4.9. Participatory approaches in potato improvement: experiences of PROINPA in Bolivia

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Introduction

Potatoes are the most important smallholder crop in Bolivia (De Franco and Godoy, 1993). Farmers grow approximately 800 landraces, principally of *Solanum tuberosum* ssp. *andigena*, *S.* × *curtilobium*, *S.* × *juzepczukii*, *S.* × *ajanhuiri*, *S. phureja*, *S. stenotonum* and *S. goniocalyx*, in highly diverse and geographically dispersed agro-ecosystems. Landraces are estimated to cover 85 per cent of the area planted with potato. The PROINPA (Promotion and Investigation of Andean Products) Foundation, formerly part of the Bolivian national agricultural research system, is now a non-profit-making private institution recognized by the Ministry of Agriculture as having the national mandate for potato research. It holds many landraces in its germplasm bank and is exploring ways to use them better. PROINPA breeds for durable resistance to late blight (*Phytophthora infestans*), which causes large yield losses on-farm, and for other biotic and abiotic constraints. Conventional breeding programmes which seek broad adaptation could lead to the disappearance of landraces that have lower yields and are less resistant to pests and climatic stresses. Breeding programmes based on landraces and participatory plant breeding (PPB) are an alternative; they aim to incorporate resistance from other sources into the local materials.

The project described here focuses on participatory varietal selection (PVS) and PPB for resistance to late blight. Much of the on-farm selection was carried out in Cochabamba in two areas (Chulchunqani and Morochata) where late blight is endemic, at altitudes between 2900 and 3300m. Three phases are distinguished in this work: for each we describe how farmers were involved, what use was made of local genetic resources, and the achievements and difficulties. Thiele et al. (1997) provide a more detailed description of the PVS phases. Most of this chapter centres on the PPB phase, which seeks new varieties with improved yield and resistance for specific niches. Finally, future directions for this work are discussed and some general conclusions are drawn.

Participatory varietal selection, 1990–94

In the first year of PVS farmers evaluated 138 clones and controls on a researcher-managed field trial. No use was made of local genetic materials because there was no advanced locally bred material available, and existing local varieties were all susceptible to late blight; all of the clones evaluated came from outside Bolivia, from the International Potato Centre (CIP), Peru and Instituto Colombiano Agropecuario (ICA), Colombia.

Clones preferred by farmers from the first year's trial were retained for trials in the next year, together with the promising clones selected by

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breeders. Over the four growing seasons the number of clones evaluated reduced from 135 to 10, and farmers' role in the management of the trials progressively increased. Techniques for evaluating with farmers changed as knowledge of farmers' criteria increased and as understanding of how to involve farmers improved.

A range of different methods for evaluating clones were tested, and much was learned about farmers' criteria for selecting new varieties. Breeders assimilated the results of farmers' evaluations and paid more attention to colour, form and size of tubers when selecting germplasm.

Communication between social scientists and breeders was a crucial issue in the PVS activities. Initially, in 1990–91, not all the breeders agreed with involving farmers in selection with such a large number of clones. Subsequently there were problems with farmers' management of seed of some of the clones. These problems were exacerbated and affected the quality of collected data when the objectives of breeders and social scientists diverged and social scientists' interest shifted from evaluating materials as such, to understanding processes by which new materials diffused amongst farmers. Because of these difficulties breeders' involvement in the participatory on-farm trials progressively declined, and as a result the direct impact of PVS on varietal release was limited.

Parallel to the PVS led by social scientists, more formal non-participatory trials were run by breeders. Breeders were influenced by the PVS but made independent decisions about which clones to select, so when they released six varieties with late blight resistance these did not coincide at all with those preferred by farmers (Carrasco et al., 1997).

Participatory varietal selection, 1995–98

When social scientists and breeders had overcome their communication difficulties, they analysed and built on their earlier experiences with different evaluation techniques and different ways of involving farmers. They jointly developed a protocol for involving farmers at different stages of varietal selection, ensuring that results of farmers' evaluations could be compared across sites and over time. Social scientists still led evaluations, but on the understanding that breeders would progressively take responsibility. Following the protocol, fixed groups of around 10 farmer-evaluators were established including both men and women, who evaluate separately.

In partnership with the Investigación Participativa en Agricultura Project of the Centro Internacional de Agricultura Tropical (CIAT), Colombia, PROINPA became a centre for training in participatory methods and establishing committees of farmer-experimenters. As a result, methods promoted by the CIAT project have become standard practice for PROINPA's scientists. Individual preference ranking is the main technique used when evaluating 10–30 clones for morphological characteristics (Ashby, 1990). Clones that rank highest for morphological criteria, such as skin colour and tuber shape, are all cooked and tasted by farmers who score them using absolute evaluation. Researchers are mainly responsible for

managing this material in on-farm plots. Farmers take home tubers of the clones they prefer (maybe 5–7 clones) to plant out and test performance on their own farms.

Production of planting material

Tuber seed has very low multiplication ratios compared to cereals. Involving farmers in seed production of selected materials is one way around this bottleneck. Farmers at higher altitudes – where late blight is less of a problem – can produce good quality seed of potentially resistant varieties, but are less interested in using it because they can manage the disease with their existing varieties. Farmers at lower altitudes are more interested in using resistant materials – because late blight pressure is greater there – but they lack access to suitable conditions for producing good quality, healthy seed (at lower altitudes viruses are more of a problem and affect seed quality). To get round this problem, PROINPA is working in PVS with both groups. Farmers involved at high-altitude sites are multiplying up the most promising potential varieties for sale as seed to farmers at lower altitudes. Linking PVS and seed use through the informal seed system in this fashion is helping to overcome the multiplication bottleneck (Thiele, 1999).

PROINPA breeders are aiming to develop varieties that are intermediate between native landraces and European varieties. For this purpose, native cultivars from our germplasm collection are evaluated and used in crossings, including *Qoyllus* from the species *S. stenotonum*, *S. andigenas* (such as *Sakampayas*, *Las Wilas*, *Palis*, *Palas* and *Imillas*), *S. phureja* (such as *yema de huevo*, 'egg yolk'), as well as a number of wild species such as *S. avilesii* and *S. chacoense* as sources of genetic resistance for late blight.

The protocol for involving farmers in evaluating clones is now used for all breeding work, and most scientists in PROINPA realize that farmer participation needs to be permanent and institutionalized. Discussions hinge on when farmer participation should begin and how farmers' and scientists' evaluations should be integrated. Whilst breeders and social scientists have learned to work much more closely together, this has still not been properly reflected in research reports, partly because of an institutional format which tends to separate research findings by discipline.

Participatory plant breeding, 1997–98

The PROINPA team has initiated PPB as a pilot experience. The breeders in PROINPA were encouraged to try PPB by the success of a family of farmer-breeders in releasing new potato varieties in Ecuador (Bastidas, 1991). Social scientists played a supporting role.

The aim of the PPB activity was to see whether PPB was effective and develop training methodologies so that farmers themselves could breed improved varieties with higher yield potential and resistance and adapted to specific niches, using local genetic resources. Morochata was picked as a test site because of the good relationships between farmers and PROINPA

staff, a history of farmer involvement in PVS, and the presence of a committee of local farmer experimenters who were interested in taking part in PPB.

The team began by explaining to farmers as clearly as possible some fundamental genetic concepts such as variability and its manipulation. They used elements that the farmers already understood. They explained to farmers that the brothers in a family are all different, that each one has its own phenotype and genotype, which means they respond differently to different problems. The team showed farmers that plants could be divided into males and females, just as amongst people and animals. Farmers were able to distinguish the anthers (male) and stigmas (female) of the potato flower.

Farmers identified late blight and false root-knot nematode (*Nacobbus aberrans*) as the problems for which they would like new varieties. Farmers selected three varieties which could be used in a local breeding programme: *Waych'a*, a landrace (*S. andigena*), which is their main commercial variety and has excellent cooking properties; *Gendarme* (*S. andigena*) which also has good culinary quality and is resistant to the false root-knot nematode; and *Runa Toralapa (Perricholi)* which is a locally popular hybrid grown for its resistance to late blight and for its high yields.

From the breeders' perspective this was interesting material to work with. *Waych'a* has minor genes for resistance to late blight, and *Runa Toralapa* has residual resistance to late blight which derives from defeated major genes. Combining these varieties should lead to higher yield through hybrid vigour. It is possible that good resistance to late blight and nematodes could be obtained in the first generation of crosses without the need for back-crossing.

Five farmers from the committee of local farmer experimenters, who have been active in PVS and who were interested in joining us in this new experience, were given specific training in making crosses. We told farmers that Waych'a should be used as a male because its pollen is more fertile. Farmers used the caps of toothpaste tubes to collect pollen from flowers of *Waych'a* in the field. They cut the inflorescences of *Gendarme* and *Runa Toralapa*, fertilized their stigma using the pollen from *Waych'a*, and put them in plastic bottles filled with water. They labelled the crosses using cardboard labels. A month later the farmers collected the fruits and extracted the botanical seed. The seed was dried and left for a month to break dormancy, then planted in rustic wooden nursery boxes in farmers' houses. At the time of writing, seeds have germinated and will be planted out shortly.

Future perspectives

Although we have learned a lot about farmers' preferences, we have not systematized all the information. We are planning a national mapping exercise of farmers' local potato ideotypes to help target breeding work more effectively.

We hope to involve a local NGO in our PPB work. Our plan is to develop a trainers' guide that NGOs and other development institutions

could use to give training courses in PPB to farmers. Our hypothesis is that increased involvement of farmers and other institutions should mean that new genetic materials can be developed at lower cost in areas where PROINPA does not work, perhaps due to constraints not addressed here.

Furthermore, PPB should contribute to maintaining genetic diversity in farmers' fields. Using landraces as parental material and selecting from amongst their progenies should lead to a large number of the genes they contain being maintained. It is likely that progenies selected by farmers will not be genetically uniform, which should be advantageous for the durability of resistance and for the maintenance of *in situ* diversity.

However, so far this is a pilot experience. PROINPA will continue to do conventional breeding, complemented by PVS, for durable resistance to late blight and for other constraints. We hope to document our experiences in PPB and compare costs and benefits with conventional breeding. If experience shows that PPB is advantageous, at least under some circumstances, then we shall begin to promote it more widely. Even if PPB proves not to be advantageous it will help us learn more about farmers' decision-making in varietal selection.

Lessons learned so far

We have learned that by involving farmers earlier in the selection of materials, they begin to regard them as their own and feel part of the breeding process. For PVS the best moment to involve farmers is when there are around 30 advanced clones. We have also learned that it is best to have a fixed group of farmers, including both men and women, who are involved over a number of years in the selection process.

Farmers have been fascinated by the crosses they have made in the PPB work and are keen to continue with it. We have begun to develop training materials based on the talks and training sessions with farmers.

Although there were difficulties in bringing together the work of social scientists and breeders at the start, this experience helped us to identify bottlenecks and search for better ways of integrating disciplinary experiences. Breeders are now managing participatory methods with the active and integrated participation of the social scientists.

Because of our experiences with PVS, we are generating materials which better fit farmers' needs with regard to skin colour, flesh type, tuber shape, blight resistance and culinary quality. Since 1996 most clones being evaluated have emerged from PROINPA's own breeding programme that has included local progenitors including *S. stenotonum*, *S. andigena*, *S. goniocalyx* and *S. phureja*.

PPB should be a way of making better use of germplasm collections *in situ* and maintaining more genetic diversity. Involving farmers in breeding should ensure that their specific needs are addressed, leading to more rapid deployment and uptake of resistant materials. However, we need to avoid rushing into PPB before we really understand the pros and cons. PROINPA, has made a large investment in conventional breeding, enriched by PVS, and we are just learning how to do PPB. Our pilot experience should

help us learn which is more appropriate under which circumstances. Success will depend upon breeders, social scientists and farmers working closely together.