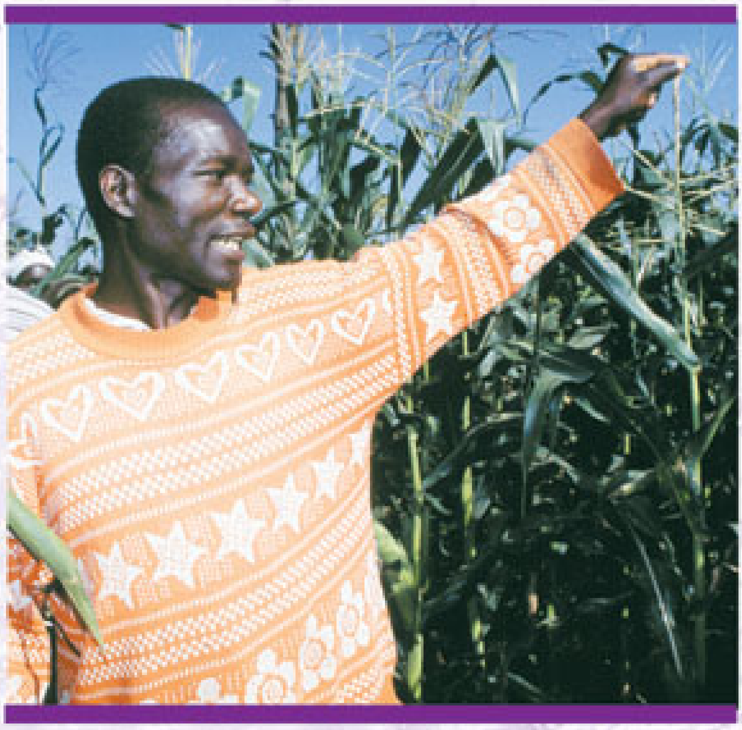
Analysis of Participatory Research Projects in the International Maize and Wheat Improvement Center



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CIMMYT® (www.cimmyt.org) is an international, not-for-profit organization that conducts research and training related to maize and wheat throughout the developing world. Drawing on strong science and effective partnerships, CIMMYT works to create, share, and use knowledge and technology to increase food security, improve the productivity and profitability of farming systems, and sustain natural resources. CIMMYT is one of 15 Future Harvest Centers of the Consultative Group on International Agricultural Research (CGIAR) (www.cgiar.org). Financial support for CIMMYT's work comes from the members of the CGIAR, national governments, foundations, development banks, and other public and private agencies.

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Abstract: Through a survey of scientists from the International Maize and Wheat Improvement Center (CIMMYT) in 2004, this study assessed the extent to which participatory methods had been used by the center, how they were perceived by the scientists, and how participatory research could be applied more effectively by CIMMYT and partners. Results for 19 CIMMYT projects suggest among other things that participatory approaches at the center were largely "functional"—that is, aimed at improving the efficiency and relevance of research—and had in fact added value to the research efforts. The authors suggest that CIMMYT should (1) create a more conducive environment for scientists to share experiences on such approaches and (2) better document their impacts on farmers' livelihoods and well-being.

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1. Executive Summary

This study systematically assessed the extent to which participatory methods had been used by CIMMYT and how they were perceived by the scientists who relied on them, both in terms of benefits and limitations. As part of the above, the study identified what was considered participatory research, how it was implemented across the projects, and what lessons had been learned by the scientists involved. Based on a review of the literature, the authors formulated five broad research questions:

1. What are the main characteristics of the projects using participatory research approaches?
2. What types of participatory research approaches did the projects use?
3. What were the researchers' opinions about the usefulness of participatory research methods and what were their skills in participatory methods?
4. Did the institutional and external environments support or constrain participatory research at CIMMYT?
5. What were the benefits and costs of participatory research?

Through a survey applied in 2004, CIMMYT scientists reported on projects they considered as having a participatory component. The range of the study was broad: there was great variation in the types and characteristics of participatory research for which researchers provided information. The survey allowed characterization of the projects but not further critical analysis of the quality or the appropriateness of the methods applied nor an objective assessment of impacts.

Information was received for 19 projects from 18 scientists (15 male, 3 female; 5 social scientists, 13 biophysical scientists). Sixteen of the projects involved farmer-participatory research; three targeted national-program scientists and seed agronomists. Most of the projects covered work in sub-Saharan Africa and Asia; only two had activities in Latin America. About a third of the projects involved participatory testing of crop varieties or production practices; the remainder involved focus group activities or stakeholder meetings.

The issues most frequently addressed via participatory methods related to increasing productivity and understanding farmers' needs and constraints. Participatory research at CIMMYT was largely of the *functional* type—that is, aimed at improving the efficiency and relevance of the research, rather than specifically to empower farmers. There was an overall lack of awareness of multiple beneficiaries or of differential effects owing to gender. None of the respondents had been trained previously in participatory methods.

The combined annual budgets of the 19 projects was in excess of US$9 million. Though not all of that money was spent on participatory activities, the figure denotes a significant investment. Nearly all respondents felt that the use of participatory approaches had been worthwhile and most believed participatory methods had added value to the research. In support of this, many respondents provided evidence of project achievements through use

of participatory approaches. As mentioned, their responses did not link those outcomes directly to impacts on farmers' livelihoods or well-being. The study also suggests that the dominant information flow in the projects was still top-down or researcher directed.

Two major recommendations of this report for adding value to CIMMYT's participatory research efforts are to (1) create a more conducive environment within the center for scientists to share experiences and learn from each other, and (2) better document outcomes and impacts of the center's participatory research.

2. Introduction

Participatory methodologies have become important in public agricultural research in recent years. These approaches aim to overcome the barriers that separate researchers from the economically and socially disadvantaged community members they serve, engaging all in the collaborative identification and study of local problems, with the ultimate goal of taking action to improve local conditions (Gaventa 1988; Chambers 1997).

There are two major sets of goals associated with participatory research. One is *functional*: to improve the efficiency of research by involving intended beneficiaries in different stages of the process, thereby generating more relevant and appropriate research products, such as crop varieties or management practices. This in turn should accelerate and increase adoption. The other type of goal is *empowering* intended beneficiaries: supporting the formation of groups capable of assessing their own needs and addressing them either directly or through demands on research organizations.

The International Maize and Wheat Improvement Center (CIMMYT) develops improved maize and wheat germplasm and cropping systems for the developing world, with an increasing emphasis on addressing the needs of the poor. CIMMYT has applied participatory methods increasingly in its research. This paper describes the first-ever analysis of the center's uses of participatory approaches, from the perspective of its scientists.

The study systematically assessed the extent to which participatory methods had been used and how they were perceived by the scientists who relied on them, both in terms of benefits and limitations. As part of the above, the study identified: (1) what was considered participatory research; (2) how it was implemented across the projects at CIMMYT; and (3) what lessons had been learned by the scientists involved. Based on a review of the literature, the authors formulated five broad research questions:[1]

1. What are the main characteristics of the projects using participatory research approaches?
2. What types of participatory research approach did the projects use?
3. What were the researchers' opinions about the usefulness of participatory research methods and what were their skills in participatory methods?
4. Did the institutional and external environments support or constrain participatory research at CIMMYT?
5. What were the benefits and costs of participatory research?

Through a survey, CIMMYT scientists reported on projects they considered as having a participatory component; thus, the projects in the study were self-selected. The range of the study was broad: there was great variation in the types and characteristics of participatory research for which researchers provided information. The survey allowed characterization of the projects but not

[1] These results are based on a survey of the project scientists. We were not able analyze local people's willingness or ability to participate, hypothesized to affect the type of participatory research conducted. Similarly, we do not have information on local opinions about the other research questions; that is, the local knowledge represented, external factors, or costs and benefits of the project.

further critical analysis of the quality or the appropriateness of the methods applied nor an objective assessment of impacts. Linking the use of participatory research to specific impacts on farmers' livelihoods is complex and requires intermediate steps. A fundamental step is to understand and document how participatory research is perceived and used by scientists within an organization. This was the scope of the present study, which is intended mainly for institutional review and learning purposes.

This report is organized as follows. Section 2 provides a brief literature review on participatory research, which led to the five research questions. Section 3 describes the study methodology. Section 4 presents the survey results, and Section 5 discusses the results. For the purposes of this paper, the term "participatory research" refers to participatory approaches and methods used in the context of agricultural research and development in developing countries.

3. Review of Relevant Literature

This section reviews the literature on key elements that should be addressed in an overview of the status of participatory research in a given institution. The readings cited were used to develop the survey questions. This is not a complete review of the rationale for participatory research or its impacts.

Objective of participatory research

Agricultural research and development typically seeks to package intervention methods and programs in one-size-fits-all, off-the-shelf approaches, based on a notion of universal best practices. Participatory methods address the drawbacks inherent in that approach by actively involving end-users in the research process, incorporating their views and representation into priority setting, reviews, research activities, product dissemination, and how results should be used to benefit the community. Among other things, this fosters trust, increases productive participation, helps keep the focus on issues of greatest importance to the communities, and aids in translating research results into useful practice.

Participatory research lets people in a study population help determine what is studied and teaches them the basics of research so they can collaborate. Furthermore, many if not most rural people in developing countries operate under imperfect markets, where prices do not completely reflect the value they attach to activities, products, or consumer goods. In such settings, simple profitability analyses may be a poor guide to decision-making about activities, technologies, or products to improve livelihoods. Participatory research can provide a more accurate assessment of what people value—one not adequately reflected in market prices. If fed back into the design and development of new technologies, this information should help make the technologies more relevant and, thus, more beneficial.

Much of the literature on participatory research falls into two broad categories: (1) papers that describe types of participatory research (Biggs 1989; Biggs and Farrington 1991; Pretty 1994); and (2) studies that describe participatory tools and how to use them (Farrington 1988; Chambers et al. 1989; Okali et al. 1994; Pretty 1994; Chambers 1997; Campbell 2001). There are no specific standards to guide research managers on what constitutes "good" participatory research, nor guidelines for deciding when participatory approaches will result in greater benefits to farmers or other intended beneficiaries than conventional research.

When should participatory research be used?

Studies claim that participatory methods are crucial in programs that require holistic approaches (rather than changing one technology at a time) and where environmental and socio-economic conditions vary widely among farmers and sites (Roling and Wagemakers 1998). But few published studies provide definite decision-rules, based on empirical evidence, about when participatory approaches are more beneficial than traditional, centralized approaches. Some studies show that traditional, scientist-designed and -directed research programs are very effective at developing varieties and technologies that can be used in homogeneous farming systems, but often less effective when the reality of the farmer is more complex and risk-prone (Byerlee and Heisey 1996; Ohemke and Crawford 1996; Maredia et al. 1998; Evenson and Gollin 2002; Dalton and Guei 2003).

In reality, participatory research is often tried or used when conventional approaches for developing improved crop varieties or natural-resource management practices fail, often with resource-poor farmers. There are various reasons for the low uptake of agricultural technologies produced and promoted through conventional systems. Nowak (1992) defines two types of barrier to adoption:

1. **The inability to adopt.** This may stem from a lack of information about the technology. The cost of obtaining the information may be too high, the technology too complex or itself too expensive or involving excessive labor requirements. The expected benefits may come too far in the future. Farmers may have limited access to the supporting resources required, may lack the managerial skills needed, or may simply have no control over the decision of whether or not to adopt.
2. **The unwillingness to adopt.** This can be due to the fact that conflicting or inconsistent information is provided about the new technology. Information about the technology may also be difficult to apply or irrelevant. There may be a conflict between the current production goal and the new technology. The technology may be inappropriate for a farmer's physical setting, or there may be an increased risk of negative outcomes. Finally, ignorance on the part of the farmer or technology promoter and belief in traditional practices can also result in unwillingness to adopt new technology.

Several studies provide insights into the question of when to use participatory research approaches. Weltzein et al. (2000) mapped 65 participatory plant-breeding projects on a matrix of biophysical and economic factors shaping the project environment. The biophysical environment scale ranged from high to low stress, based on actual versus expected yields, coupled with an index for the incidence of crop failure. The economic environment parameter ranged from a high degree of homogenous demand versus heterogeneous demand (for instance, high-input, marketed, commercial crops versus low-input subsistence crops). The projects in the sample ended up being widely dispersed in the matrix. Many plant breeders consider participatory approaches most appropriate for high-stress, low-input (subsistence) settings, but many projects in the Weltzein et al. (2000) study fell in intermediate areas, where agro-climatic stress was less severe.

Johnson et al. (2004) looked at 59 participatory natural resource management projects, among which the most common resource was soils: nearly half the projects focused on soil-related topics. Water was the second most common resource, followed by forests and biodiversity. The priority given to different resources varied across geographical regions. Institutional innovations were the most common technology on which projects reported working, followed by agronomic practices in Africa and agro-forestry in Asia and Latin America. Half the projects addressed more than one resource or technology. The average project in the inventory was developing 2.4 types of technologies directed at 1.9 types of resources.

Both of the above studies also found great variation in research objectives, reasons for involving various stakeholders in the research process, intended users or beneficiaries, duration of the project, geographical focus of the projects, as well as other scale measures of the project. We would expect similar variation in characteristics among CIMMYT projects.

How should participatory research be applied?

Participatory research is not an alternative research method, but an approach that can be applied to any methodology—survey, experimental, qualitative. The term "participatory research" has sometimes been abused; particularly, when held as an unrealistic ideal. This may discourage researchers from identifying their projects "as engaged in participatory research."

On the other hand, participatory research does not just mean involving people more intensively as subjects of conventional research. There is a misconception that any type of dialogue or interaction with farmers counts as "participatory research," and scientists may identify themselves as engaged in participatory research when in fact they are only involved in contractual relationships with farmers. As Weltzein et al. (2000) point out, collaborating with farmers exclusively to decentralize testing and to draw on their labor and land has nothing to do "participation" per se.

Typically, a project may contain some components that are participatory and others that are not, but to the extent that a project entails an interaction between scientists and defined farmers or a group of farmers, and this interaction leads to changes in the research design, technology development, or technology diffusion pathways, one can talk of a project as "participatory."

There is a vast literature that attempts to define types of participatory research, or proposes the best participatory research and gender-analysis protocol for plant breeding or natural resource management. Examples include Martin and Sherington (1997), Weltzein et al. (2000), Agarwal (2001), Sperling et al. (2001), van der Fliert and Braun (2002), and Vernooy and McDougall (2003).

In determining which approach is best, criteria include the potential for having the largest impact and—increasingly, when we are concerned about targeting a certain type of end-user—the intended impact. Many studies on the type of participation reveal a variety of approaches and mixing of methods. As mentioned, researchers apply participatory approaches for functional reasons—to increase the validity, accuracy, or efficiency of research and its outputs—or to empower end-users, increasing their human and social capital (Ashby 1996; Johnson et al. 2004). According to Vernooy and McDougall (2003), the objectives, scale, and scope of questions addressed by the proposed research determine the feasibility of a particular participatory approach. Social or biophysical issues may be adequately addressed with low participation; some research issues may require greater participation (for example, if the participation is intended to enable the participants to solve their own problems, such as by generating new knowledge). Less frequently, researchers' capacity to conduct participatory research is examined.

The type of participatory approach used also depends on local communities' or research partners' willingness and abilities to participate, as well as the processes by which participants are selected and involved (Vernooy and McDougall 2003). Representation of community interests and local knowledge in research is complicated and affected, for example, by struggles over resources and gender issues. Haddinott (2002) cautions that participatory processes may enable more or less powerful groups to assert preferential rights over research outputs.

In identifying what is a "participatory research project," an oft-cited schema has been proposed by Biggs (1989). It allows for a range of objectives for a research project, all quite valid in the right contexts (Table 1). In this way, it encourages a characterization of research projects or programs, rather than research activities considered in isolation. The ways in which participatory and on-station activities are ordered and coordinated differ considerably among projects, which bears out the idea that it is projects or programs, not activities in isolation, that should be evaluated for their degree of participation.

Bigg's schema is well-suited as a guideline for a project's internal assessment, but it is difficult to apply in a survey of projects to determine their degree of participation. To assess externally the type of participatory research that projects use would require an in-depth analysis of each project's activities and interviews with scientists and other stakeholders. But Biggs' schema suggests three key survey questions that can be used to characterize the type of participatory research used in a project: (1) How were participants (stakeholders) selected? (2) At what stage of the research did stakeholders participate? and (3) What types of participatory tools were used?

Studies show that *functional* participatory approaches are used to improve communication among researchers and clients, thereby improving technology design, acceptability, promotion, and adoption. This is most applicable in highly-variable environments that are difficult to manage; in such settings researchers are unable to predict what will work or obtain clear market signals regarding farmer or consumer preferences (Courtois et al. 2001; Ceccarelli et al. 2003; Morris and Bellon 2004). *Empowering* participatory approaches are used to build or enhance capacities important for beneficiaries' learning; for example, being able to analyze opportunities, set priorities for innovation, seek information, experiment and draw conclusions, monitor and evaluate, and learn from mistakes. There has been little research on when an empowering approach is most appropriate.

What about the quality of science in participatory research?

Scientific rigor and the merits of participatory approaches have been debated in the literature (Gladwin et al. 2002; Hayward et al. 2004), mainly due to the conventional notion of scientific rigor as equivalent to replicable methods and processes. Several plant-breeding studies have formally tested the effectiveness of farmer versus breeder selection, as well the adoption potential of products from either approach, in terms of narrow versus broad adoptability (Ceccarelli et al. 2001, 2003; Courtois et al. 2001; Joshi et al. 2001; Joshi and Witcombe 2002). Many of these studies have been very effective in abolishing myths about participatory breeding. One widespread and rather untested assumption is that farmers are not able to examine, express judgment, and translate that judgment in a quantitative score on a large number of breeding lines. Ceccarelli et al. (2001) is an example of research that shows that farmers can indeed handle the evaluation of a large number of breeding lines, and moreover are efficient in doing so. More importantly, the study shows that farmers are as efficient in their selection as breeders.

Table 1. Researcher–farmer relationships.

Contract	Consultative	Collaborative	Collegial
Farmers' land and services are hired or borrowed, e.g. the researcher contracts with the farmer to provide specific types of land	There is a doctor–patient relationship: researchers consult farmers, diagnose their problems and try to find solutions	Researchers and farmers are partners in the research process and continually collaborate in activities	Researchers actively encourage the informal R&D system in rural areas

Source: Biggs (1989) as presented in Okali et al. (1994).

One topic ignored in most published studies about the scientific rigor of participatory research is that the quality of the approach used is influenced by researchers' capacity to conduct participatory research and their views on its effectiveness and appropriateness. The latter are shaped in turn by researchers' training and experience in participatory approaches, the usefulness of that training and experience, and researcher perceptions of the need to build local capacity (in the case of "empowering" approaches).

Are there any institutional issues associated with the use of participatory research?

Some critics say that the advocacy of participatory research has been too prescriptive and coercive, and attention should be focused on the real impact of these methods and the receptiveness of the institutional settings for which they are advocated (Hall and Nahdy 1999). Contextual factors—institutional culture and practice in the planning, budgeting, and implementation of research; in cooperation and learning; and in rewards and incentives to innovate; along with the involvement of partner institutions—certainly help determine the potential feasibility of different participatory approaches (Groverman and Gurung 2001).

To assess the integration, in terms of linkages and disciplinary inclusiveness, of participatory projects with other projects at CIMMYT, it might be useful to think about linkages among scientists in terms of "social networks." Empirical studies of social networks show that tighter networks are actually less useful to members than networks with loose connections to other individuals outside the main network. More open networks are more likely to introduce new ideas and opportunities to members. In other words, a group of scientists who do things only with each other already shares the same knowledge and opportunities. A group of individuals with individual connections to other social worlds is likely to have access to a wider range of information. It is better for individual project success to have connections to a variety of networks, rather than many connections within a single network.

What are the benefits and costs of participatory research?

Several studies have documented outputs of participatory research. Most use traditional indicators: number of varietal trials, number of crosses, improvements in management techniques, number of varieties released and potential yield gains, types of varieties preferred by different types of farmers (see Heong and Escalada 1998; Snapp et al. 2002; Bellon et al. 2003; Phiri et al. 2004). These are important measures of intermediate achievement, but do not prove the presence of impacts on farm income, consumer welfare, or agricultural growth. Some empirical studies have captured the impact of participatory research on farm productivity and consumer welfare, and show technology adoption and rates of return calculations (Franzel et al. 2003; Johnson et al. 2003; Smale et al. 2003). These provide measures of the profitability of an investment in participatory activities, compared to conventional research approaches.

The increasing use of participatory development approaches poses new challenges for decision-makers and evaluators. Because these approaches are designed to be responsive to changing community needs, one of the most pressing challenges is to develop participatory and systems-based evaluation processes to allow for ongoing learning, correction, and adjustment by all parties concerned. According to Hall et al. (2003), the greatest challenge is that such holistic learning frameworks (often less quantitative in nature) must contend for legitimacy, if they are to complement the dominant paradigm of economic assessment, which quantitatively assesses the rate of return on resources invested in research.

For an institution such as CIMMYT, the ultimate value of participatory approaches lies in their ability to enhance the impacts of center outputs and services (germplasm, crop management practices, policy information, capacity building, to name several) on intended beneficiaries. So it is important to place participatory research in a model to deliver impacts. It is also important to realize that, between research outputs and impacts, there is an important intermediate stage called "project outcomes." As defined for CGIAR centers by the World Bank, "outcomes" are the changes resulting from uses of center outputs by stakeholders and clients (for example, changes in knowledge, attitudes, policies, research capacities and agricultural practices), whereas "impacts" are the longer-range social, environmental, and economic benefits consistent with a center's mission and objectives (for example, increased agricultural productivity, improved food distribution). Ekboir (2003) has argued that what counts most in research evaluation is to evaluate the new rules and patterns of participation in research networks. Ideally (and as suggested in the previous paragraph), participatory research should result in mutual learning: feedback from end-users on both products and methods should influence the whole technology development process. These complex interactions are frequently ignored in conventional impact-assessment studies, which focus on the impact of the technology itself on end-users' livelihoods. Knowledge of such interactions is important for those, like research managers, who seek to understand the full impact of participatory research.

The conventional technology development model can be described as a linear, unidirectional progression from research to outputs to outcomes and finally to impacts. A participatory model incorporates the important component of a feedback loop connecting the research process and outputs with intended beneficiaries, so that the process is adjusted to produce more relevant and appropriate outputs. The research outputs produced with participation could generate outcomes and impacts that are either similar to or different from those of the conventional model. Clearly, if the impacts were the same, there would be little point in engaging in participation at all, unless the methodology cost less than the conventional methodology. If the outcomes are different, they could lead to "better" or "worse" impacts (Berardi 2002). Even if better impacts are produced, one then has to ask whether there were additional costs or savings associated with participation, and whether the benefits were worth these extra costs or savings.

4. Methodology

Externally defined criteria were not used for selecting participatory projects among all CIMMYT projects. In September 2004 an open call was issued for all CIMMYT staff to provide information about participatory research projects, both current and completed.

A structured survey (Table 2) was used to elicit information about the five research questions regarding project background, type of participatory approach used, its impacts, and respondents' personal views about participatory research in general. The survey form was based on the relevant literature described in Section 3.[2]

Information was received about 19 projects that, based on self-selection, were described as having a participatory research component; 18 scientists provided this information.[3] Fifteen respondents were male, and three were female. Five respondents were social scientists and 13 were biophysical scientists. Figure 1 shows the geographical locations of the projects.

Table 2. Summary of the survey questions.

Research question	Indicators used
1. What are the main characteristics of the projects using participatory research approaches?	a. What was the research problem targeted? (Objective) b. What were the reasons for including stakeholder participation? (Motivation) c. Whom did the project target? (Beneficiaries) d. Length (duration) of the project. e. Geographical focus. f. Scale of the project (number of sites, farmers, scientists). g. Budget.
2. What type of the participatory research approach did projects use?	a. How were the participating farmers selected? (Process of selection.) b. At what stage(s) of the research did participation take place? c. How was stakeholder participation made operational/implemented?
3. What are researchers' opinions about the usefulness of participatory research methods and what are their skills in participatory methods?	a. For what types of questions or issues is participatory research approach best suited? b. How much training have you received on participatory tools and methods (or how did you gain your knowledge about participatory methods)? c. How long did it take you to feel comfortable using the methods? d. How long did it take you to feel comfortable extending the methods to others? e. At the start of the project, was it determined that farmers needed to learn new information?
4. Do the institutional and external environments support or constrain participatory research?	a. Does the project have links with other CIMMYT projects? Are the participatory components interdisciplinary? b. How is the participatory research aspect of the project considered by colleagues at CIMMYT? c. How often do colleagues at CIMMYT ask for advice on participatory research from you or your project staff? d. Do CIMMYT and its partner institutions have enough human capacity to carry out the participatory research activities of the project?
5. What are the benefits and costs of participatory research?	a. In your opinion and in the context of your project, was participatory research worthwhile? b. What can you say about the cost of research? c. Did it add value to scientists' work? d. Has being part of the project increased participants' knowledge and skills? e. What difference did the project make?

[2] The survey form with detailed questions is available from the authors.
[3] In all projects except one, only one person filled out the survey. In that one project, two people filled out the survey form jointly. Also, one person provided information about three projects.

Sixteen of the projects involved farmer-participatory research; three projects, although they did not have direct *farmer*-participatory components in them, were also included in this study because they involved participatory research with other levels of stakeholders (that is, national-program scientists and seed agronomists). Table 3 provides full titles of the projects covered in this study and information about the research question each project addressed.

It is assumed that the persons responding were knowledgeable about the projects, and were either actual or *de facto* leaders of the project. It is also reasonable to assume that, because only currently employed CIMMYT staff were contacted in this survey, some completed participatory projects were omitted (if the project leaders or participating scientists were no longer employed at CIMMYT).

It is important to emphasize that this is a qualitative study, and while we will provide some quantitative information on the answers provided by the respondents as a general reference, these furnish only a rough indication of the consensus or lack of it among respondents.

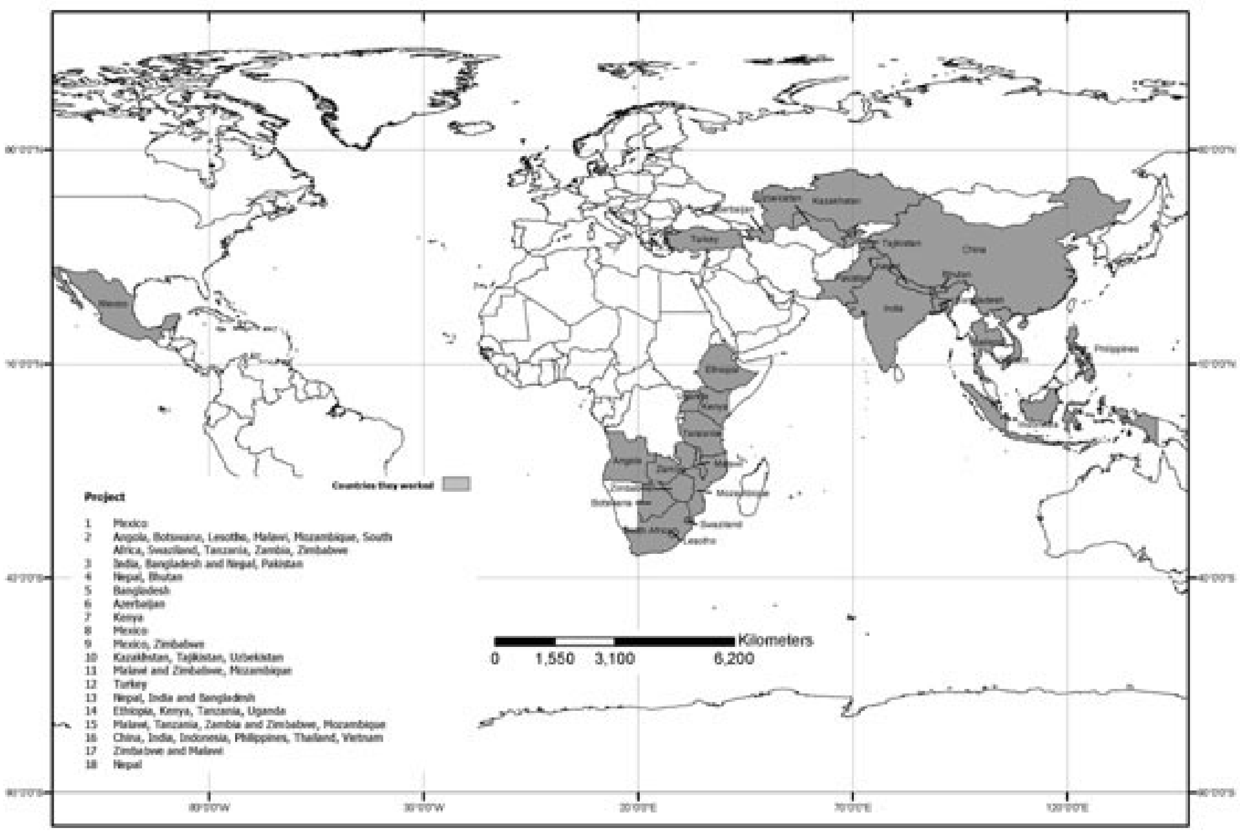

Figure 1. Countries in which surveyed projects operated.

Table 3. List of projects covered in the study, the research problem they targeted, and participatory methods used.

Project title	Research problem[4]
CG maize diversity conservation: A farmer–scientist collaborative approach [Mexico].	To assess whether collaborative crop improvement can benefit farmers today, while maintaining or enhancing genetic diversity for tomorrow.
Mother–baby trials for variety evaluation [Southern Africa].	Assess farmers' perception and acceptance of new maize varieties.
Participatory research to increase the productivity and sustainability of wheat farming systems in the eastern subcontinent of South Asia.	Identifying (through farmer participation) suitable technologies (improved wheat germplasm and resource-conservation techniques). Varietal and crop diversification. Promotion of those technologies to farmers' fields. Research on genotype x tillage interaction. Constraints to technology adoption.
Mother and baby trials: diamond trials (a 2 x 2 factorial experiment) [Nepal].	Adoption of new maize varieties. Technology adoption (farmers' practice v. improved practice).
Food security in Bangladesh: Improving wheat, maize and papaya production, and impacts of arsenic contamination.	Food security in a very broad sense.
Winter-cereal variety promotion, seed production and improved crop management practices for the irrigated areas with increased soil salinity in west Azerbaijan.	Using improved varieties and crop management practices to increase competitiveness of agricultural production in the areas with increased soil salinity content.
Insect-resistant maize for Africa (IRMA)— characterizing the cropping environment to establish the natural refugia that exist for insect-resistance management [Kenya].	Characterizing the cropping environment to establish the natural refugia that exist for insect-resistance management.
Targeted allele introgression [Mexico].	How to reach small-scale farmers in Mexico who have not adopted improved maize varieties.
Quantifying post-harvest losses in Mexico.	We surveyed farmers and placed maize samples in traditional maize stores to quantify storage losses over time in Mexico. This was done from small-scale farmers up to Cargill and Maseca commercial maize stores.
Regional network for wheat variety promotion and seed production [Kazakhstan, Tajikistan, Uzbekistan].	Low yields due to old varieties and unavailability of seed.
Soil-fertility management and policy network for maize-based farming systems in Southern Africa (Soil Fert Net).	Low and declining soil fertility in smallholder farming systems in Southern Africa, leading to inefficient use of agricultural inputs and food insecurity. Inadequate knowledge about technology solutions to soil infertility.
Improved livelihoods of isolated rural communities through variety demonstration and adoption of conservation tillage technologies in the southeast of Turkey.	In this region of Turkey, many newly developed varieties are not being utilized by many of the farmers due to isolation of farming communities and inadequate mechanisms for this information to reach farmers. Furthermore, most of the area is currently using conventional planting technologies; however, significant advancement in sustainability and profitability could be achieved through the adoption of bed planting technologies. Again, however, farmers are not aware of the benefits and use of this technology.
Multi-stakeholder program to accelerate technology adoption to improve rural livelihoods on the rainfed Gangetic plains.	Selection of prototype technologies for site-specific community-based verification and adoption that would be instrumental in reducing rural poverty by improving farmers' livelihoods through sustainable gains in the productivity and diversity of rainfed environments in the Indo-Gangetic plains.
Quality protein maize (QPM) development for the Horn and East Africa.	Malnutrition, especially among children from weaning age to 5 years due to diets based heavily on maize with few protein sources. Hence, the purpose is to develop adapted QPM varieties and to promote their adoption in target areas.
Facilitating the widespread adoption of conservation agriculture in maize-based systems in Eastern and Southern Africa.	Soil degradation, declining yields and poor water-use efficiency, all leading to declining farm income.
Developing new maize germplasm through biotechnology for resource-poor farmers in Asia.	Development of maize germplasm that is high yielding, locally adapted (resistant/tolerant to local stresses) and with high nutritional value.
Development and scaling out of targeted recommendations for small-holder maize systems in Southern Africa through integrating farmer-participatory research and simulation modeling.	Project addresses the problems of low soil fertility, climatic variability, and low and unstable agro-ecosystem productivity in drought-prone rainfed areas of Southern Africa.
Africa maize stress project.	How to develop new maize varieties, tolerant to biotic and abiotic stresses.
Accelerating adoption of zero tillage in rice–wheat systems in the Indo-Gangetic plains.	Declining and stagnant yields in rice–wheat systems of the Indo-Gangetic plains; lack of appropriate and efficient power- and resource-conserving machinery for smallholders.

[4] The research problem is presented as stated by each project.

5. Survey Results

The data were collected through a questionnaire that allowed for descriptive and, in some cases, quantitative responses. In the analysis that follows, the descriptive responses are categorized or grouped to provide summary answers across the 19 projects; the results are subject to the authors' interpretations of the answers given by the project scientists.

What are the main characteristics of the projects using participatory research approaches?

What was the research problem that the project targeted? In thinking about the diverse portfolio of participatory projects at CIMMYT, we first tried to conceptualize the overall subset of CIMMYT projects they represent by grouping the projects according to the primary research problem they addressed. Project goals inevitably shape the research design (including the nature of participatory research) and the outcomes.

The most frequently addressed issues were related to increasing productivity (8 projects out of 19), both through improved wheat and maize germplasm (including improved local adaptability, stress resistance, micronutrient content, and enhanced biodiversity), and through better crop management (including storage and seed selection, as well as resource-conservation practices). The second most frequently addressed research problem (7 projects) involved the need to better understand farmers' preferences and constraints, and incorporate farmer knowledge and preferences into the development of appropriate varieties and management practices, thereby improving overall research efficiency.

Improved adoption through improved dissemination and extension of varieties and management practices was the primary research problem targeted by the remaining projects (4).

What were the reasons for including stakeholder participation in the project? More than two-thirds of the projects surveyed (13 out of 18) said that their primary reason for involving stakeholder participation was to increase the relevance of research and to bring about more demand-driven and client-oriented research and extension by better understanding farmer preferences and constraints, as well as to use farmer knowledge in technology evaluation and development. The remaining respondents (5) said that their main motivation for including participatory approaches was to involve stakeholders in technology dissemination and to improve awareness and hence the "reach" of technology.

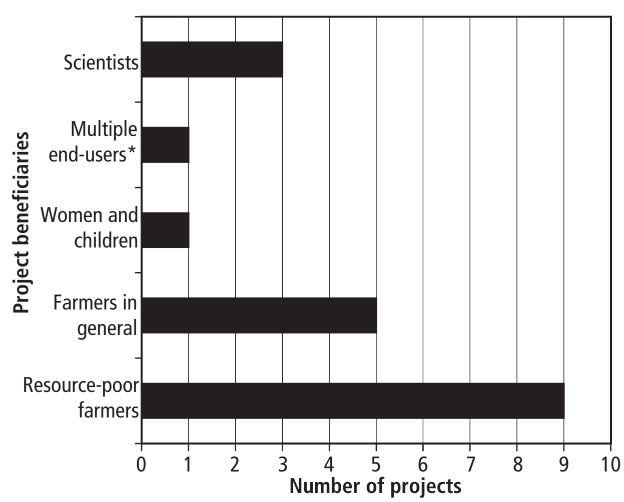

Figure 2. Targeted end-users.
(* Project targeted small-scale farmers, scientists and policy-makers.)

Whom did the project target? A clear and specific understanding of project beneficiaries should make the selection of project participants easier and more appropriate, thus increasing the likelihood of successful project design and implementation, as well as successful monitoring of the outcomes and assessment of project impacts. Of the 19 projects surveyed, 15 were targeted to farmers (Figure 2). Whereas all the other projects were designed to implement participatory research approaches, the "multiple end-user" project was specifically designed to test the participatory research methodology itself.

Length of the project. Of the 19 projects surveyed, 6 were either completed prior to 2004 or ended that year; the remainder were still ongoing. For 15 projects, we have information about their actual or anticipated end date,[5] and can calculate that average project length was 4.3 years, with a minimum project length of 1 year and maximum of 10 years; the most frequent project length was 5 years.

Geographical focus. Most projects were situated in Asia (9) or Africa (8). Target areas for two were in Latin America, and one project worked in both Latin America and Africa. The scope for 9 of the projects was a single country; 10 covered multiple countries.

Scale of the project. Researchers in 15 projects provided information about the number of sites in which they worked, ranging from a minimum of 2 to a maximum of 125 sites per project. The median number of project sites was six.

We obtained information about the numbers of farmers involved for 11 projects. The smallest number of farmers involved in a project was 16, the largest 10,000. The median number of farmers per project was 400.

We obtained information about the numbers of scientists involved for 11 projects. The minimum was one scientist, the maximum 200. The median number of scientists per project was 8.

Budgets of the projects. All 19 projects provided annual budget information.[6] The combined annual budgets of the 19 participatory projects was US $9,323,169. The minimum average annual budget of a project was US $3,000, the maximum US $2.62 million. The median annual project budget was US $225,695. Nearly half the projects (9) had an annual budget of less than US $200,000; over a third of the projects (7) had an annual budget exceeding US $350,000.

What type of participatory research approach did projects use?

How were the participating farmers selected? Most projects (10 out of 15) selected participating farmers on the basis of some purposive criteria. Three said farmers were self-selected; in the remaining two projects, selection of farmer participants was random.

It is not possible to assess the effectiveness of farmer selection in each project, but it is useful to note that purposive selection is often called for in participatory research. If collaboration needs expertise, persons who have those specific

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5 Four projects were specified as "ongoing" and no information about the end date was available.

6 The budget information should be considered with some reservations. The survey question asked: "What was the approximate annual budget of the project?" Some respondents may have reported only the cost of specific participatory activities, some may have reported the special project grant or funding which may or may not include all the costs of core scientists' time.

qualities must be sought to participate. Many of the projects surveyed gave examples of farmer selection being based on agro-ecological factors and access to a range of environments; thus, farmers with the matching resource profiles were needed. Gender-based selection criteria address both equity and gender-based varietal and technology preference issues. In only two projects did researchers say farmer selection was based on gender.

At what stage(s) of the research did stakeholder participation take place? Technology innovation can be defined as a process in which the problems are identified; solutions are found, tested, and modified if needed; and, as a result, the target group adopts a technology or other type of innovation. For the purpose of categorizing the survey answers, the innovation process can be roughly divided into three stages: design, testing, and diffusion. In the design stage, problems or opportunities for research are identified and prioritized, and potential solutions to priority problems are determined. The testing stage is when potential solutions chosen for testing are evaluated, and decisions are made about who does the testing, and where and how it is done. Diffusion involves building the awareness of recommended solutions among future users; it involves decisions about when, to whom, and in what way to build awareness, supply new inputs, and teach new skills to future users (Lilja and Ashby 1999).

Most respondents (10 out of 19) said stakeholder participation took place during all stages of research. One-quarter of respondents (5) said they used stakeholder participation in the testing stage, and the remainder (4 projects) said they involved stakeholders during the research-design stage only. Complete answers to this question are presented in Box 1.

Box 1. At what stages(s) of the research did stakeholder participation take place?

In all stages of research.

- In all stages, from the collection of germplasm to the monitoring and evaluation of the project.
- Before, during, and after maize harvest.
- Planning, execution of trials, feedback workshop.
- I would hope to say at the beginning and all along the way, using both formal and informal means.
- From the beginning.
- From the beginning.
- Continuous process.
- The NARS did all the local research in their institutes.
- Planning the action-plan, implementation (selection for training, informal monitoring and evaluation).
- At project initiation and conclusion (embassy, national program and CIMMYT) and at many times during the project with farmer field days and information sessions (national program, farmers and CIMMYT).

At research design and planning stage.

- Planning stage.
- Initially research plans for on-farm research have been devised from "gaps" identified by multiple stakeholders—this for the first year. In following years, on-farm (and possibly on-station) research will largely be defined by the questions raised by farmers in the target communities (2 projects).
- Development of the project document during results-based management workshop.
- During first year.

At the technology testing and evaluation stage.

- Technology demonstration.
- After conducting controlled trials to establish which are most important alternative hosts of stem borers, we then conducted a pilot survey to test the methodology. We realized that we needed to ask farmers about both growing seasons to get a complete picture for insect-resistant maize. Over time, the survey became more focused in order to reduce the interview time and to allow for time to explain to the farmer what we are doing.
- Variety selection.
- Very little farmer involvement took place in the first few years of soil-fertility research, partly because it was widely accepted that information generated during earlier farming systems/on-farm research surveys and research had guided the initial focus on finding solutions to soil-fertility problems identified on the farms. Later, as prototype "best bets" were identified, there was a clear need for farmer assessment and feedback on performance.
- At the last stage of on-station selection (52 varieties in the first year), and each year thereafter till release (5 projects).

How was stakeholder participation made operational/implemented? Four projects (out of 19) engaged stakeholders in multiple participatory activities (Figure 3). Six projects engaged stakeholders in participatory varietal or technology evaluation. For three projects, the primary participatory research activity was diagnostics and focus-group interviews, and six projects mainly implemented participatory research through stakeholder meetings. Box 2 gives the full list of answers to this question.

What are researchers' opinions on the usefulness of participatory research methods and what are their skills in participatory methods?

For what types of questions or issues is participatory research approach best suited? To capture a broader and more general perception about the usefulness of participatory methods, we asked the respondents to comment on what type of issues participatory approaches are useful for in general, not in the context of their specific projects. Rather surprisingly, none of the scientists said they would be best suited for all aspects of the research continuum. A distinction of two categories of responses was clear: most scientists (11 out of 17) considered participatory methods most appropriate for technology and varietal evaluation, testing, and dissemination, while one-third of the scientists (6) considered participatory methods most appropriate for involving stakeholders in priority-setting.

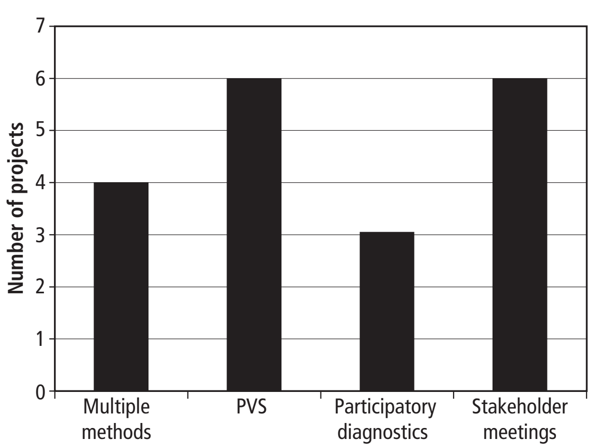

Figure 3. Stakeholder activities.

How much training have you received on participatory tools and methods (or how did you gain your knowledge about participatory methods)? Most respondents (14 out of 20) had not received any training in participatory research, but defined themselves as "self-taught." Six of the respondents had received some training in participatory research methods, of whom four said that the training was useful; two did not answer the question on the usefulness of the training.

How long did it take you to feel comfortable using the methods? Fifteen scientists responded to the question. Most (10 out of 15) said a year; the rest (5) said it took them two or more years. Two said they were still learning.

How long did it take you to feel comfortable extending the methods to others? Thirteen scientists answered the question. Nine said it took them two years or less to start extending the methods to others, and four said it took them more than two years—one of the latter was not yet ready to extend the method to others.

At the start of the project (before participant involvement), was it determined that farmers needed to learn new information? Most respondents (15 out of 19) said that at the onset of the project it was known that farmers needed to learn new information, whereas four did not start the project with that assumption. Of those scientists who said that farmers needed to learn new information, 13 said the information farmers needed to learn was about varieties and new management practices or the benefits of these technologies; one respondent said farmers needed to learn breeding skills; one did not specify what farmers needed to learn.

Box 2. How was stakeholder participation made operational/implemented? (What activities?)

Multiple participatory methods.

- Farmers were invited to participate in various activities, which included evaluation of landraces, elicitation of the traits they value, farmer experiments, field days with seed sales, training on seed selection and storage practices, evaluation and use of metal silos.
- Focus-group discussions, farmer-group demonstrations, workshops, farmer-exchange visits, etc.· Participatory rural appraisal to determine selection criteria; on-station evaluation; mother–baby trials on farm.
- All stakeholders received some operational funds (based on responsibilities and involvement). Depending on their experience and research infrastructure, stakeholders were involved in several activities: socio-economic studies, seed production, germplasm development, machinery manufacture, training, information dissemination, extension and agronomy.

Participatory varietal or technology evaluation.

- Variety evaluation in the field, filling in a questionnaire.
- Variety selection during the field days and regular visits.
- Trials and demonstrations were placed with farmer groups on host fields. Farmer feedback sessions, field days, etc., were held (run by farmer groups, extension and sometimes researchers) to elicit feedback and responses.
- So far, basically in initial workshops. Community awareness activities are now being held. Different stakeholders will put out best-bet farmer-managed demonstration plots in the communities, form farmer groups, and these will discuss the development of the demonstrations, problems, possibilities, etc.
- Farmer groups given control/charge of resource-conserving technology machinery; yearly stakeholder meetings; and *MECHNET* newsletter**.**
- Participatory varietal selection: planning, evaluation and feedback with and from the farmers.

Participatory diagnostics/focus groups.

- We have just surveyed farmers at this point and have mapped the refugia contained in the mixed cropping system that will be used to focus extension research to train farmers on the importance of IRM.
- By asking farmers what traits they considered limited maize production and profitability, and if they were willing to share seed of their local variety for the purpose of making crosses to special-trait germplasm developed by CIMMYT.
- Participants were first interviewed to characterize their maize production and storage environment. Samples were then placed into their grain store along with a temperature and relative-humidity sensor to characterize the storage environment.

Stakeholder meetings.

- Through training researchers before planting. Group formation, training, and Hill Maize Research Project (HMRP) formats are implemented.·
By letting the participants plan within given guidelines and resources.
- Working groups of stakeholders were established in participating countries; representatives participated in the project management committee and planning workshops.
- We had a project inception meeting where we discussed the overall project themes (application of biotech tools to improve maize for high yield, stress tolerance, high nutritional value) and each team prioritized these themes according to their own local needs. Each team then decided their own research objectives, activities, budget allocations.
- Through funding the project and being open to presentations about the objective of the project (meeting with CIMMYT/Embassy) and attendance at field day. A final report was also compiled.
- Stakeholder meetings during whole-family training.

Do the institutional and external environments support or constrain participatory research?

Does the project have links and collaboration with other CIMMYT projects or programs? Are the participatory components of the project interdisciplinary? CIMMYT participatory projects appear to have many ties outside their own projects: respondents for most projects (16 out of 19) said they had links to other CIMMYT projects. All but one project were interdisciplinary, and included both social and biophysical scientists.

How is the participatory research aspect of the project considered by your colleagues at CIMMYT? Good connections to pre-existing networks of scientists foster and promote peer acceptance of new approaches and allow rapid movement to scale out research. Most respondents (14 out of 18) perceived that the participatory aspect of their project was well-received and respected by CIMMYT colleagues; the remaining respondents felt that they could not assess what colleagues thought about their projects.

How often do colleagues at CIMMYT ask for advice on participatory research from you or your project staff? Given that most respondents thought their project was well received at CIMMYT, it was rather surprising that most respondents (10 out of 15) also said CIMMYT that colleagues from CIMMYT had never solicited their advice on participatory research. Three respondents said colleagues had asked for advice occasionally, and two said relatively often.

Do CIMMYT and its partner institutions have enough human capacity to carry out the participatory research activities in the project? Seven of 17 respondents thought that CIMMYT had sufficient human capacity to carry out participatory research, 10 said that human capacity was insufficient. Most respondents (12) said that partner organizations did not have sufficient human capacity and 5 thought they did. Unfortunately, the responses did not allow us to analyze whether the lack of human capacity refers to partners' participatory research skills or to the available workforce in more general terms.

What are the benefits and costs of participatory research?

In your opinion and in the context of your project, was participatory research worthwhile? Not surprisingly, as it implies self-evaluation as well, all 18 respondents said that participatory research was "worth it" in the context of their project.

What can you say about the cost of research? Respondents were asked to reflect on the cost of participatory research; most compared costs with the costs of conventional research. Eight respondents out of 17 thought that the research costs would have been about the same, or were unsure what the relationship between the two costs would have been. Seven respondents thought that research costs would increase and two thought they would decrease. Some respondents reflected more on the cost-effectiveness than on the absolute cost. Detailed answers for this question are given in Box 3.

Did it add value to scientists' work? Most respondents (14 out of 18) said participatory research added value to scientists' work. Four said the participatory component did not add value—three of these respondents did not elaborate on why, and in one case the respondent said "the results were not used in the breeding process," which we also interpreted to mean that results did not add value to scientists' work. Detailed answers to this question are presented in Box 4.

Has being part of the project increased participants' knowledge and skills? Most respondents (14 out of 16) believed that their project had increased participants' knowledge or skills; the remainder did not think their project had any impact on participants' knowledge or skills. Of those who thought their project had had impact on participants' skills, 9 thought the impact was increased awareness about available varieties and technologies; 5 thought it was enhanced skills.[7]

What difference did the project make? To collect some lessons learned, we asked the respondents to give examples of some of their participatory activities, and then asked them (1) whether the research process or project outcomes were influenced by the stakeholder participation, and (2) what would have been the process or the outcome without stakeholder participation.

Box 3. Cost of participatory research (compared with conventional research).

Increased.

- Added costs as it was a new activity, but greatly contributed to impact.
- The cost has been increased because more stakeholders are involved.
- Probably increased the cost, but the benefits from the additional costs keep the program alive and relevant to the clientele.
- More or less the same, but if done properly will increase the cost due to training and more visits.
- It undoubtedly raised the costs. Whether the increase in costs was more than offset by raised benefits, I very much believe so. However, no studies of cost-effectiveness have been done.
- Very costly.
- Without it, the earlier programs were getting nowhere in terms of getting technology adopted by farmers.
- Without it, success would have come much later if at all. Cost was obviously more than the earlier farming systems demonstration approach, but now there is widespread adoption, i.e. we think the cost was more, but it was worth it.

Decreased.

- The cost is low as we want to minimize the amount of "research" that is done on research stations and conduct the breeding work on the farm using the farmer. The model that is being developed should minimize costs and maximize capacity building of farmers so as to reach the many and diverse maize-growing environments found in Mexico. The system should also be evaluated in the Andean region.
- Costs of participatory research are lower.

Same or unknown.

- It remained the same.
- Not much change in cost.
- Cost remains the same provided you stay in cheap hotels! Participatory research really boils down to common sense and recognizing where other disciplines can make a value-added contribution in delivering a better product—in this case maize to farmers.
- It was an essential element of the project and was budgeted from the start. Cost of scientific time is an issue, but if one is involved heavily at the beginning to make sure methodologies are established, then one can reduce their level of involvement and have technical staff carry on with the research.
- In this case, it is not really the cost of the research, it is rather about taking the technology from the research to the farmers. The overall cost of conducting the project is minimal compared to developing the technology (research), but the benefit is enormous.
- Compared to a project doing everything on-station, certainly!
- There are a lot of transaction costs. But I think the value was enabling the national programs to learn by doing. In a teamwork and network mode, there is also added value, as there are outcomes that one institute alone could not accomplish.
- On-farm trials are expensive, but farmer evaluation of a mother trial is cheap.

[7] Verifying the accuracy of these perceptions would require a survey of project participants—in most cases, the farmers—to assess if farmers' skills had actually been enhanced..

We received a total of 27 specific examples of impact: 14 were about impact of variety or technology evaluation, 11 were about impact of surveys, one about training and one about monitoring and evaluation. All the details are presented in Boxes 5–8.

Box 4. Did stakeholder participation add value to scientists' work?

- Definitely. Stakeholders look at different aspects from those that scientists do.
- Scientists benefited from the available expertise from other participating stakeholders. Annual Review and Planning meetings have helped in this.
- Yes, as it enabled the key national scientist to take their knowledge and experience to farmers on farmers' fields. Furthermore, it enabled a network of farmers and scientists to be established for future benefit.
- Yes. It made far more of the work by Soil Fert Net members more relevant to the needs of farmers and so more likely to be used by them, and so raise production and livelihoods. As more members were introduced to these approaches and began to use them, their work became more reflective of farmer inputs and needs.
- Yes, scientists did not work in isolation as before, but worked as a team. Also as part of a regional network, scientists were able to exchange information/experiences and learn from each other.
- Absolutely, they [farmers] help teach the course! Their ideas are incorporated into the materials distributed the next year. Scientists learned many farmer-based concepts that they would never learn from a book.
- [Farmer] survey results are a direct input into the research by allowing us to characterize the maize cropping system in Kenya.
- Yes. We learned about participation, who participated, who benefited, the costs of participation, the value to these farmers of accessing diversity, the impact of farmers' management on genetic diversity. Most of this information has [subsequently] been published in the literature.
- It showed the angle the farmers look at varieties.
- Yes, without the farmer varieties and input from farmers on what traits they want added, the project would not exist. This process will also accelerate the delivery of resistance traits to farmers who have not been served by the formal seed sector, and will facilitate technology adoption in areas where these technologies have traditionally had no impact. We also hope to increase *in situ* biodiversity through this process.
- Yes, it allowed us to identify where maize storage issues are likely to be most important and where interventions would be most effective. It also allowed us to identify indigenous storage technologies that may be suitable for other parts of the world.
- Yes. Some modifications in technology are made based on farmers' experience and recommendations.
- Yes—better understanding of farmers' circumstances.
- Yes. Came a much better understanding of the dynamics human and social relations and how this affects/impacts the adoption of any technology, but especially expensive machinery technologies like the two-wheel tractor.

Box 5. Impact of variety or technology evaluation, including field days.

Evaluation of landraces.

PR impact (were the process or outcomes influenced by stakeholder participation?):

- Farmers evaluated landraces collected in an earlier phase of the project by voting for them during agronomic evaluations. This information was used to select the subset of landraces that was included in the subsequent activities of the project.

What would have been the process or outcome in the absence of PR?

- Fewer landraces would have been included in the project (6 vs. 16). Landraces that were interesting to farmers would have been excluded, particularly those of interest to women.

Field days with seed sales.

PR impact:

- Farmer participation was the crux of the activity. Farmers were invited to field days where they could see the landraces selected with their help and, if they liked any of them, they could buy seed, mainly for experimentation. This activity provided farmers with access to the regional diversity at a relatively low cost. The fact that they participated and spent money buying seed attests to its value to them. During this activity we identified the need for farmer experiments (*see* next activity).

In the absence of PR:

- The project would not have fulfilled its goals.

continued...

Box 5. Impact of variety or .....*cont'd*

Farmer experiments.

PR impact:

- This activity grew from farmer feedback, in which they said that they did not trust that the landraces we were offering would perform under their conditions. We set experiments with some farmers to test this hypothesis.

In the absence of PR:

- Many farmers would have believed that the landraces that we were offering were not adequate for their farming conditions.

Evaluation and use of metal silos.

PR impact:

- This activity also grew from farmer feedback, when we identified that metal silos were used in one community in our study, but not in the others. These silos addressed the need for better storage alternatives.

In the absence of PR:

- Farmers would have missed a new technological option that turned out to be very popular, and that seems to have had a large impact on their welfare, plus the impact was relatively easy to quantify.

Maize varieties and hybrids were evaluated by farmers and partners in several Southern African countries.

PR impact:

- Farmers preferred open-pollinated varieties (OPVs) over hybrids, and selected mainly the new stress-tolerant OPVs from CIMMYT.

In the absence of PR:

- No such clear identification of the strong preference of smallholder farmers for stress-tolerant OPVs.

Maize varieties and hybrids were evaluated by farmers and partners in several Southern African countries.

PR impact:

- Partner organization sourced seed of farmer-selected varieties and made it available to the wider farming community.

In the absence of PR:

- Slower adoption, less demand for seed and less seed production.

Mother–baby PVS trials were conducted by all stakeholders in their own countries.

PR impact:

- Farmers were aware of the new, high-yielding, early-maturing wheat germplasm available.

In the absence of PR:

- Farmers would have continued growing their local, low-yielding, disease-susceptible wheat varieties.

Genotype x tillage interaction experiments were conducted through close farmer collaboration.

PR impact:

- Farmers are now aware of the cost benefit of the new resource-conserving technologies.

In the absence of PR:

- Farmers would have continued using traditional, labor-intensive and costly methods of wheat cultivation.

Mother–baby participatory plant breeding trials were conducted by stakeholders through close farmer participation.

PR impact:

- New wheat populations have been identified with potential for adaptation to specific biotic and abiotic stresses in South Asia.

In the absence of PR:

- Breeders would not be able to identify those populations.

Mother and baby trial.

PR impact:

- ZM-621 and Pop. 44 c10, two white maize varieties, will be released in Nepal. Farmers had selected because of "stay-green" character, fewer foliar diseases, non lodging, and better yield compared to the local varieties.

In the absence of PR:

- Farmers would be exposed to and would have adopted the maize varieties three years later (by 2007).

continued...

Box 5. Impact of variety or .....*cont'd*

Participatory winter-cereal varietal selection trials were organized with women and men farmers in two sites in Azerbaijan.

PR impact:

- The participants selected the most disease-resistant variety. They also demonstrated preference for awnless and red grain wheat genotypes, similar to the variety that had been widespread in the region. [Farmer choice coincided with the yield data and varieties for further multiplication were selected with higher confidence.]

In the absence of PR:

- [Reply not available.]

Variety selection.

PR impact:

- The varieties to be grown by the farmers were selected by them, though the researchers may have recommended different ones.

In the absence of PR:

- The new varieties "imposed" may have not been accepted well.

Participatory rural appraisal/needs assessment.

PR impact:

- Helped to narrow down the type of technologies tested on–farm based on their potential relevance and by providing new technological options/ideas for testing.

In the absence of PR:

- More standard and stringent set of technological options tested based solely on expert assessment.

Providing [farmers] seed of local varieties for [on-farm] crossing.

PR impact:

- Without the seed from farmer varieties, this work would not be possible. We must deliver what we promise to ensure that we maintain farmer confidence and, for this reason, we worked hard to turn around the crosses in time for planting—no small task.

In the absence of PR:

- No crosses with local varieties would have been possible. Crosses could have been done with bank collections, but farmers would not have had "ownership" in the final product, which would likely impact adoption and dissemination of the new variety within the community.

Box 6. Impact of surveys (elicitation of farmer preferences and knowledge) and diagnostic needs assessment.

Elicitation of the traits they value.

PR impact (were the process or outcomes influenced by stakeholder participation?):

- Yes, with farmers' help we identified and prioritized the traits in maize that they valued. These traits were used as the basis to identify some of the interventions that we did later, such as focusing on storage and providing training to improve seed selection practices.

What would have been the process or outcome in the absence of PR?

- We would have focused on agronomic traits only, mainly on yield of grain. Thanks to this activity, we identified that storage, yield by volume and of dough, as well as stability under stressful conditions were important traits for them.

Knowledge gaps in farmers' understanding of maize reproduction as a sexual process as identified in participatory diagnostic.

PR impact:

- Training was designed to teach farmers about maize reproduction and breeding principles.

In the absence of PR:

- Without identification of knowledge gaps, farmer training interventions would not have been included in the project at all, and the final varietal selection would have been very different.

Baseline surveys.

PR impact:

- Basic socio-economic constraints have been identified that may be tackled through the project's activities. This information will help us to measure the impact at the end of the project.

In the absence of PR:

- That information would not have been available.

continued...

Box 6. Impact of surveys (elicitation of .....*cont'd*

Farmer surveys to characterize the maize cropping system in Kenya.

PR impact:

- Yes, in the light of earlier surveys, the survey methodology was modified to make it more efficient (survey questions and sampling strategy) that also allowed us to inform farmers of the technology and to understand what their main sources of information are.

In the absence of PR:

- Without the surveys, we would not be able to map the refugia in Kenya, neither would we have understood the information pathways to reach maize farmers.

Identification of production constraints and profitability issues raised by small-scale farmers.

PR impact:

- Yes, farmers identified drought and storage losses as the major constraints in all regions and it was these traits that were incorporated into local varieties through controlled crosses.

In the absence of PR:

- The correct traits for incorporation may not have been properly identified. We assume that yield is most important, but farmers may face other constraints that are poorly understood by breeders.

Survey farmers on storage practices and perceived losses due to storage pests of maize.

PR impact:

- Yes, as farmers provided considerable detail on store management that then led to other researchable issues.

In the absence of PR:

- We would have an incomplete picture of storage constraints and health issues associated with on-farm storage.

Quantify storage losses by placing grain samples in farmers' stores.

PR impact:

- No, this was just an observational component of the project to physically quantify losses.

In the absence of PR:

- No quantitative data would have been generated that truly reflected on-farm storage conditions.

Farmer-developed resource-allocation mapping.

PR impact:

- The process provided a platform for discussing whole-farm resource-allocation strategies and how new technologies can be integrated into the system.

In the absence of PR:

- The relative importance of different technologies for specific land and farmer types would not have been easy to identify.

Stakeholder meetings.

PR impact:

- Direct interface with the bankers, government officials and big importers. This made it possible for each group to hear about the others' problems, needs and also suggestions.

In the absence of PR:

- Farmers would never have had an opportunity to meet with these other stakeholders, so there would have been no direct feedback from the real users.

Group formation.

PR impact:

- Group members included all categories of farmers (cash croppers, subsistence, marginal as well as landless). In addition, women were included. This made it possible for all categories to use the technologies.

In the absence of PR:

- All categories might not have had an opportunity to use the technology (power tiller). In fact, the power tiller could have been only for "demonstration" at the research farms and at the most at the fields of the bigger farms but operated by the research-farm technicians.

Participatory planning.

PR impact:

- Farmers actively participated in developing the action-plan, so they decided on the timing, the participants and the types of training they wanted.

In the absence of PR:

- It would have been as the earlier result with the farming-systems approach; i.e., no impact.

Box 7. Impact of training.

Training on seed selection and storage practices.

PR impact (were the process or outcomes influenced by stakeholder participation?):

- Farmer participation was crucial. This was an intervention that we believe helped empower farmers by providing key information missing in their local knowledge, that had been leading to bad decisions, such as incorrect use of pesticides during grain storage.

What would have been the process or outcome in the absence of PR?

- Farmers would not have had access to knowledge that they found very valuable.

Box 8. Impact of participatory monitoring and evaluation.

Monitoring the consequences of participation.

PR impact (were the process or outcomes influenced by stakeholder participation?):

- Yes, because this activity allowed us to assess the impacts of our project on the farmers, and to learn from them. A lesson was that the benefits from some of the most important interventions were difficult to quantify (i.e., access to diversity), while the costs were easy to quantify.

What would have been the process or outcome in the absence of PR?

- We would not have been able to evaluate the impacts of the project interventions.

6. Discussion of Results

Characteristics of participatory projects

Among the CIMMYT projects with participatory components, the most commonly cited goal was that of at increasing productivity (broadly defined, but especially aiming for improved performance under various stresses). The main motivation for using participatory methods was to understand farmers' preferences better. Primary beneficiaries of CIMMYT participatory research projects are marginal farmers, but beneficiaries are not generally differentiated by gender. An "average" CIMMYT participatory research project lasts for less than five years, has an annual budget of less than US$100,000, works in Asia or Africa, and has six project sites, involving 400 farmers and eight scientists. That said, there is a great range and diversity in the self-defined participatory projects at CIMMYT.

CIMMYT participatory research projects can be viewed as collaborative activities that bring together the scientific and local knowledge and efforts of all stakeholders to improve upon the status quo. The biggest obstacle to participatory research is an approach in which beneficiaries are thought of as objects of research and not as actors. Of the 19 projects surveyed, 15 targeted farmers, but only one specified multiple beneficiaries. Given that nearly three-quarters of the projects also stated in the survey that the motivation for stakeholder participation was to understand farmers' preferences and constraints better, this lack of recognition of multiple beneficiaries (especially the scientists) may be due to the conventional notion of "project beneficiaries" seen as synonymous with "end-users of the technology," and less emphasis placed on benefits to scientists.

It is well-documented in many empirical studies that most agricultural innovations affect men and women differently (Doss 1999). There was a noticeable absence of gender focus in the survey results. This does not necessarily imply exclusion of gender concerns by the projects in actual research activities, only the lack of disaggregation of beneficiaries by gender. Only one project targeted women and children specifically. One other project had used a "whole family training" approach, which included wives and other adult females in households.

Type of participatory research approach used

The type of participatory research conducted influences the outcome of the process. The type of participatory research is shaped by the stage at which stakeholder involvement takes place and the types of activities in which stakeholders are involved (Johnson et al. 2003; Morris and Bellon 2004). As mentioned in the literature review, the decision about the type of participatory research to use depends largely on whether the project's primary objectives are *functional* or *empowering*. The two are not mutually exclusive, but in a given project emphasis typically falls more on one or the other. Empowering can mean giving farmers the ability to take more control of the technology options available to them and make informed decisions about their farming practices. Participatory *approaches* with either functional or empowering objectives can achieve both functional and empowering *outcomes*. In economic development, the empowering approach focuses on mobilizing the self-help efforts of the poor and is less often associated with the use of a single type of participatory activity or tool.

In this survey, half the projects applied participatory tools either during priority-setting only or during technology testing only; the other half used participatory tools at more than one stage of research. Most projects (15 out of 19) applied a single participatory tool. These two facts combined (stage and methods) can be used to characterize the types of participatory research the projects applied, which under certain circumstances could be linked to outcomes. Most CIMMYT projects surveyed appeared to be associated with functional types of participatory methods, but we do not have the necessary information to link the use of methods directly to types of outcomes.

Respondents for three-quarters of the projects said their primary reasons for involving stakeholder participation were to increase the relevance of research and to bring about more demand-driven research and extension by better understanding farmers' preferences and constraints, and to use farmer knowledge in technology evaluation and development. This can be interpreted as a functional approach, with an emphasis on co-learning. Respondents for a quarter of the projects said their main motivation was to involve stakeholders in technology dissemination and to improve their awareness—and hence the reach—of the technology. Our interpretation is that these projects also have a functional, but more action-oriented approach, where emphasis is placed on translating new knowledge into improved farmer practices through participatory dissemination. Both of these functionally-motivated approaches may also lead to greater farmer empowerment.

Quality of science in participatory research

Regarding the potential advantages of participatory approaches, several methodological issues related to blending scientific and local knowledge require careful consideration (Campbell 2001; Berardi 2002). Rather surprisingly, none of the scientists in the survey said that participatory research would be best suited for all aspects of the research continuum; about two-thirds said it was best suited for technology evaluation, testing, and dissemination, and one-third said the participatory research approach was best suited for priority-setting activities. The answers may reflect two opposing attitudes and situations. One is where research has identified what is believed to be a set of suitable technology options, and interaction with farmers is believed to increase adoption by informing farmers about the options through experimental learning plus better, farmer-to-farmer dissemination. The other situation may reflect the opinion that farmers have a key role in defining the research priorities, but less of a role in developing the technology options.

Most participatory research at CIMMYT has a functional objective, aimed basically at either increasing research efficiency—that is, generating "better" research products—or at fostering the diffusion of these products by enhancing the awareness and knowledge of potential beneficiaries. For example, as the physical and economic resource bases of different groups necessitate tailored research, the functional approaches allow scientists to direct their research according to the needs of specific groups of farmers and specific environments. Working with farmers can assure scientists that they are assessing trade-offs among variety traits and management practices "correctly and under real-life conditions," which fosters increased adoption.

More empowering objectives to participatory research would aim at increasing farmer knowledge and skills, so that farmers can participate more fully in the collaborative breeding efforts and be better at their own personal efforts.

Empowering approaches to participatory research are not merely about increasing farmers' awareness. As most CIMMYT projects are concerned with understanding farmer preferences, less focus is on targeting, equity concerns, or building the skill of participants. For example, many scientists felt at the onset of the project that farmers needed to learn about new varieties and management practices. The apparent emphasis on raising farmers' awareness is understandable, if we think that the limiting factor in scientist–farmer exchanges is farmers' (limited) knowledge base. Thus, in marginal areas and smallholder farm settings, exposure to new genotypes and best-bet management options would be a first requirement for effective interactions.

The fact that most respondents said farmers needed more information could be viewed in two contexts. On one hand, it may reflect the prior understanding of farmers' needs and constraints in relation to improved varieties, management, and resource-conservation techniques. On the other hand, it may reflect scientists' biases: that formal-sector research has fully identified solutions to farmer problems and constraints. Four-fifths of the respondents said that it was determined from the outset of projects that farmers needed more information.

Participatory research has its origins in qualitative methods, and the use of these methods is most often associated with social scientists. Interestingly, 13 out of 18 respondents to the CIMMYT survey were biophysical scientists. The survey method did not allow for assessment of scientists' competence in participatory methods, as doing so would have required more detailed individual interviews and field observations. Instead, we asked about their "comfort level" in use of participatory methods, but this should not be understood as a proxy for competence.

Responses bespeak a very high level of confidence in the use of participatory methods, yet hardly any of the respondents had training in participatory research. Some of the answers reflected the common attitude that the use of participatory methods is "common sense," requires little or no formal training, and is easy for "people-oriented" researchers.

There seems to be a positive perception of participatory research among most practitioners across the institute. The majority considered participatory methods most appropriate for technology and varietal evaluation and testing. Rather surprisingly, although there is apparent comfort in extending the methods combined with a perception that colleagues at CIMMYT appreciate participatory research, the majority of scientists said that they had never been asked to advise on participatory research. This suggests that there is a lack of communication and sharing of knowledge and experience among them. It may be problematic, given that most scientists are self-taught in participatory methodologies. They felt comfortable using the methods after one year and with extending the methods to others after two years, but they do not seem to have any formal training on participatory research. In many cases they may be "reinventing the wheel," or their work may not be as efficient as it could be. Furthermore, this suggests a lack of institutional space to share and learn from the extensive and valuable experience being generated by CIMMYT scientists.

Three facets of CIMMYT participatory research are expected to further foster and promote peer acceptance of new approaches and allow for faster scaling up in research efforts: namely, that biophysical scientists (and not just social scientists) are involved in participatory projects, that there seems to be an interdisciplinary approach in most projects, and because these projects seem rather well connected to pre-existing networks of scientists and other projects.

Institutional issues

Participatory methods enhance ongoing activities, establishing research partnerships that result in more relevant technology by complementing existing farmer experimentation and by improving farmers' ability to use and understand professional researchers' methods. The cornerstone of participatory research is farmers' active search for and evaluation of ideas and options. Limitations and challenges to achieving the above include:

1. Most programs' chief concern with evaluating, adapting, and extending technologies developed previously by the formal research system—this is what our results show too.
2. Perceived problems associated with reduced researcher control and most evident in on-farm trial activities. There is no clear, broad trend towards client participation in the testing stages of research.

This model of participation—farmers actively involved in research—is often set as an "ideal type." The evidence from this study suggests that while information flows go both ways between scientists and farmers, the dominant information flow is still top-down or researcher directed. This is consistent with studies in Nepal (Gauchan et al. 2000; Biggs and Smith 2003). What this implies is that participatory research (with its two-way information flows) conducted within a linear, pipeline model of innovation still has a dominant supply-driven agenda.

In short, it is unrealistic to think that these two-way information flows will occur without structural adjustments in the institution; or rather, if they do, such flows will most likely be isolated to an individual research experience in the field and to a researcher with capacity or experience in participatory approaches. Additionally, any research process can stimulate some sort of information feedback from end-users, but that in itself does not constitute "participation," in the sense implied by participatory research.

The survey results show limited interaction among CIMMYT participatory projects. One possible explanation is that there is sometimes a tendency for individual scientists or projects to "trademark" their participatory methodology with an excessive focus on participatory acronyms (Berardi 2002). This is good, as it shows a sense of ownership regarding participatory methodologies developed, but can be problematic if it leads to seeing the development of technical solutions as a separate, isolated effort.

Benefits and costs

The scientists' perceptions of the differences participation made in the research process or outputs (reported as "impacts" in Boxes 5–8) are rather "outcomes" (*see* Section 2.6), and these are compared with the expected outcomes had participation not been used (again in Boxes 5–8). At least conceptually, these perceptions provide a sort of counterfactual regarding participation. Box 9 presents a synthesis of the outcomes derived from these perceptions—these clearly are not impacts, since the link to changes in the beneficiaries' livelihoods have not been documented or measured; however, they are fundamental, being a necessary but not sufficient condition for impact.

The identified outcomes can also be the subject of a more rigorous study and of monitoring. Furthermore, since the outcomes have been identified, it may be easier to make predictions about the potential impacts that may be associated with them. These predictions could then be the basis for more rigorous quantitative analyses that link research process and outputs to livelihood changes. Such a study would have to address the perceptions of the outcome of participation from the perspectives of the beneficiaries and other stakeholders, and would require additional work and funds.

The benefits of a research project are evaluated against its costs. The survey results show a diversity of views about costs: some respondents said there were additional costs, while others did not think so. Furthermore, it is clear that in many cases comparing the costs of participatory research to those of more conventional research may not be meaningful, because the two approaches are so different. It seems that for CIMMYT practitioners, participatory research may not entail additional costs or, if it does, the results justify the expense.

In reality, research is often shaped by both conventional and participatory activities. It would be erroneous simply to conclude that participatory research is more costly than conventional research. The share of the overhead and personnel costs often remains fixed, and operations are adjusted according to the availability of funds. Participatory research usually affects operational costs the most, and not always by increasing them, especially if it replaces other activities. If participatory research is implemented as an add-on activity, then the research costs are likely to increase (Lilja and Aw-Hassan 2003).

Nearly half the survey responses on the impact of participatory research provided examples of impact of variety and technology evaluation and showed the improvement over the status quo in understanding farmers' preferences, experiences, needs, and social and production constraints, as well as solutions this knowledge may offer to the collaborative research process. The results imply success in shortening the time-lag between technology development and adoption, which has important implications for overall returns to research investment.

Examples of impact in the section "elicitation of farmer preferences and knowledge" (11 out of 27 surveys) and diagnostic needs assessment show the benefits of broader socio-economic information, how it can help determine actual beneficiaries in various social strata or resource-dependent groups, and specific preferences and constraints for each. Such information can also

Box 9. Outcomes associated with participatory research at CIMMYT.

- Increased diversity.
- Demonstrated the value of diverse maize landraces to farmers.
- Demonstrated the farmers' preference for OPVs over hybrids, particularly under stress conditions.
- Provided farmers with access to seed and promoted faster adoption.
- Made farmers aware of new varieties and fostered faster adoption.
- Provided farmers with varieties with valued traits.
- Increased the ability of farmers to evaluate resource-conserving technologies and assess their benefits.
- Minimized the error of developing varieties that farmers do not want (or with traits they do not value) or are not relevant for their preferences and circumstances.
- Developed research products (varieties) that are relevant for users that value multiple characteristics.
- Understood the constraints faced by farmers; established baselines to assess impacts.
- Made the research process more efficient by identifying pathways to reach farmers.
- Understood the context in which new technology has to operate.
- Allocated technologies to appropriate niches in the farming system.
- Provided farmers with information from other stakeholders that have impact on their lives.

help point in advance to unintended impacts—both positive and negative—of a project on different groups within the project area.

Concluding remarks

The amount of money associated with what is claimed to be participatory research is rather surprising—approximately US $9 million per year. While this refers to research that has participatory components, and may not reflect specific expenditures in participatory activities, this level of investment clearly indicates that participatory research is more than just a marginal activity in the institute. CIMMYT may need to consider investing additional resources to create a more conducive environment for scientists to share experiences and learn from each other, and in doing so add value to this research endeavor, or else participatory research may become a meaningless, catch-all term used for data collection or the analytical phase of research. Furthermore, this may also require more investment in documenting the outcomes and impacts of participatory research at CIMMYT. We believe that, by identifying the projects and the outcomes associated with participation, the research reported here is laying the groundwork for further advances in this area.

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