Participatory research: a catalyst for greater impact

Hellin, J.[1], Badstue, L.[1] and Bellon, M.R.[2]

[1]International Maize and Wheat Improvement Center (CIMMYT)
[2]International Plant Genetic Resources Institute (IPGRI)

Abstract

This paper discusses the notion of farmer empowerment as a primary objective of participatory research. The authors argue that agricultural technologies are adapted - not adopted – through a social and cultural process which includes the transformation of the technology. Farmer participation in agricultural research is important and necessary first of all to increase the efficiency and impact of agricultural research and technology development. This includes the identification of traits that can guide crop breeders' work. Farmer empowerment is valuable and desirable, and while it can result from participatory research, direct empowerment *per se* should not be the main objective of participatory research conducted by research organizations. Of more importance is the empowerment of partner organizations and the identification of future research needs, i.e. the functional purposes of participatory approaches in agricultural research.

Introduction

Farmer participation in agricultural research can be defined as a systematic dialogue between farmers and scientists to solve problems related to agriculture and ultimately to increase the impact of agricultural research. While internal rates of return and cost–benefit analyses may have been sufficient for the accountability functions of impact assessment, they do not satisfy those interested in knowing how, and why, a project affects peoples' lives. Impact-assessment practitioners must now document a much broader range of project impacts, especially in the areas of poverty alleviation and environmental sustainability.

In this context, one of the key questions is what are the impacts of participatory agricultural research on rural innovation capacity? Rural innovation can occur in two ways: i) when external, new technologies become more accessible, e.g. as a result of lower costs of adoption, or ii) when new technology is developed locally, e.g. due to increase in the local capacity to adopt, adapt or develop new technologies. Different actors can be involved in reducing the costs of adoption of new technologies, e.g. research and extension organizations, private companies, farmer organizations etc. Meanwhile, when rural innovation takes place as a result of an increase in local innovation capacity, the focal point generally is the farmers themselves. This is especially the case when there is an erroneous assumption that the technology is appropriate and desirable, i.e. innovation is seen as a supply issue, when it may be the case the technology is inappropriate and needs adapting so as to complement farmers' needs. The use of participatory approaches is one way of enhancing rural innovation capacity, whether through increased accessibility of externally developed technology or through increased local capacity to address problems and devise solutions for them.

Lilja and Bellon (2005) posit that when participatory approaches are used to enhance the first version of rural innovation, they are characterized by what the authors call its' functional purposes', while the use of participatory approaches to achieve the second version of rural innovation can be referred to by its 'empowerment purposes'.

The issue explored in this paper regards the ability of participatory agricultural research to enhance rural innovation capacity and to identify crop traits that can guide crop breeders' work. This paper reports on a project in Oaxaca, Mexico, which sought to strengthen on-farm conservation of maize genetic diversity through a participatory research process. The project offered training to farmers on basic principles of maize reproduction and ways of maintaining the traits that the same farmers value in their local maize landraces; as well as on improving seed selection and seed/grain storage practices. In this sense the Oaxaca project covered both functional and empowering purposes.

While both are desirable and important, the question of whether research for development should use participatory approaches in order, primarily, to improve the efficiency and the impact of research, or as a means for empowerment, is important for how we target research and measure its impacts.

From transfer of technology to farmer participation

Transfer of technology

Farmers' livelihoods, especially in regions beset by low endowments of 'geographic capital' (natural, social, human and physical capital), tend to be diverse and complex, with farmers reliant on non-agricultural and non-farm as well as agricultural and farm sources. Reflecting the complexity of their livelihoods, farmers' problems are often multiple and interrelated. Farmers are commonly faced with a range of adverse agro-ecological, social and economic conditions including erratic rain, low fertility soils, fluctuating market prices for agricultural products, and labor shortages (Douglas, 1993). In addition, farmers minimize risks and seldom take chances that might lead to hunger, starvation or loss of their land. Complex and diverse livelihood and farming systems reduce vulnerability and enhance security.

Outsiders[1] have often failed to understand and appreciate the complexity of farmers' realities and the impact that this complexity has on farmer decision-making. When faced with a tension between farmers' complex and diverse realities and practical action, the tendency amongst

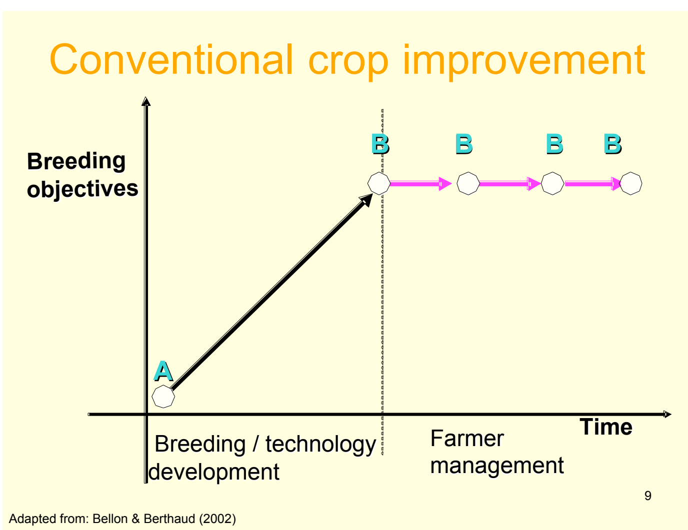
[1] In this paper, the term 'outsider' refers to anyone who is not a small farmer and who is deemed to be dominant or superior to or by farmers (Bunch, 1982:30). In this context, outsiders are researchers and development practitioners including extension agents.

professionals has often been to ‘simplify’. As a consequence, this has led to inappropriate recommendations in many cases (Chambers, 1997:49). Mono-disciplinary recommendations that reflect the technical focus of the expert adviser are often made to deal with what are, in fact, multi-faceted problems (Shaxson, *et al*., 1997).

Chambers (1997:68) refers to this as the ‘Model-T approach’ where technology (e.g. improved crop germplasm and soil conservation technologies) is uniform and mass-produced as a standard package destined for wide diffusion across multiple local conditions (Warren and Cashman, 1988:4; Pretty and Shah, 1997; Hallsworth, 1987:145). As Kloppenburg comments (1991), this transfer-of-technology approach often involves a loss of social, political, physical and biological context. In many cases, the result is that the new practice is not tuned in to the variability and particularity of local systems. Furthermore, within this approach farmers are seen merely as ‘adopters’ or ‘non-adopters’ of technologies, rather than originators of either technical knowledge or improved practices (Scoones and Thompson, 1994).

Figure 1 illustrates the conventional model associated with a released of a “modern” variety. The variety is developed by the formal system, increasing its performance (defined as breeding objectives). The variety then is released to farmers (point B) and it is supposed to stay unchanged under subsequent farmer management.

Figure 1 Transfer of technology from plant breeder to farmer



The Model-T approach is not, of course, always used as such a blunt instrument. Increasingly in on-farm and farming systems research, development practitioners use recommendation domains to target better a particular technology (CIMMYT, 1988:7). A recommendation domain refers to areas and/or farmers that share similar agro-ecological, social and economic conditions. If a technology works and is appropriate for one site or group of farmers, there is more justification for introducing it to areas that fall within the same recommendation domain. It can be argued that the concept of recommendation domains needs to be expanded to include the institutional environment and to be refined so as to encompass common livelihood strategies.

Technology diffusion

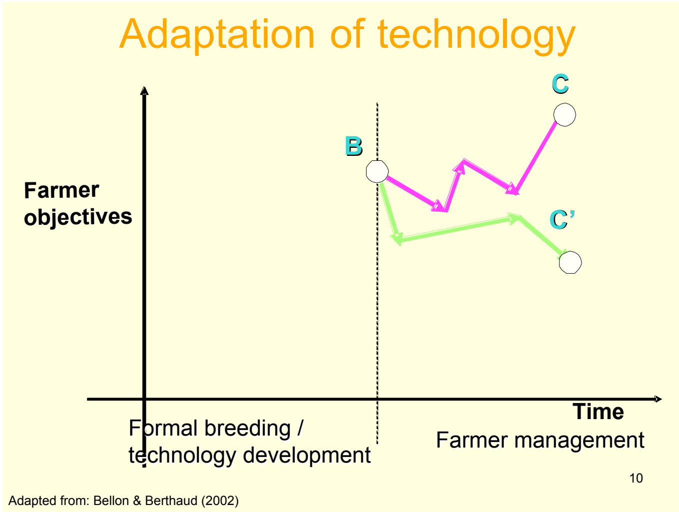
In the past it was often assumed that a technology will diffuse almost by itself if it is superior to the existing technologies and/or if the technology is more profitable than existing alternatives. (Campbell 1996) refers to these approaches as technological determinism and economic determinism. The former assumes that new technology will diffuse due to the advantages inherent it. In a similar fashion economic determinism assumes that the market forces will oblige the producers to adopt the new technology lest they will be forced out of the market. Both theories only consider one variable and have an appealing simplicity.

Empirical studies, however, have often shown that reality is much more complex, and the comparison between the empirical results and the deterministic theories often appear confused and contradictory (Campbell 1996). Moreover, research has shown that though both technological and economical factors are important in new technologies, they are by no means a guarantee for success. In fact, most technologies that fulfill these criteria have had no or very little practical impact, and often it can be observed that the technology that achieves widespread adoption is neither the best from a technological stand point, nor necessarily the most profitable.

In countless cases the spread of technology does not happen as illustrated in Figure 1. Rather than merely adopting the technology and putting it into practice under ideal conditions, farmers tend to adapt the technology to their individual circumstances and preferences, moderating the technology or developing it further. In addition, farmers' modifications and use of new technologies do not always coincide with the ideas or the intentions of those who originally developed or introduced the technology, see Figure 2.

Figure 2 shows that once a variety is released and ends up in farmers' hands, there are changes in its performance and it can go to different points (C or C'). Unlike the previous model, illustrated in Figure 1, that assumes that all stays static, reality shows that improved varieties change under farmers management (particularly for maize, and open pollinated crops).

Figure 2 Farmers' management of technology



Technology diffusion as a process of social interaction and adaptation

Others have pointed out that individuals participate in social change not as passive subjects of the economic, social and institutional structures, but rather as social actors whose strategies and interactions shape the outcome of development within the limits of the information and resources available (Long 1992 and 2001). In response to this, modern approaches to technology diffusion stress the elements of social interaction and adaptation, emphasizing the importance of conceptualizing technology diffusion as a social process, which includes the transformation of the technology, and where people's perceptions and networks play a crucial role.

Fundamental to this social interactionist perspective is the assumption that technology is socially constructed. The diffusion is therefore the result of interaction between the technology and potential users within particular cultural and organisational contexts. Given the huge differences between contexts and widely varying values and motivations of the individual, present within these environments, the social interactionist approach suggests the process of diffusion to be complex and problematic. The outcome is regarded as resulting from the socially constructed values underlying adoption rather than the technical characteristics of the innovation. Consequently, even in relation to exactly the same technology, the response of potential users is likely to vary considerably (Masser et al, 1996, p 31f).

Nevertheless, paradigms of development and under-development, whether from the left or right of the political spectrum, have tended to underestimate the innovative nature and resourcefulness of local peoples and their ability to be pro-active in adverse conditions. All too often farmers' entrepreneurial spirit has been under-appreciated and "c*aricatured in their vulgar terms, both neo-classical and Marxist theory* (sic) *render the individual virtually powerless to change the course of human affairs*" (Chambers, 1997:12).

For research to contribute to sustainable livelihoods and poverty reduction, it must provide solutions to problems that influence people's livelihoods, and help identify guiding principles for their implementations. Emphasis must therefore be on the application of appropriate knowledge, rather than merely developing it. As such, the research and technology development process should focus on and closely interweave with the practical application of appropriate knowledge in real-life situations. For this to happen, experience highlights the importance of involving end-users and other relevant actors in the process in order to adapt the technology development as much as possible to their particular situation. The key is farmer participation.

Farmer participation

If local peoples' knowledge and capacities are valued and granted legitimacy within scientific and development communities, researchers and extension agents will pay greater attention to the priorities, needs and capacities of rural peoples. This will enable outsiders to make more appropriate and sustainable recommendations (Scoones and Thompson, 1994). In recent years, therefore, research and extension agendas have sought to find out more about farmers' realities and to seek active farmer participation at all stages of the development process. The so-called farmer-first approach, and more recently the focus on sustainable livelihoods, represents a paradigm shift whereby farmers are engaged to help construct outsiders' understandings of the way in which their world operates, rather than have outsiders' realities imposed on them (Chambers, 1997:103; Edwards, 1989; Bellon, 2001).

Participation is very much part of the development lexicon, but the term has been misused and abused. Pretty (1995:173) identifies a seven-level typology of farmer participation that ranges from manipulative and passive participation, where people are told what is to happen and act out predetermined roles, to self mobilization, where people take initiatives largely independent of external institutions. Farmer participation in problem identification and subsequent project formulation and implementation is now recognized as one of the critical components of rural development (Pretty and Shah, 1997).

While the roles of participatory approaches may differ between development research versus actual development interventions as well as their principal impact pathways, the contribution of participatory approaches is equally important both in applied development interventions as well as in development research. As Bellon (2004a) notes, "*participatory research in agriculture is a tool to increase the efficiency and the impact of agricultural science and technology in the welfare of society. Its effectiveness depends on becoming an integral component of the development and diffusion of agricultural innovations based on systematic feedback loops that link the "formal" with the "informal." Participation cannot be left to the end of the technological innovation process, but should be an integral part of it*".

Despite broad recognition of the benefits of participation, the reality has changed less than the rhetoric, with many development and research projects tending to a more passive participation

(Warren *et al*., 1995; Bunch, 1982:58; Fujisaka, 1989; Röling and de Jong, 1998). There remains a need to spread among development professionals and scientists, effective means to enhance farmers' participation, competence and choice (Chambers, 1993). The changes are radical because they go beyond putting the last (farmers) first, and require a process of disempowerment, whereby researchers and extension agents are put last (Chambers, 1997:211). Instead of teachers, outsiders become facilitators, supporting a process of change (Enters and Hagmann, 1996; Pretty, 1998:24).

Farmer participation in agricultural research

The involvement of farmers and other stakeholders in agricultural research for development can contribute in the development of solutions to problems that influence people's livelihoods, and in the identification of guiding principles for their implementations, as well as in the overall definition of research priorities. At the same time, research has an important role at a more general level, namely that of informing policy and in this way helping create an enabling environment that allows individuals and communities room for manoeuvre to improve their livelihoods.

Lilja and Bellon (2005) point out two main purposes for which participatory approaches are normally used in the field of development research: 1) for functional purposes in order to increase the validity, accuracy and particularly the efficiency of the research process and its outputs; or, 2) for the purpose of empowerment, e.g. to strengthen farmers capacity to analyze opportunities and set priorities for change and innovation.

With particular reference to participatory crop research, functional purposes may include: enhancing biodiversity and germplasm conservation; developing adapted germplasm for especially disadvantaged user groups (e.g., women) in marginal areas; and making breeding programs more cost-efficient, particularly through decentralization of programs which target more niches (Sperling et al., 2001) and the key identification of traits that crop breeders should focus on. In this context, functional purposes can be divided in upstream ones that address more the traits that breeders should focus on and downstream ones that deal more with local processes, adoption and adaptation.

Empowering purposes may include enhancing farmers' capacity to seek information, strengthen social organization and build trust, experiment with different crop varieties or management practices, analyze and draw conclusions; and learn from mistakes (Humphries et al, 2005; Lilja and Bellon, 2005).

Despite these laudable purposes, Sperling et al (2001) suggest that in practice, three degrees of participation are generally found: consultative, collaborative, and collegial[2]. Consultative

[2] See Morris and Bellon (2004) for a more comprehensive typology of participation in PPB.

participation signifies that information is sought from farmers and, sometimes, from other clients of the breeding program; collaborative means that there is some degree of task sharing between researchers and breeders, along lines determined by the formal research program; while collegial means that researchers support a farmer-initiated, farmer-managed program which is accountable in a direct way to the farmers and other client groups with a stake in the results of the germplasm development. Sperling et al. (2001) point out, though, that the most frequently observed degree of participation is consultative i.e. a degree of participation that tends towards the 'passive participation' end of the participation typology spectrum developed by Pretty (1995:173).

Farmer participation as a means for empowerment

Rather than diffusion and adaptation of technologies *per se*, rural and agricultural development can be seen more as a process of farmer empowerment whereby people achieve the abilities needed to address problems affecting their livelihoods by way of participation and innovation (Edwards, 1989). From this perspective, it could be argued that the transfer of technology approach or the focus on technology development can be seen as 'anti-development'. From this point of view, the only way to avoid the dependency associated with top down development initiatives is to motivate farmers to do things for themselves and to facilitate their active participation (Bunch, 1982:23).

The driving force behind participation is enthusiasm and this enthusiasm comes from programs that address farmers' priority problems, work with farmers, and bring about early recognizable success (Bunch, 1982:24). People who participate in programs often experience increased self-confidence, pride and a certain satisfaction of having made significant achievements. In this context, success can be defined as "*the solution of a felt need with results that are both readily observable and desirable according to the culture's own value system"* (Bunch, 1982:25).

Positive experiences resulting from participation can further stimulate farmers' motivation for exchanging ideas and experimentation (Edwards, 1989). Innovation is part of development and is vital because agro-ecological, social and economic conditions change. In an increasingly globalized world that places a premium on adaptability and responsiveness, farmers need to be able to adapt to changing circumstances (Ellis and Seeley, 2001). As Bunch commented several decades ago (1982:11) the goal of agricultural development programs should not be to develop the people's agriculture, but to help facilitate a process in which they develop their own agriculture.

Experience in with a range of participatory extension and research models such as Farmer Field Schools, Local Agricultural Research Committees and Farmer-to-Farmer extension models demonstrate that these initiatives may be effective in empowering farmers and supporting them in their own identification of solutions to local production problems (Williamson, 2002; Meinzen-Dick et al., 2004; Humphries et al., 2000; Johnson et al., 2003). A growing number of experiences where active farmer participation has contributed to a process leading to greater human development include watershed management in Kenya (Thompson and Pretty, 1996; Thompson and Guijt, 1999); irrigation programs in Sri Lanka (Uphoff, 1996) and agricultural programs in Honduras (Bunch and López, 1999; Hellin, 1999).

However, the development community cannot and should not underestimate the potential of scientific knowledge properly applied. Scientists and science has a lot to contribute to agricultural development. Farmers are eager to get new options and solutions to their problems, but in many cases they do not have them. As Bentley (1989) and Bentley et al (1994) have argued, there are many areas where scientists can help farmers by providing information and technologies to which they have not had access earlier. This strengthens the case for true participatory research between scientist and farmer.

Farmer participation for better technology and policy adaptation

The success of the Green Revolution to increase yields of a number of crops in developing countries through the development and spread of modern high-yielding crop varieties and new agricultural practices remains indisputable (Byerlee 1994, Muir 1998, Evenson and Gollin 2003). The early improved varieties of rice and wheat spread quickly in tropical and subtropical regions with good irrigation systems or reliable rainfall and yielded substantially more grain than previous varieties. While this focus undoubtedly had huge impacts in terms of the improvement of national food security in a series of countries, large differences across crops and regions influenced the process. Outside of these more favorable environments, varietal improvement was slower and more limited. Research to adapt modern varieties of rice, wheat, and maize as well as other crops to "marginal" environments took time to yield dividends and the diffusion of modern varieties into less favorable agro-ecological zones was slow. In recent times, however, this has started to change, and ultimately, as documented by Evenson and Gollin (2003), the efforts to broaden the Green Revolution have shown increasing success.

Participatory crop research emerged during the last two decades and grew with the efforts to extend the success of modern crop improvement to areas that had previously seen little or no benefits in this regard, e.g. small-scale farmers in agro-ecologically and socio-economically marginal and variable environments (Almekinders and Elings, 2001). The term "participatory plant breeding" has been used to refer to different forms of interaction between farmers and researchers at different stages of the crop research and improvement process. Participatory crop research and improvement can involve scientists, farmers, extension agents, industry and consumers and others in the research process. The objective is to facilitate quicker and more extensive uptake of new cropping technologies by shifting the locus of plant genetic improvement research toward the local level through direct stakeholder involvement at different stages of the breeding process (Morris and Bellon, 2004).

Crop varieties favored by smallholder farmers typically have multiple uses (e.g. young leaves as vegetables and dried stalks for fodder). Yield is therefore often assessed by farmers less in terms of the grain, root or tuber production *per se* and more in terms of an optimum function of production of different plant parts. Furthermore, in many areas quality traits are highly valued and play a significant role in farmers choice of varieties. Finally, farmers in marginalized areas with low agricultural potential and heterogeneous agro-ecological conditions have special needs and value adaptation to low soil fertility, drought, resistance to pests and diseases, and storability of grains and seed etc.. Even if they are high yielding, modern varieties may not be attractive to farmers unless they also possess other characteristics that farmers consider important (Almekinders and Elings, 2001).

In recent times several formal plant breeding programs have experienced shifts in research priorities towards increased attention to issues affecting, in particular, poor farmers in marginal areas. Over the last 10-15 years, for example, CIMMYT maize research has increasingly focused on problems which are of special importance to smallholders in marginal areas, e.g. drought tolerance, low N and acid soils tolerance, disease and pests tolerance, yield stability and improved storage ability.

The above mentioned aspects constitute an area where participatory crop research can make important contributions. In order to develop germplasm that suits farmers needs, multiple traits must often be considered. However, identifying these multiple traits and assessing their relative importance to farmers is not always a simple task. Unlike their counterparts in the developed world, where markets are relatively efficient and the value of different crop traits is reflected in prices, in most situations small-scale farmers in the developing world operate under conditions of imperfect markets, where prices do not reflect the value of traits to them. These traits which may be obvious to the farmers may not be easily recognized by outsiders.

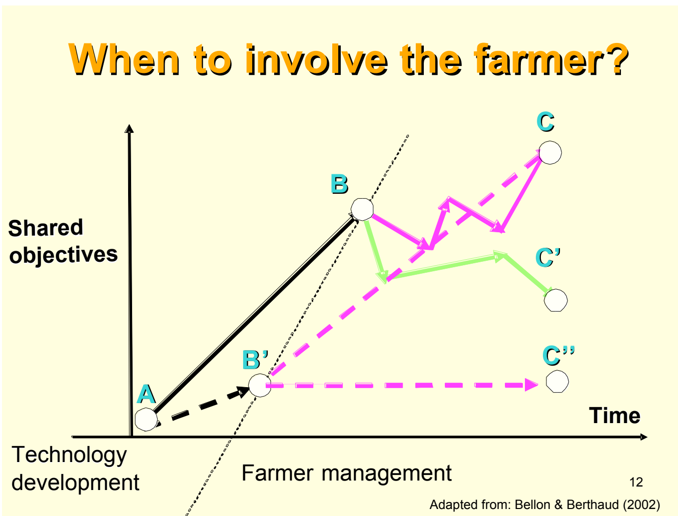
Simple profitability analyses may work well under the conditions of good market development, common in developed countries. However, this may be a poor guide to decision-making about new varieties where multiple traits are valued, but these values are not reflected in market prices. Participatory methodologies can play an important role in identifying and valuing these traits, and if this information is fed back into the design and development of new varieties, it can help to make them more relevant and appropriate, so that they generate more benefits to these people (Bellon 2002; Lilja and Bellon 2005).

Mainstreaming a new paradigm

With the recognition of technology diffusion as a social process which includes modifications to the technology or practice in question, the question is no longer whether or not to include participation by end-users and others: it is simply un-avoidable. The issue is rather: how and when in the process to incorporate this? This is illustrated in Figure 3.

Figure 3 illustrates that we need to integrate the process of managed changed/improvement that is conducted by the formal system with the actual management practiced by farmers. Farmers may be involved at different stages in the technology development process and the letter C in its different versions (C, C', C'') represents the range of possible outcomes once farmers have taken full responsibility of the technology. The change in the performance of the variety under farmers' conditions is often complex, and can lead to completely different outcomes than assumed in Figure 1. That is why we need to work closely to farmers, to really assess what could happen to a technology when it is released.

Figure 3 When should farmer participation be incorporated?



The conclusion of this brief review of different perspectives on technology diffusion is that it is impossible to separate agricultural technology development from farmers. The issue at stake turns out to be one of division of labour, and the roles of farmers, researchers and the organizations linking the two.

An example of farmer participation in CIMMYT research: enhancing productivity and conserving maize genetic diversity in Oaxaca, Mexico.

Objectives

This project was carried out in the Central Valleys of Oaxaca in Southern Mexico, an agro-ecologically and ethnically diverse region recognized as within the center of genetic diversity and domestication of maize (Matsuoka et al., 2002; Piperno and Flannery, 2001; Sanchez et al., 2000). The objective was to determine the possibilities of improving maize productivity while maintaining or enhancing genetic diversity by increasing the benefits from growing local landraces, e.g. grain quality for traditional consumption purposes, multiple production objectives and heterogeneous agro-ecological conditions (see Bellon 2004)[3].

Farmers in this region have a long tradition of cultivating maize and have maintained the diversity of their landraces to the present. These landraces have considerable value for agriculture beyond the Central Valleys, because they have contributed to the development of improved, drought-tolerant maize cultivars that are popular elsewhere in Mexico (Aragón-Cuevas et al. 2000; Ortega-Paczka, R., 1995). Modern maize varieties have had an almost negligible impact in the Central Valleys, and while their virtual absence may or may not have helped to conserve maize diversity in the region, it indicates that scientific research has not provided farmers in this region with new germplasm options.

Project activities

The project included a participatory study of regional maize landrace diversity, including a collection of more than 150 different types of maize from a total of 15 communities, chosen for their range of agro-ecological, socio-economic and ethnic diversity. All maize samples were planted under experimental conditions and characterized agro-morphologically and male and female farmers from the region were invited to assess the characteristics of the different maize types by voting for the ones they liked best.

Based on farmers assessment and the agro-morphological characterizations a subset of 17 different types of maize were selected which were considered to represent the span of the agro-morphological diversity as well as the preferences of the farmers. The subset of 17 materials was planted in researcher-managed demonstration plots in six of the 15 communities. Again, at different stages in the crop cycle open invitations were extended to all the farmers who were interested, to participate in field days where the maize plants and ears could be observed and information about each variety's performance in the field was available. Once again, farmers' input regarding the different materials was solicited. At the same time anyone who wished to do so could buy seed of the varieties that interested them in particular.

Meanwhile, a socio-economic and agricultural baseline study was carried out including a random sample of 240 households across the six communities, i.e. 40 households in each community. Activities also included elicitation of local soil and crop taxonomies, climate information and wealth ranking. In addition, following Bentley's ideas about the interaction between local and scientific knowledge (Bentley 1993), and in order to assist farmers in maintaining the characteristics they value in local landraces, a series of training sessions were offered on aspects regarding maize reproduction and the selection and management of maize seed.

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[3] The research project referred to here was funded by the Canadian International Development Research Centre (IDRC), and implemented jointly by the International Maize and Wheat Improvement Center (CIMMYT) and the Mexican National Institute of Forestry, Agriculture and Livestock Research (INIFAP).

Furthermore, a simple experimental design and seed of three of the 17 materials were provided to a subset of highly motivated, but skeptical farmers, in order for them to plant and compare these materials with their own maize landrace(s) under their own production conditions and management. Finally, as part of the training on maize seed and grain storage, different technologies were introduced, including a simple metal silo, unknown in five of the six communities. A small program to test the silos was developed, in which a number of farmers agreed to test the silo, and were given the opportunity to purchase the silo at the end of the testing period if they wished to do so, or, alternatively return it to the project without incurring any costs. Except for one, all the silo-tester farmers chose to keep the silo after the experiment, despite the cost of the investment. Interest grew among farmers and in view of this the project facilitated the acquisition of silos for more farmers. Later, farmers have in some cases organized silo acquisition on their own account.

Results

The results of this project have been thoroughly described elsewhere (Aguirre et al. 2002; Bellon 2001, 2004a and 2004b; Bellon et al. 2003; Smale et al. 2003), hence we will limit our comments here to aspects of particular relevance to the question addressed in this paper.

Through this research project farmers gained access to seed and information about a range of maize diversity present at the regional level. A considerable number of farmers welcomed this opportunity. The training on maize reproduction, seed selection and management motivated some of them to try new management and storage techniques. Male and female farmers were trained in seed selection and storage practices, conducted experiments and gained access to new storage technology. Farmers who evaluated a selection of the 17 materials in comparison with their own landrace(s) verified that the "experimental" maize types worked well under their circumstances, and some were even considered to be better than some of these farmers' own maize landraces.

Five types of participation were defined in a gradient of involvement:

- Participation in field days (low involvement);
- Purchase of seed of "elite" landraces (medium involvement);
- Participation in training (medium involvement);
- Purchase of seed of "elite" landraces and participation in training (high involvement); and
- Participation in joint experiments (high involvement).

Over the three years (1999-2001) that the project facilitated access to seed of the 17 materials in the subset considered to represent the spectrum of regional maize diversity, a total of 2,726 kg of maize seed were sold in a total of 371 transactions[4]. On average the amount of seed/transaction

[4] A farmer could purchase seed of different maize landrace materials.

was small, approximately 4.3 kg[5]; a fact which suggests that a lot of the maize seed farmers purchased on these occasions were for experimental purposes.

Across the six communities a total of 509 farmers attended the first three training sessions on maize reproduction and plant and seed selection in the field, while 409 farmers participated in the last two training sessions on post harvest seed selection and storage (Smale et al., 2003).In general though, even though most farmers said they benefited from the training, few participants applied any of the practices that were introduced in the training sessions. This was particularly the case with regards to the training on seed selection, while slightly more farmers showed interest in experimenting with some of the practices introduced in the training on seed storage.

Effect of research on local farmers practices

In order to monitor the effects of the project interventions, monitoring interviews were carried out with a sample of the farmers who participated in the project. This was a yearly activity and participants were divided in five groups: Group 1 consisted of those that tried the varieties (only monitored the next year after the experiment took place); Group 2 those that purchased seed, Group 3, only participated in training; Group 4, purchased seed and participated in training; Group 5 only participated in demonstrations (could be seen as a control group).

Out of 74 participants who participated in at least one of the training sessions and who were monitored, only 11 applied at least one practice (14.9%). Only one farmer applied the practices related to improving seed selection by taking into account plant characteristics in the field, though only 11 (of the 74) participated in the training session to select plants in the field. Two to five farmers applied practices related to improved storage out of the 20 (of the 74) that participated in the storage training session. In general there was a very low application of the practices introduced during training among the monitored farmers.

Of the farmers, who participated in the monitoring, 77% said that they perceived a benefit from the training sessions; the most common benefit mentioned being simply to acquire knowledge. In general participants did not perceive any costs of attending the training. Two participants said they felt it was their duty to attend the training (Aguirre et al. 2002). It was only possible to evaluate the extent to which farmers applied the practices that were introduced during the project activities. Hence, it was not determined whether the new knowledge led these farmers to modify other behaviors.

Still, the training activities showed that in several cases participating farmers were not familiar with certain aspects of maize reproduction. While farmers knew that pollen from one plant had an impact on another one, most of them did not conceptualize this as a sexual reproduction process. However, once this knowledge was provided, some of them were keen to try new management

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[5] According to farmers, the normal seeding rate of the region is 16kg/ha.

techniques. Many of the techniques for maize improvement can only make sense if one understands maize reproduction as a sexual process, where the selection of good parents leads to the production of good offspring, and where the contribution of inferior plants to the next generation should be minimized. Once the process of maize reproduction as a sexual process was explained and understood by them, farmers said that they valued this knowledge very much, and asked why this type of knowledge had not been provided earlier. In other projects, CIMMYT has included a session explaining maize reproduction to farmer participants as a way to thank them for their participation, and farmers always have appreciated to be given this knowledge.

Effect of research on the efficiency and impact of agricultural research

While the effect of the projects interventions at the local level in terms of influencing farmers' practices relative to seed selection and management was limited, the research project described here has played a significant role in a series of other regards. The research yielded important insights and large amounts of data regarding local maize agriculture and maize growing smallholder livelihoods, in particular with respect to issues such as local seed selection and seed management practices, farmers knowledge of maize reproduction, local uses and preferences with regards to maize and maize characteristics, the importance of consumption characteristics, market aspects and much more. In this regard, the results of this research contributed significantly to the improved understanding of the mechanisms of local crop genetic resource management in a broad sense, its actors and the challenges they face. The project assisted researchers in CIMMYT to identify key traits that can be the focus of crop breeding programs.

This improved understanding of farmers' use and management of local crop genetic resources, in turn, has served to inform and guide further research both by national and international institutions, and has served as reference for development practitioners, academia and policy makers. Moreover, it has yielded important insights into different options for contributing to on-farm conservation of crop genetic resources. At the same time it has brought attention to a series of issues that are of importance from a farmer point of view in relation to maize and maize agriculture, and which may have important implications for the design and feasibility of further research or development interventions.

Finally, this project has explored ways of facilitating farmers' active engagement in these processes. In a broader perspective the research project described here is likely to contribute in various ways to improving the conservation of crop genetic resources both locally and globally. Further down the impact pathway, this may, in turn, impact on the livelihoods of farmers, in Oaxaca or elsewhere.

Discussion

Components of the Oaxaca research project sought to stimulate local innovation capacity by:

- Engaging farmers in the collection and comparison of a wide selection of regional maize diversity
- Providing opportunities for practical inspection of this diversity in the field
- Making this maize diversity and information about it readily available to farmers
- Engaging farmers in the testing and comparison of diverse maize materials under their own production conditions and management
- Organizing practical training activities for those interested in which basic concepts and techniques were introduced for improving seed selection and seed management techniques including storage, as well as other basic principles to help maintain the characteristics of local maize landraces.
- Providing access to improved grain/seed storage technology as well as technical guidance with regards to its use.

Nevertheless, while a considerable number of farmers participated in the field days and many of them purchased small amounts of seed of the diverse maize types on display, relatively few farmers had adopted any of the techniques or practices introduced in other project activities at the end of the project, with the possible exception of the metal silos for improved grain storage. As such, evidence that the research project had lead to increased innovation capacity in the study communities, appeared to be limited. Elsewhere, impacts of agricultural innovation have been reported to become more pronounced over the years following the end of project intervention (Johnson et al. 2003; Hellin and Larrea, 1998, Bunch, 1999). That a similar situation could arise in the case of the Oaxaca project should not be excluded, until examined.

On the other hand, in terms of the functional purpose of participatory research as increasing the validity, accuracy and particularly efficiency of the research process and its outputs, scientists' understanding of local maize agriculture and the importance of local landraces in this context improved substantially, as a result of this investigation. The richness of data, ranging from local maize and soil taxonomies and detailed socio-economic baseline information, to the uses of maize, local knowledge, farmer concepts and practices, priorities and challenges etc. provided a wealth of information in relation to local conservation of crop genetic resources and other related issues. The results from this research have played an important role in the further development of crop genetic resource improvement and conservation, both from a research perspective as well as from an extension and a policy perspective. This would never have been achieved without farmers' participation.

The outcome of the Oaxaca project raises critical issues for research organizations engaged in participatory research:

1. Under what circumstances is it reasonable to expect participatory research projects to have a direct impact on farmer empowerment and rural innovation capacity?

2. Should farmer empowerment and stimulation of farmer innovation capacity be primary objectives of organizations engaged in participatory research?

With regards to the impacts of research on rural innovation capacity, the Oaxaca example brings us back to the division of labor and the roles of farmers, researchers and the organizations linking the two. The benefits of using participatory approaches in agricultural research are first and foremost their ability to bring to the research process new and important perspectives. These can help to achieve

- Quicker and more widespread diffusion of technologies better suited to farmers' needs
- Better targeting of research and technology development
- Lower costs of technology development
- More efficient extension and
- More appropriate policies

The use of participatory approaches in agricultural research can also support local empowerment processes and contribute to the stimulation of local innovation capacity. However, this should not, perhaps, be the primary objective for participatory research. It is reasonable to consider the possibilities of increase in local innovation capacity and empowerment as an adequate result of the participatory research activities, only when the research process involves components which can be considered as actual development interventions; or, where the research process takes place in close coordination with actual development interventions, e.g. action research.

In most cases, however, research alone does not have the capacity to generate significant impacts in terms of increase in rural innovation capacity. Despite the use of participatory research methodologies, most participatory research initiatives do not have the sufficient presence on the ground, and do not involve sufficient interaction with farmers, to actually generate and support direct empowerment by themselves to any significant degree. In addition, the impacts of most participatory research on farmers' innovation capacity and livelihoods are seldom sufficient, in themselves, to justify the total expenditure of the research process.

The most effective way for participatory research processes to contribute to increased rural innovation capacity is by close coordination and collaboration with other organizations which are better placed to link farmers and researchers by virtue of their relatively longer-term contact with farmers. These organizations include extension services, farmer organizations and NGOs. Conceptually it is better to think less in terms of participatory research leading directly to farmer empowerment and innovation, and more in terms of participatory research leading to the empowerment of partner organizations.

This emphasis on functional as opposed to empowering purposes is shared by other research organizations. For example, a review of participatory rice improvement research and gender analysis in West Africa concluded that "*the participatory research approach implemented by WARDA's national partners has been very functional, that is, trying to understand better what* *farmers want or need, and to feed back insights to formal research for improving future on-farm productivity …….In the next phase, WARDA and its partners may consider options for incorporating and implementing a more "empowering" type of participatory research, which builds local capacity, and leads also to enhanced skills and knowledge of farmers and communities*"(Lilja and Erenstein, 2002). Interestingly the authors stress that the empowering type of participatory research be carried out by the research organization and its partners.

Rather than being a direct causal agent of actual empowerment and innovation at the farmer level, the role of participatory research may be principally to produce information, test methods and approaches, which in turn, feed into the generation of empowerment tools and initiatives. Meanwhile, others e.g. government or NGOs, have comparative advantages in relation to the role as direct causal agent of empowerment processes.

Conclusion

Over the last 15 years interest in participatory crop research and improvement has grown in recognition of its potential contribution to research efficiency and impacts. This is particularly the case with regards to research and technology development for marginal areas with low agricultural potential. There is a need to identify crops and varieties that are suited to a multitude of environments and farmer preferences.

Participatory crop research and improvement can undoubtedly contribute to improved understanding of farmers' crop genetic resources management, and lead to better targeting of research and policy as well as practical recommendations for development interventions. At the same time it is likely also to contribute to local capacity building and, in the case of the individuals who take part in the process, to the stimulation of human and social capital. However, unless the research process involves strong components of applied development interventions, or takes place in close coordination with practical development interventions (e.g. action research) the potential for impacts in terms of empowerment should be expected to be limited.

Furthermore, the main objective may unashamedly not be this type of empowerment: the majority of participatory agricultural research projects, including the CIMMYT-INIFAP project in Oaxaca discussed in this paper, focus primarily on understanding the challenges farmers face as well as their practices and priorities, and secondly on strengthening the capabilities of and empowering participants.

The principal purpose behind the use of participatory approaches in agricultural research has implications for the assessment of research impacts. When the objectives of participatory research is primarily functional, impact assessment should look primarily at the impacts of the participatory research on other research for development outcomes in a broader sense. This would include impacts in terms of policy development; extension efficiency and partner organizations' capacity. If empowerment, however, is an explicit objective of the participatory research process, impact assessment should direct attention to the impacts of the participatory research process on the skills, organizing capabilities, initiatives and livelihoods of the participating individuals and communities.

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