reduce the attractiveness of farmer participation for the private sector.

Many private companies concentrate on breeding hybrids. Participatory varietal selection can be used to identify hybrids that farmers prefer. Many private companies are already ahead of public institutions in using participatory methods, as they routinely carry out market research on the acceptability of new hybrids before embarking on their large scale production and sale.

The role of the CGIAR and the NARS

Despite the demonstrable value of farmer participation, there has been a disappointing failure to adopt the approach widely. In part, this is because institutional support and training has been aimed at conventional approaches. Fortunately, the situation is changing. In the *Consultative Group for International Agricultural Research* (CGIAR), four International Agricultural Research Centres have undertaken, or are planning, some form of participatory breeding programme. The *International Crops Research Institute for the Semi-Arid Tropics* (ICRISAT) has used participatory methods in pigeonpea and pearl millet in India, the *International Centre for Agricultural Research in the Dry Areas* (ICARDA) with barley in Syria. In rice, participatory methods have been used by the *International Rice Research Institute* (IRRI) in Vietnam and by the *West African Rice Development Association* (WARDA) in Côte d'Ivoire. The *Centro Internacional de Agricultura Tropical* (CIAT) has been the strongest advocate of participatory approaches and has carried out pioneering work on beans in Rwanda and Colombia. There is now a critical mass of scientists in the CGIAR that practises participatory approaches. The CGIAR is planning participatory approaches to plant breeding and farming systems research.

There has been an encouraging response by the *National Agricultural Research Systems* (NARS) that have been exposed to participatory approaches. For example, in Nepal a variety bred by using participatory methods has been released officially and there is an increasing willingness to provide farmers with material early in the breeding

process. In India, at least four State Agricultural Universities have started participatory breeding programmes. NGOs and Farm Science Centres that have seen the results of participatory varietal selection are enthusiastically adopting the approach.
The support of the CGIAR and the NARS for participatory approaches to plant breeding is encouraging. Participatory approaches offer a tremendous opportunity to increase agricultural production and to meet the needs of an increasing population. If this happens, it provides an opportunity, perhaps no less important than that offered by biotechnology, to improve the food security of the world.

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Three articles on participatory approaches to plant breeding co-authored by the J.R. Witcombe have appeared in *Experimental Agriculture*, vol. 32, 1996, pp. 445-496. Reprints are available from the author.

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