5.8 Participatory crop improvement in Central America

Encouraging farmers to use local varieties

*Sergio Romeo Alonzo Recinos, Mario Roberto Fuentes López, Juan Carlos Rosas Sotomayor, Silvio Aguirre Acuña and Rolando Herrera Torres*

The Collaborative Programme on Participatory Plant Breeding in Mesoamerica

The Collaborative Programme on Participatory Plant Breeding in Mesoamerica (Programa Colaborativo de Fitomejoramiento Participativo en Mesoamérica, PPBMA) is a pioneer in its area, and has been operating in the region for the last ten years. It promotes the participation of farmers in decision-making through the various steps of plant breeding, and increases farmers’ knowledge on ways to improve the performance of their local varieties. PPBMA is funded by the Development Fund (Norway), which fosters the establishment of relationships between governmental institutions, non-governmental organizations, and national and international research centres in Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua. Through PPBMA, we have been working with small-scale farmers on a number of national projects to conserve, characterize and improve varieties of maize, beans, sorghum and other crops. In the current chapter, we describe the methods used in participatory crop improvement (PCI) in Guatemala, Honduras and Nicaragua. The locations are indicated in Figure 2.6.1 (p. 100).

Participatory crop improvement methods: matching crops, local situations and capacities

Key participants in PPBMA are community-based organizations (CBOs) that include cooperatives, associations and local agricultural research committees (CIALs). We aim to promote capacity development at local level, particularly among male and female farmer leaders of the CBOs, and foster farmer participation in breeding, research and the coordination of activities.

During the process of implementing breeding activities, strategic alliances are established between key stakeholders. Although these alliances are initially formed at local level, they may later cross national borders, thereby legitimizing the regional structure of the programme. Since the professional and institutional capacity for plant breeding in the various Central American countries is in general rather limited, we aim to develop those capacities through PPBMA’s regional structure, and to enhance the efficiency of the regional breeding programmes, through PCI.
The programme has identified a range of PCI methods, based on a number of factors, including type of crops and crop reproduction systems involved, the plant genetic resource (PGR) base, the key problems faced, and the capacity of farmers to contribute to, and appropriate, the breeding process. In the current chapter we examine the PCI approaches that we use in the programme, following the terminology outlined by De Boef et al. in Chapter 5.1.

**Strategy 1: Conservation of local varieties**

By supporting farmers and researchers in their activities to rescue local maize, beans and sorghum varieties, the programme aims to contribute to their conservation. Farmers are organized in groups to register, characterize and document their local varieties, and this information is used for the design of both in situ and ex situ conservation strategies. Farmers display and exchange seed of local varieties through diversity fairs, thereby contributing to on-farm management.

**Strategy 2: Use of diversity in PCI**

The heart of our programme is to encourage farmers to use the diversity of local crops and to participate in their improvement. Initially, the major problems that farmers want to solve for a specific crop are identified, in order to choose the most appropriate breeding and selection methods to be used. The gene pool of local existing varieties is used as much as possible to solve the problems identified. It is crucial that farmers participate in the identification of criteria to be used during selection, and that the various PCI steps are mainly conducted in farmers’ fields.

**Strategy 3: Quality seed production of PCI varieties**

The third strategy involves the local production and marketing of quality seed of the varieties produced. We aim to increase the availability of high-quality seed to farming communities through the implementation of activities related to seed production and processing. Farmers’ capacities in seed production and processing are improved through intensive training, and support is provided for the establishment of farmers’ groups for engaging in collective action in seed production and marketing.

**General framework: food security, income generation and out-scaling**

In addition to the three technical strategies, the programme is also guided by a more general approach that has three aims:

1. to promote access to and availability of food crops, focusing on food and nutritional security;
2. to support income generation, where the aim is to develop higher yielding varieties, for which a demand exists in local, regional, national and international markets;
3. to seek ways for out-scaling the PCI methodologies to other organizations.
We encourage the involvement of other stakeholders in the PCI processes, including farmers, communities, government institutions and non-governmental organizations, and aim to promote a wider use of PCI methodologies, thereby increasing the efficiency of plant breeding in responding to farmers’ demands.

**Practical experiences**

**Participatory varietal selection and plant breeding of common beans in Nicaragua**

In 2001, the programme began to support a PCI process in the municipalities of Pueblo Nuevo and Condega, in the Esteli Department, in Nicaragua (see Figure 2.6.1, 100). The aim was to generate new common bean varieties by crossing local varieties with elite breeding lines, which served as donors of useful genes. Our partners use the participatory plant breeding (PPB) method, in which farmers and breeders carry out selection within segregating populations of common beans in farmers’ fields. PPB is complemented with participatory varietal selection (PVS) to evaluate and select among advanced breeding lines that carry combinations of traits. For several cycles, our partners selected for a broad set of agronomic, commercial and consumer characteristics. They concluded the PPB process with the release by the CBO of outstanding bean varieties. Subsequently, the programme strengthened the capacity of the CBO in the production, distribution and marketing of good quality seed. Through the participatory bean improvement programme, farmers and breeders in Nicaragua have become able to improve the tolerance of local varieties to drought and their resistance to bean golden yellow mosaic virus. To this date, the PPBMA partners in Nicaragua have released six bean varieties.

**Participatory improvement of common beans and maize in Honduras**

The Zamorano Pan-American Agricultural School (in short, Zamorano School) is engaged in participatory bean improvement in Honduras (Hocdé *et al.*, 2010). It collaborates with non-governmental organizations (NGOs) that include the Foundation for Participatory Research with Honduran Farmers (FIPAH) and the Rural Reconstruction Programme (PRR). CBO partners consist of farmer research groups associated with CIALs. As with our partners in Nicaragua, Zamorano School and its local partners combine PPB and PVS methods, with strategies for producing and disseminating seed of improved varieties to rural families.

Farmers from the participating CIALs received training in PCI methods during the implementation phase of the programme, using a learning-by-doing approach at each stage of PVS or PPB; a process that can take several seasons and years. The training included recognition of reproductive mechanisms and pollination in common beans and maize, collection and characterization of local and introduced germplasm, hybridization techniques, management of field trials, and evaluation of breeding nurseries for physiological traits, major diseases and pests, commercial qualities concerning yield and grain, and other traits to be selected during the PCI process. Farmers also learned about crop management practices, seed production and post-
harvest technologies, which are important for the management of breeding nurseries and for improving the productivity of their commercial fields.

Since 2000, our partners have released 13 common bean varieties and four maize varieties that were developed using PPB and PVS methods (Rosas, 2001; Rosas et al., 2003, 2006). These varieties are now being used in the regions where they were released, contributing to an increase in the productivity of maize and bean crops. Some of those PCI varieties were developed using local varieties as parents in crosses with varieties that are resistant to certain diseases, or which possess other desirable agronomic traits, such as better plant architecture and yield in common beans, and shorter plant stature and better lodging resistance in maize. The PCI varieties are particularly valued for being adapted to specific agro-ecological niches, where they perform better than the conventionally improved varieties.

Participatory genetic enhancement of local maize varieties in Guatemala

Most maize in Guatemala is produced by small-scale, poor, subsistence farmers, who generally have limited access to good quality maize seed. If these farmers do have access, it is only to the seed of conventionally improved varieties that are generally not well adapted to their agro-ecological and production systems. Participatory genetic enhancement (PGE) of local varieties creates a possibility to achieve significant improvements by selecting from within existing local diverse maize varieties. The local maize varieties and the diversity that they harbour are a product of the structure and functioning of the informal seed systems. In 2000, partners of the programme began the maize PGE programme in the highlands of Huehuetenango (see Figure 2.6.1, p.100), the highest areas of which reach up to 2200 m above sea level, by collecting and characterizing varieties that represented the local maize diversity.

Subsequently, our partners identified the most promising materials through PVS, taking into account the criteria established for their enhancement. They used recurrent reciprocal selection of half-sib families, and applied a method that allowed us to select within existing variation in preferred local varieties. Ogliari et al. (Chapter 5.7) describe in detail a variation to this method, which they used for the PGE of a local maize variety favoured by small-scale farmers in southern Brazil. The method used in Guatemala allowed our partners to evaluate half-sib families in different environmental conditions, and select those half-sib families that scored well for the selected traits. Only selected half-sib families were used for the formation of genetically enhanced local varieties. Since this breeding procedure requires some understanding of genetics, the programme organized community training workshops to improve farmers’ skills in selection, and enhance their understanding of plant breeding. Farmers proved to be well able to conduct selection among half-sib families. In fact, they subsequently carried out several cycles of mass selection to create some uniformity within the composite assembled, based on the selected half-sib families. Moreover, with their improved skills in selection, farmers became more capable of maintaining the elite materials. Such enhancement of farmers’ skills and capabilities is vital for ensuring that the varieties can be maintained in various agro-ecological niches, in situ, through their management by farmers. Our partners in Guatemala have developed
ten maize varieties under this scheme for the PGE of local maize varieties, which were subsequently multiplied and marketed.

**Participatory varietal selection and plant breeding of sorghum in Nicaragua**

A study carried out in four locations in Nicaragua in 2002 showed that local varieties of *tortillero* (short-cycle) and *millón* (day-length sensitive) sorghum did not perform well. They produced poor-quality fodder, were late maturing, and were vulnerable to diseases and pests during storage. We initiated our participatory sorghum improvement programme in 2002, with the evaluation of advanced sorghum lines of African origin, in collaboration with the International Centre for Tropical Agriculture (CIAT, Colombia) and the Agricultural Research Centre for International Development (CIRAD, France). In 2002, our partners trained farmers and local field technicians in the municipalities of Totogalapa and Somoto, in the department of Madriz (see Figure 2.6.1, p. 100), in the use of participatory varietal selection (PVS). They subsequently carried out PVS on local varieties and materials introduced by CIAT and CIRAD. In 2003, more farmers and communities became involved and new materials were introduced.

During the PVS process, one farmer, Orlando Gómez, said that he favoured the black tow variety because of its local adaptation, but that he would like to reduce the plant height, and improve grain and fodder quality. This statement motivated PPBMA’s partners in Nicaragua to move from PVS to PPB in their sorghum breeding programme. Farmers began to participate in selecting among segregating populations. Once they had stabilized a new population, they included the materials in the yearly series of PVS trials. In 2004, farmers in more municipalities joined in the development of new composites of both tortillero and millón sorghum varieties. Since 2005, local NGO partners have been ensuring the continuity of the participatory sorghum improvement programme. In 2007, our Nicaraguan partners registered a new white tortillero sorghum variety, which was followed in 2008 by the local distribution of three tortillero, and four millón, sorghum varieties.

The formal release of a variety is a lengthy procedure that involves standardization tests, which the sorghum PCI varieties are unable to pass. This does not mean that participating farmers and their organizations refrain from using and disseminating the PCI varieties. The sorghum varieties are becoming popular, resulting in their production and marketing through informal seed markets. However, they are not included in formal seed production, simply because they have not passed, and will not pass, the formal release procedures. Until these procedures change, such sorghum PCI varieties will remain in the informal seed sector by default.

**The use of local diversity and collective action for enhancing farmers’ autonomy**

The Central American region is a strategic reservoir of biodiversity for maize, beans and other food crops. The PCI methodology, with its variations in methods ranging from PVS to PGE and PPB, as applied in the PPBMA, constitutes a pathway for contributing to the management, conservation and utilization of biodiversity at
community, national and regional levels. PPBMA brings researchers, technicians and farmers together. We use quite simple procedures that help both farmers and breeders to improve and select within local varieties. The results can be identified easily, since farmers are increasingly using local, genetically enhanced, or PCI varieties.

We consider the transformation of farmers into plant breeders as another important achievement of PPBMA. These farmer-breeders improve their own varieties and consequently market the seed of such unique varieties, which provides them with the opportunity to increase their income and share the seed of their breeding work with others. In our network, the seed of most PCI varieties is distributed through informal markets.

To date, our regional network has released 31 bean, 18 maize and 10 sorghum varieties, which is only a fraction of the material produced and informally distributed and used by farmers. Another, more indirect result that concerns food security and income generation is that farmers who have access to our varieties have been able to increase the productivity of maize, beans and sorghum up to 200%. More than 5000 farmers have become affiliated with CBOs that are our partners. About 450 farmers and 30 technicians have improved their capacity to manage agrobiodiversity, thereby enhancing the overall capacity in the region in plant breeding and the in situ conservation of local plant genetic resources. Farmers’ organizations in Costa Rica, Guatemala, Nicaragua and Honduras have increased their share in the market for seed and grain production. These organizations have enhanced their capacity in entrepreneurship, and improved their infrastructure for processing seed and grain in drying, cleaning, classification, packaging and storage.

**PCI innovations: overcoming obstacles created by varietal regulations**

The process of releasing crop varieties that are produced through PPB and PGE by farmers’ organizations has exposed the limits of the formal system concerning the incorporation of these innovations at a more institutional level. For example, the network of bean breeders in Nicaragua has contributed to national level discussions on the legal and procedural mechanisms that remain a solid obstacle for the future release of more diverse materials produced through PCI. On the other hand, many farmers that belong to our partner CBOs are motivated in their work with PCI because they can contribute to the development of good varieties and produce good-quality seed of those varieties (Aguilar-Espinoza, 2007). In this way, PPBMA has increased the self-esteem of farmers, who are now beginning to see themselves as innovators and breeders, just like their scientific colleagues in PCI.

**Access to seed and varieties: motivating farmers to participate in PCI**

Farmers have other, rather opportunistic although quite valid, arguments for joining our programme. As seed security at farm household and community levels remains an issue that should not be overlooked in Central America, access to seed of appropriate varieties remains the primary objective for joining in participatory crop
improvement. The increased adaptation of their varieties helps farmers achieve this objective. Moreover, our activities result in the increased autonomy of farmers and their CBOs in the seed system. The mechanisms for participatory crop improvement, seed production and marketing that we put in place ensure farmers’ access to varieties and seed. In this way, PPBMA improves the food security of both its partners, and the farmers who depend on purchasing seed of the varieties we produce and disseminate through the market, fostering collective action to make the informal seed system work.

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