Creating common ground in collaborative crop improvement

Improving farmers' crop populations may help meet farmers' needs and ensure the continued use and *in situ* conservation of local crop varieties. Collaborative or participatory plant breeding (CPB or PPB) is an approach with the potential to increase the productivity and relevance of crop improvement efforts, especially for low-resource farming households in difficult environments. Two elements are central in CPB. First, the adaptation of crop populations to local biophysical and sociocultural environments and second, interaction between farmers and professional plant breeders. Creating an effective basis for collaboration that integrates the insights and skills of farmers and breeders and ensures mutual respect is a major challenge for CPB. What methods can be used in CPB to help farmers and breeders talk and work together to produce crop varieties that better meets farmers' needs?

Daniela Soleri, David A. Cleveland, Steven E. Smith

What can plant breeders offer?

Many small farmers in the Third World have derived little benefit from modern plant breeding. In part this was because conventional breeding approaches were ineffective, or because of the belief that improving the productivity of higher input systems was a better way of increasing food production and peoples' well-being than supporting low input systems. Modern scientific plant breeding has tended to emphasise the development of modern varieties (MVs) adapted to producing high yields in geographically widespread, but generally favourable environments. However, low adoption rates among small-scale, low-resource farmers indicate that MVs are not appropriate for these communities. Still, when some of the conclusions of modern plant breeding are understood in terms of the contributions of both the values and theory on which they are based, it is easier to see what plant breeders have to offer CPB . Theories, empirical knowledge, and techniques for analysis developed from years of experimentation and observation about plant development, the way genes function in this development, and the influence of growing environments, provide a systematic research framework. Recognising this fact, a small minority of plant breeders are applying plant breeding theory and techniques and CPB specifically to the needs of small-scale, low resource farmers.

What can farmers offer?

Until recently much CPB activity has emphasised the participation of farmers in such plant breeding tasks as selecting from breeder-developed material. Farmers' plant breeding experience and theory has not been brought into CPB because little is known about it, either in farmers' terms or in terms of the theory of scientific plant breeding. Farmers obviously have much to offer CPB. First, they are the ones who will use and judge varieties. Second, farmers' practices and theory frequently represent long-term experience with the plant genetic and environmental variation components of their farming system.

Table 1. Characteristics of the communities studied in the Central Valleys of Oaxaca, Mexico.

Characteristic	Santa Maria	San Antonio
Elevation (msal)	1490	1780
Average annual precipitation (mm)	685	468
Predominant soil characteristics	alluvial, sandy clay	piedmont, gravel
District average maize yield (t/ha)	0.76	0.45
Average maize sowing rate/ha	47,000	40,000
Population (1995) *	2800	2533
Predominant ethnic/linguistic group	Mestizo/Spanish	Zapotec/Zapotec

** 1998 estimates for both communities = 3000, M. Rees personal communication 1998.*

Research approach

In this article we use examples from ongoing research with maize farmers in the Central Valleys of Oaxaca, Mexico, to illustrate how the insights of farmers and plant breeders can be brought together to facilitate a better understanding of local maize seed selection practices. We also explore the implications for collaboration and hope to come to a clearer understanding of what the components of the biological model of selection used by plant breeders looks like from the farmers' perspective. Given the time and often money invested in seed, it seemed likely that farmers expect certain results from the selection process.

Materials and methods

We worked with a sample of eight farm families in a community in the Zimatlan Valley and with five families in the Mitla Valley (Table 1). We tried to make the sample representative of household types in each of these communities in terms of wealth and the gender of head of household. Interviews were conducted with those primarily responsible for agriculture: the wife and husband or mother and son. Younger workers were also interviewed but they usually deferred to the primary pair. In our analysis of these maize seed selection systems we wanted to describe and quantify selection and come to an understanding of the theory that guided farmer seed selection practices.

Quantifying farmers' practice

Through participant observation, informal discussion, and formal interviews with the 13 collaborating households, we identified three categories of selection criteria. First, seed quality and seedling vigour. Second, traits such as ear length, weight and diameter, kernel size and weight as well as the weight/volume of shelled kernels. Third, traits that define a variety type or subtype, which in our sample included such traits as grain type, grain form, and cob and husk colour. Although criteria in the third category varied from household to household and between the communities, the first two categories were universally applicable.

As selection exercises demonstrated, these criteria and particularly the first two categories, were reflected in farmers' selection practices. Using a random sample of 100 ears of the common local white maize variety from a field in their community, we asked households to select ten of the "best" ears for local planting seed. These were then evaluated for a series of traits including ear diameter, length and weight.

We then conducted a field experiment with white maize populations from three households in each community in order to quantify the response to farmers' selection in the maize populations. Since 1996, we have obtained three generations of farmer-selected samples and two generations of corresponding random samples from the same population from each household (Figure 1). All of these samples were sown with eight replications in a completely randomised block design in a field belonging to one of the collaborating households in the Zimatlan Valley. The experimental field was prepared and managed by the household according to local practices.

Farmers' theory

Participant observation, informal discussions and formal interviews all contributed to our understanding of the theory underlying farmers' selection practices. Using maize ears and photographs of maize tassels of different colours to illustrate the scenarios, farmers were asked what the phenotypes of the progeny of particular selections grown in different environments would look like. Questions about the expression of traits in normal and optimal environments provided a way of understanding farmers' theories regarding abstract concepts such as heritability in their maize varieties and environments. We found that the biological model provided a useful framework for understanding local selection practices. However, its utility in terms of supporting CPB appeared best when we tried to deliberately investigate its components from farmer's perspectives.

Common ground

We started to explore farmers' selection practices with the idea that selection is about changing crop populations. When we asked households what they were looking for when they made selections, we were invariably told "los mejores" - the best. When we asked questions about how they wanted to change their populations, the answers we got were often confusing. Looking at farmers' perspectives-exploring farmers' practices, the theory behind them, and their implications for maize populations was more productive. It revealed our own mistaken assumptions and allowed farmers to explain their own understandings, theories, practices and objectives in maize seed selection.

The following findings from the interviews, selection exercises, genetic perceptions scenarios, and field experiment in this study are of relevance for facilitating farmer and plant breeder interaction.

- Farmers' selection criteria as they defined them and their selection criteria as demonstrated by the selection exercises identified ears and, to a lesser extent, seed size traits as important once seed quality (freedom from pest and disease damage) had been assured.
- Selection for these criteria appeared directional and seemed to try to change the populations' mean value for these traits.
- Farmers' answers to genetic perception scenarios, however, showed that they saw traits such as ear length as having no heritability either in their own, variable fields or in hypothetical uniform ones (Figure 2). Most farmers regarded ear length to be product of the growing environment in which the maize population developed. This being the case they expected no response to selection for such traits and implied that they saw no genetic variation for that trait. This did not mean farmers were unable to recognise genetic variation or understand the potential of selection. They pointed out that a trait with a high heritability such as tassel colour, could be selected and change would appear in the progeny as a result of that selection (Figure 3). The presumption that farmers practise selection to change their maize populations, our original interpretation of farmer responses to interviews and selection exercises, was not supported by farmers' theories.
- There was virtually no response to selection in the field experiment. The absence of a response to selection for traits identified as primary selection criteria confirmed farmers' own opinion that their selection would not change their maize populations.

Relevance

Several of these findings are relevant to practice and may change the way in which farmers and breeders work together on CPB. Farmers are concerned with seed quality and seedling vigour at the moment. Farmers would probably be interested in research into improving the pest and disease resistance of maize ears especially during storage.

Second, understanding that farmers do not see the potential of selection to change some of the traits in their maize populations, and, therefore not the purpose of their seed selection, highlights a significant difference between their objectives and those typical of plant breeders. For this reason attempts to improve selection practices may not always seem worthwhile or even logical to farmers. A more affective approach may be to improve heritability for the traits farmers may want to change if they believed they could. This means making genetic variation visible and accessible to them and making it possible to respond to selection.

Finally, helping plant breeders and other researchers achieve a better understanding of farmers' practices and knowledge, including their theory, helps create a basis for mutual respect and collaboration. The genetic perception scenarios were not undertaken to test farmer knowledge, nor

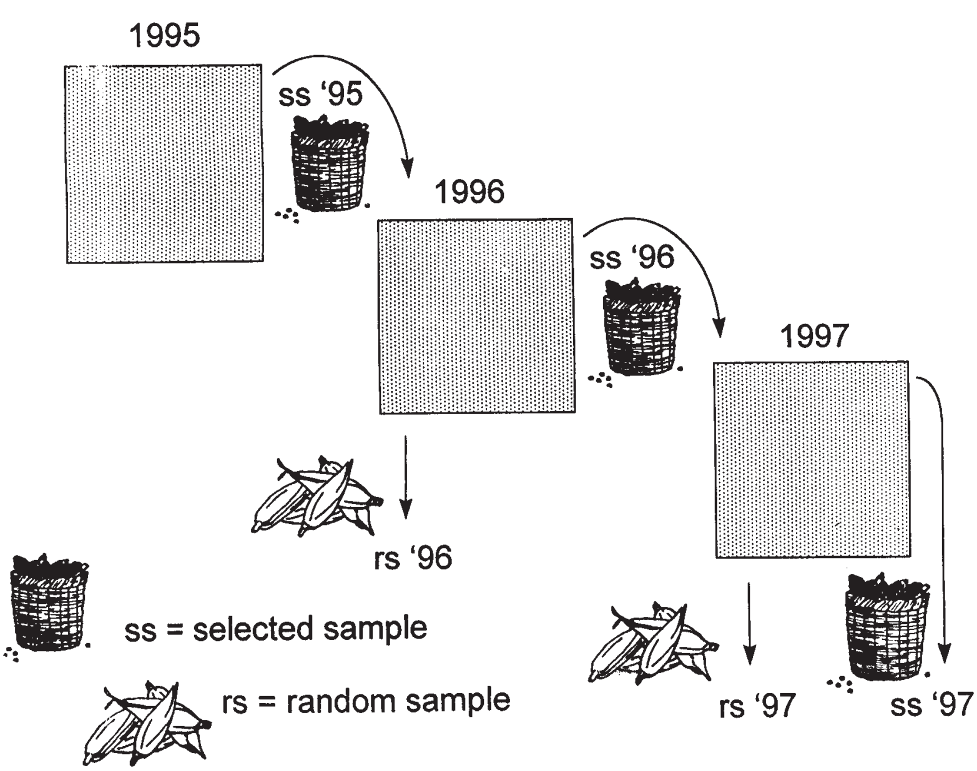

Figure 1 Response to selection: year and type of seed used for each population

was their knowledge compared to any "correct" or "scientific" standard. We recognise that many other factors contribute to farmers' knowledge about their crops including sociocultural, economic and individual variables. The approach described here tries to neutralise the realm of practice—in this case seed selection and crop improvement—to the extent that the dichotomy between "scientific" and "non-scientific" practice is abandoned—and the common elements contributing to farmer and plant breeder practice are recognised.

This is an abridged version of the original article. A full version together with references is available from www.oneworld.org/ileia or from ILEIA, PO 64, 3830AB Leusden, The Netherlands.

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Daniela Soleri, NSF/NATO Postdoctoral Research Scientist, Research Group on Technology and Agrarian Development (TAO), Wageningen Agricultural University, Nieuwe Kanaal 11, 6709 PA Wageningen, The Netherlands (until 31-8-2000), email: dsoleri@ag.arizona.edu.
David A. Cleveland, Associate Professor, Department of Anthropology and Environmental Studies Program, U C Santa Barbara, Santa Barbara, CA 93106-3210 USA; Visiting Research Professor, Research Group on Technology and Agrarian Development (TAO), Wageningen Agricultural University, Nieuwe Kanaal 11, 6709 PA Wageningen, The Netherlands (until 31-8-2000); email: clevelan@lifesci.ucsb.edu.
Steven E. Smith, Associate Professor, School of Renewable Natural Resources, University of Arizona, 301 Biological Sciences East, Tucson, AZ 85721 USA, email: azalfalf@ag.arizona.edu.

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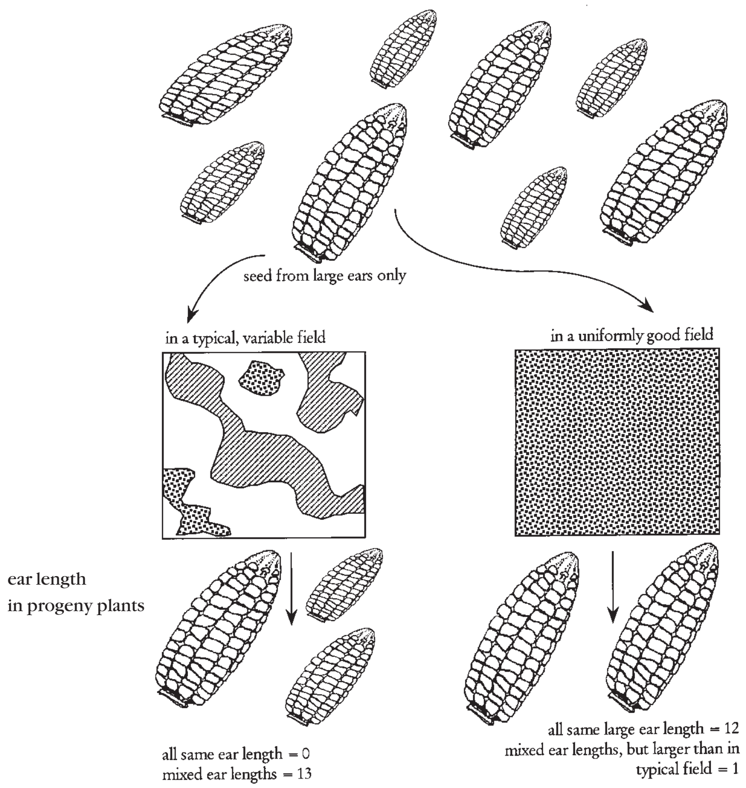

Figure 2 Genetic perceptions: responses to ear length scenarios

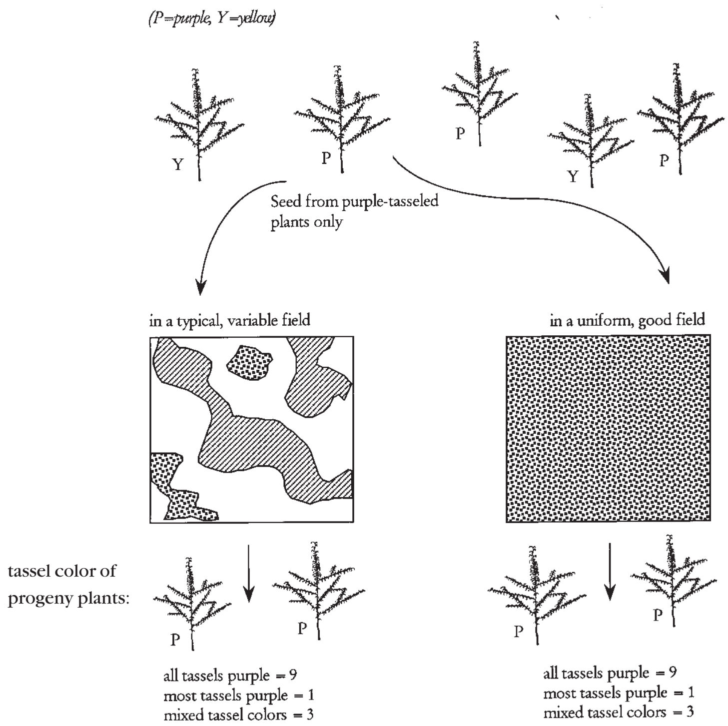

Figure 3 Genetic perceptions: responses to tassel color scenario